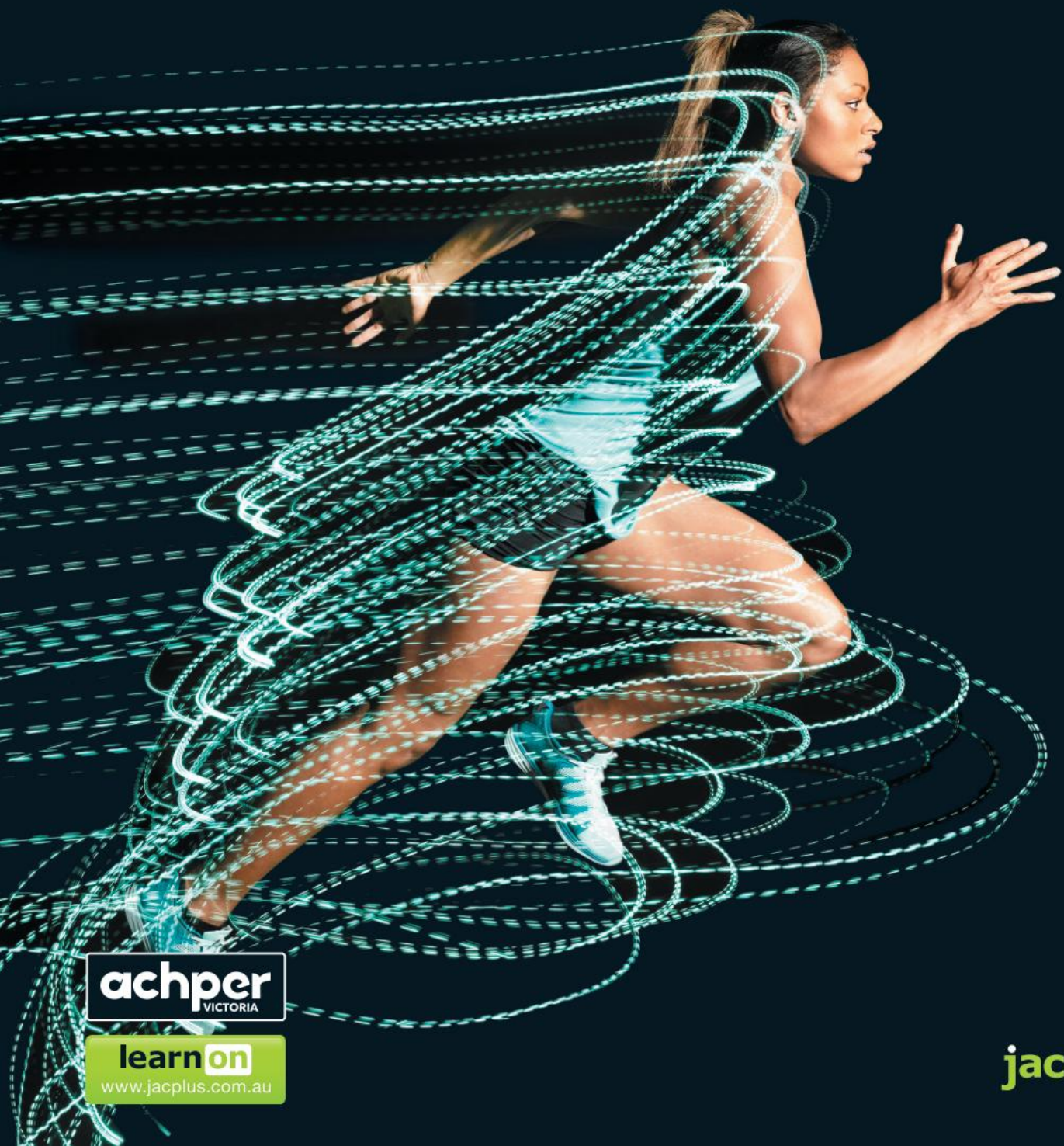
O'KEEFFE | ROSCOE | RAYNER | BARR | GEAR

JACARANDA

LIVE IT UP 1

VCE PHYSICAL EDUCATION | UNITS 1 AND 2

FIFTH EDITION



achper VICTORIA

learnon www.jacplus.com.au

jacaranda
A Wiley Brand

JACARANDA

LIVE IT UP 1

VCE PHYSICAL EDUCATION | UNITS 1 AND 2

FIFTH EDITION

MICHELLE O'KEEFFE

SHANNON ROSCOE

JEFF RAYNER

CORINNE BARR

PAUL GEAR

achper VICTORIA

jacaranda
A Wiley Brand

Fifth edition published 2024 by
John Wiley & Sons Australia, Ltd
Level 4, 600 Bourke Street, Melbourne, Vic 3000

First edition published 1999
Second edition published 2006
Third edition published 2011
Fourth edition published 2017

Typeset in 10.5/13 pt TimesLTStd

© Australian Council for Health, Physical Education and Recreation, Victorian Branch, 1999, 2006, 2011, 2017, 2024

The moral rights of the authors have been asserted.

ISBN: 978-1-394-26940-2

Reproduction and communication for educational purposes

The Australian *Copyright Act 1968* (the Act) allows a maximum of one chapter or 10% of the pages of this work, whichever is the greater, to be reproduced and/or communicated by any educational institution for its educational purposes provided that the educational institution (or the body that administers it) has given a remuneration notice to Copyright Agency Limited (CAL).

Reproduction and communication for other purposes

Except as permitted under the Act (for example, a fair dealing for the purposes of study, research, criticism or review), no part of this book may be reproduced, stored in a retrieval system, communicated or transmitted in any form or by any means without prior written permission. All inquiries should be made to the publisher.

Trademarks

Jacaranda, the JacPLUS logo, the learnON, assessON and studyON logos, Wiley and the Wiley logo, and any related trade dress are trademarks or registered trademarks of John Wiley & Sons Inc. and/or its affiliates in the United States, Australia and in other countries, and may not be used without written permission. All other trademarks are the property of their respective owners.

Front cover image: © Henrik Sorensen/Getty Images

Typeset in India by diacriTech

A catalogue record for this book is available from the National Library of Australia

The Publishers of this series acknowledge and pay their respects to Aboriginal Peoples and Torres Strait Islander Peoples as the traditional custodians of the land on which this resource was produced.

This suite of resources may include references to (including names, images, footage or voices of) people of Aboriginal and/or Torres Strait Islander heritage who are deceased. These images and references have been included to help Australian students from all cultural backgrounds develop a better understanding of Aboriginal and Torres Strait Islander Peoples' history, culture and lived experience.

It is strongly recommended that teachers examine resources on topics related to Aboriginal and/or Torres Strait Islander Cultures and Peoples to assess their suitability for their own specific class and school context. It is also recommended that teachers know and follow the guidelines laid down by the relevant educational authorities and local Elders or community advisors regarding content about all First Nations Peoples.

All activities in this resource have been written with the safety of both teacher and student in mind. Some, however, involve physical activity or the use of equipment or tools. **All due care should be taken when performing such activities**. To the maximum extent permitted by law, the author and publisher disclaim all responsibility and liability for any injury or loss that may be sustained when completing activities described in this resource.

The publisher acknowledges ongoing discussions related to gender-based population data. At the time of publishing, there was insufficient data available to allow for the meaningful analysis of trends and patterns to broaden our discussion of demographics beyond male and female gender identification.

Contents

Meet our author team vi
Learning with learnON vii
Acknowledgements xiv
Exam terminology xv

UNIT 1 THE HUMAN BODY IN MOTION 1

UNIT 1 AREA OF STUDY 1 HOW DOES THE MUSCULOSKELETAL SYSTEM WORK TO PRODUCE MOVEMENT?

1 Structure and functions of the musculoskeletal system 2
- **1.1** Overview 2
- **1.2** The structure and function of the skeletal system 4
- **1.3** The structure and function of the muscular system 19
- **1.4** Muscle fibre characteristics and functions 25
- **1.5** Neural control of muscles 33
- **1.6** Types of muscular contractions 38
- **1.7** Interactions of muscles and bones to produce movement 43
- **1.8** Key skills 48
- **1.9** Review 51

2 Injuries and illnesses of the musculoskeletal system 58
- **2.1** Overview 58
- **2.2** Injuries and illnesses of the musculoskeletal system 59
- **2.3** Physiological strategies to prevent musculoskeletal injuries 71
- **2.4** Physical aids to support the musculoskeletal system 78
- **2.5** Key skills 85
- **2.6** Review 88

3 Performance enhancement of the musculoskeletal system 92
- **3.1** Overview 92
- **3.2** Permitted methods that enhance performance of the musculoskeletal system: training 94
- **3.3** Permitted substances that enhance the performance of the musculoskeletal system: nutritional supplements 101
- **3.4** Prohibited substances and methods that enhance performance of the musculoskeletal system: hormones 117
- **3.5** Key skills 123
- **3.6** Review 125

UNIT 1 AREA OF STUDY 1 REVIEW 130
Extended response — Build your exam skills 130
Practice examination ..... online only
Practice school-assessed coursework ..... online only

UNIT 1 AREA OF STUDY 2 WHAT ROLE DOES THE CARDIORESPIRATORY SYSTEM PLAY IN MOVEMENT?

4 Structure and functions of the cardiovascular system 136
- **4.1** Overview 136
- **4.2** Exploring the cardiovascular system's structure and function – heart, blood and blood vessels 138
- **4.3** Role of the cardiovascular system in thermoregulation 148
- **4.4** Responses of the cardiovascular system to physical activity 153
- **4.5** Key skills 161
- **4.6** Review 163

5 Structure and functions of the respiratory system 167

5.1 Overview 167
5.2 The respiratory system — structure and functions 169
5.3 The respiratory system — mechanics of breathing and gaseous exchange 173
5.4 Responses of the respiratory system to physical activity 181
5.5 Summary of the interaction of the cardiovascular and respiratory systems during physical activity 186
5.6 Key skills 191
5.7 Review 194

6 Enhancing the performance of the cardiorespiratory system 198

6.1 Overview 198
6.2 The impact of regular aerobic exercise on the cardiovascular and respiratory systems 200
6.3 Enhancing the performance of the cardiorespiratory system: permitted substances and methods 204
6.4 Enhancing the performance of the cardiorespiratory system: prohibited substances and methods 212
6.5 Ethical and social considerations for using permitted and prohibited substances and methods 219
6.6 Key skills 227
6.7 Review 229

UNIT 1 AREA OF STUDY 2 REVIEW 234
Extended response — Build your exam skills 234
Practice examination ..... online only
Practice school-assessed coursework ..... online only

UNIT 2 PHYSICAL ACTIVITY, SPORT, EXERCISE AND SOCIETY 237

UNIT 2 AREA OF STUDY 1 HOW DO PHYSICAL ACTIVITY, SPORT AND EXERCISE CONTRIBUTE TO HEALTHY LIFESTYLES?

7 Physical activity and sedentary behaviour: sociocultural influences, enablers and barriers 238

7.1 Overview 238
7.2 Types of physical activity 240
7.3 Benefits of maintaining an active lifestyle 244
7.4 Sociocultural enablers and barriers to physical activity 250
7.5 Physical activity and sedentary behaviour guidelines 258
7.6 Prevalence and trends in physical activity, physical inactivity and sedentary behaviour 265
7.7 Methods of assessing physical activity and sedentary behaviour 273
7.8 Key skills 282
7.9 Review 285

8 Strategies to increase physical activity and reduce sedentary behaviour 290

8.1 Overview 290
8.2 The social-ecological model 292
8.3 Population-based initiatives that promote physical activity 305
8.4 Key skills 316
8.5 Review 319

9 Promoting physical activity through a personalised plan 324

9.1 Overview 324
9.2 Health-related fitness components and factors 326
9.3 Functional Movement Assessment 332
9.4 Creating a personalised physical activity plan 337
9.5 Evaluating a personalised physical activity plan 342
9.6 Key skills 345
9.7 Review 349

UNIT 2 AREA OF STUDY 1 REVIEW 353
Extended response — Build your exam skills 353
Practice examination online only
Practice school-assessed coursework online only

UNIT 2 AREA OF STUDY 2 WHAT ARE THE CONTEMPORARY ISSUES ASSOCIATED WITH PHYSICAL ACTIVITY AND SPORT?

10 Intrapersonal issues 358
10.1 Overview 358
10.2 Hormonal considerations 360
10.3 Injuries 367
10.4 Psychological skills 375
10.5 Mental fitness in physical activity and elite pathways 383
10.6 Key skills 390
10.7 Review 392

11 Interpersonal issues 396
11.1 Overview 396
11.2 Geographic location 398
11.3 Coaching 406
11.4 Sports technology and the media 414
11.5 Institutional and structural inclusion and equity 423
11.6 Gender equity 433
11.7 Key skills 443
11.8 Review 445

UNIT 2 AREA OF STUDY 2 REVIEW 449
Extended response — Build your exam skills 449
Practice examination online only
Practice school-assessed coursework online only

Glossary 452
Index 458

Meet our author team

Michelle O'Keeffe

Michelle is an experienced VCE Physical Education and Health and Human Development teacher. She has served as a VCAA Physical Education examination assessor for over two decades. Throughout her career she has created numerous school-assessed coursework and examinations across Units 1–4 Physical Education and has also presented at ACHPER conferences. Michelle has authored content for the last two editions of Jacaranda *Live It Up* and has an extensive understanding of the Physical Education curriculum.

Shannon Roscoe

Shannon is a distinguished Health and Physical Education teacher and Learning Specialist at Kambrya College, where he has held many influential positions, including Head of Assessment, Curriculum and Reporting, Sports Coordinator, and Year 12 VCE coordinator. He has experience teaching Senior Health and Physical Education Studies at Deakin University and has led the creation of school-assessed coursework and examinations in PE for other esteemed organisations. Shannon was also a VCAA Physical Education assessor for many years.

Jeff Rayner

Jeff has taught across Australian, United Kingdom and International Baccalaureate curricula while teaching Physical Education in Melbourne, London and Hong Kong schools. He is an experienced exam moderator in the UK and has held a number of leadership positions including Assistant Principal, Head of Department and Head of Year. Currently, he is the Director of Learning & Development – Professional Learning at De La Salle College.

Corinne Barr

Corinne is a passionate and dedicated Physical Education teacher who graduated from Deakin University with distinction. She has taught VCE PE for several years and held pivotal roles as a Learning Specialist in Teaching Practice and Head of Health and Physical Education at Mullauna College. Currently based in Western Australia, she teaches Physical Education Studies at a specialist Year 11 and 12 College.

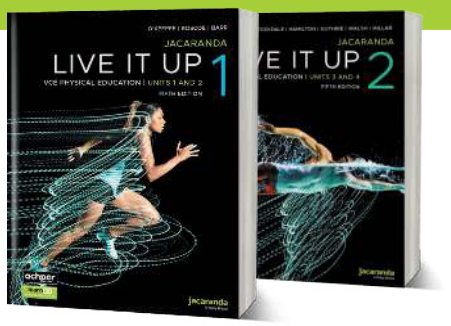
Paul Gear

Paul has taught VCE Physical Education for 10 years and in this time has been a year-level coordinator, Head of Wellbeing, and is currently a Learning Specialist of Engagement and Development for Senior School at Balwyn High School. He has also been a VCAA PE exam assessor and has presented at a number of PE conferences for curriculum development, assessment tools and engagement strategies.

Learning with learnON

ALIGNED TO THE

VCE Physical Education Study Design (2025–2029)



JACARANDA

LIVE IT UP 1 VCE

PHYSICAL EDUCATION
UNITS 1 & 2 5E

Developed by teachers for students

Tried, tested and trusted. The fifth edition of the Jacaranda Live It Up VCE Physical Education series, completely revised and updated, with a toolkit of resources to simplify concepts and encourage learning through participation. Freeing up time in your day to have more impact in the classroom and support every student – from the athlete to the academic.

Because both *what* and *how* students learn matter

Learning is personal

Whether students need a challenge or a helping hand, you'll find what you need to create engaging lessons.

Whether in class or studying at home, students can progress and achieve success! Scaffolded lessons with visuals and practical activities help students connect theory to practice. Automarked, differentiated, question sets with detailed solutions, alongside new quick quizzes and video eLessons that explain key concepts.

Learning is effortful

Learning happens when students push themselves.

With learnON, Australia's most powerful online learning platform, students can challenge themselves, build confidence and ultimately achieve success.

Learning is rewarding

Through real-time results data, students can track and monitor their own progress and easily identify areas of strength and weakness.

And for teachers, Learning Analytics provide valuable insights to support student growth and drive informed intervention strategies.

Learn online with Australia's most

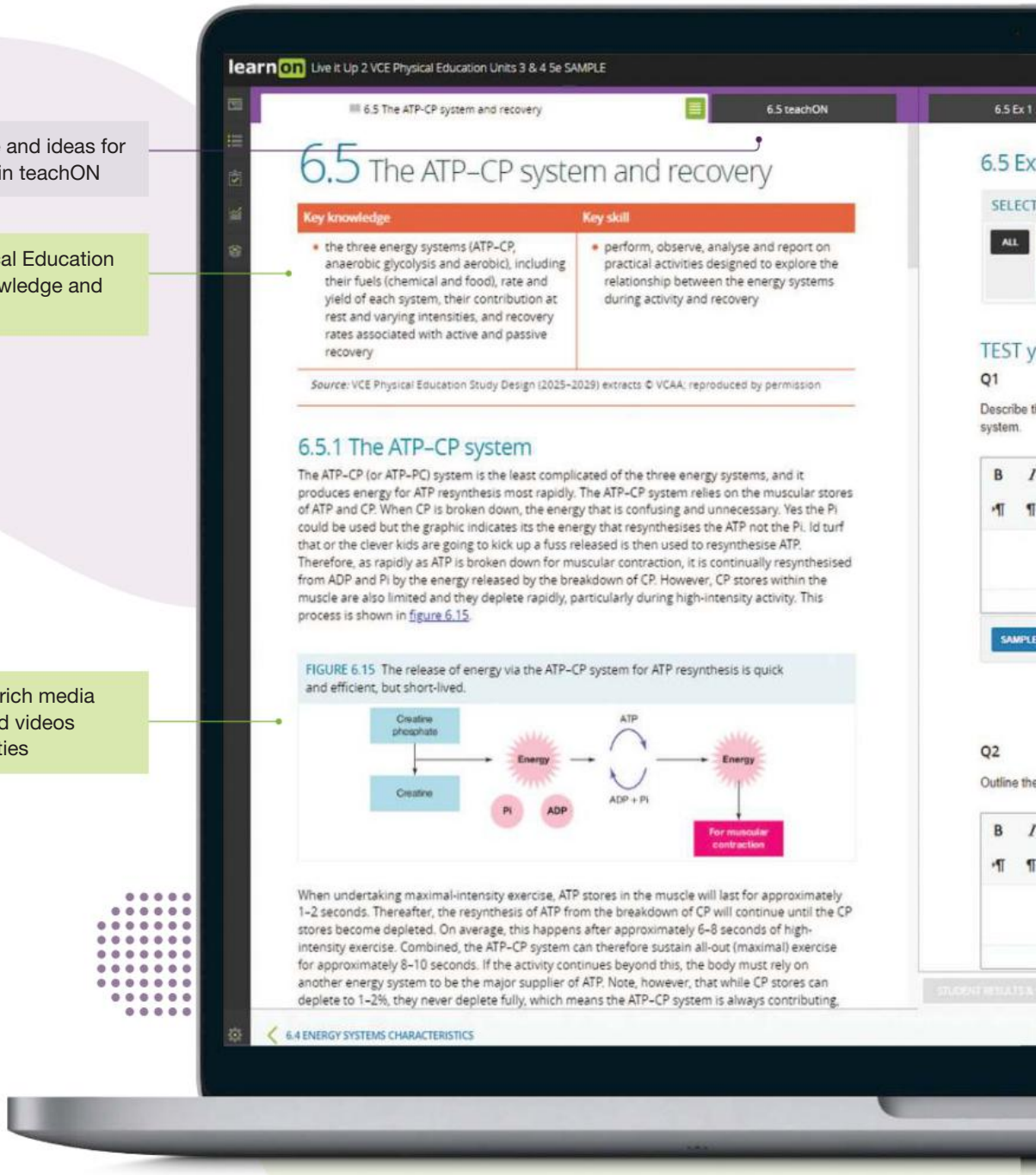
Everything you need for each of your lessons in one simple view

- **Aligned to the VCE Physical Education Study Design**
- **Engaging, rich multimedia**
- **All the teaching-support resources you need**
- **Deep insights into progress**
- **Immediate feedback for students**
- **Create custom assignments in just a few clicks.**

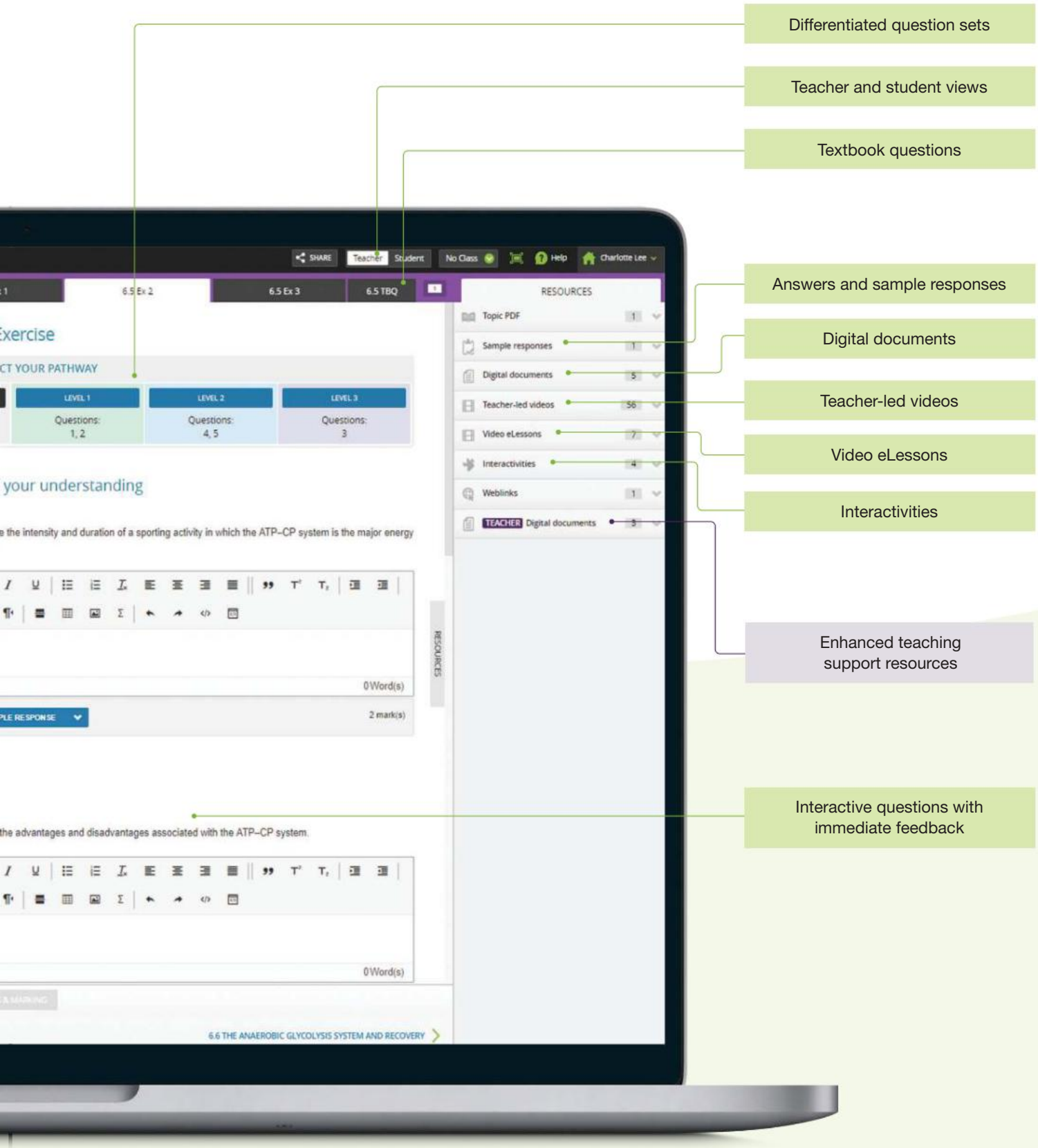
Practical teaching advice and ideas for each lesson provided in teachON

Links to the VCE Physical Education Study Design Key knowledge and Key skills

Reading content and rich media including embedded videos and interactivities



powerful learning tool, learnON

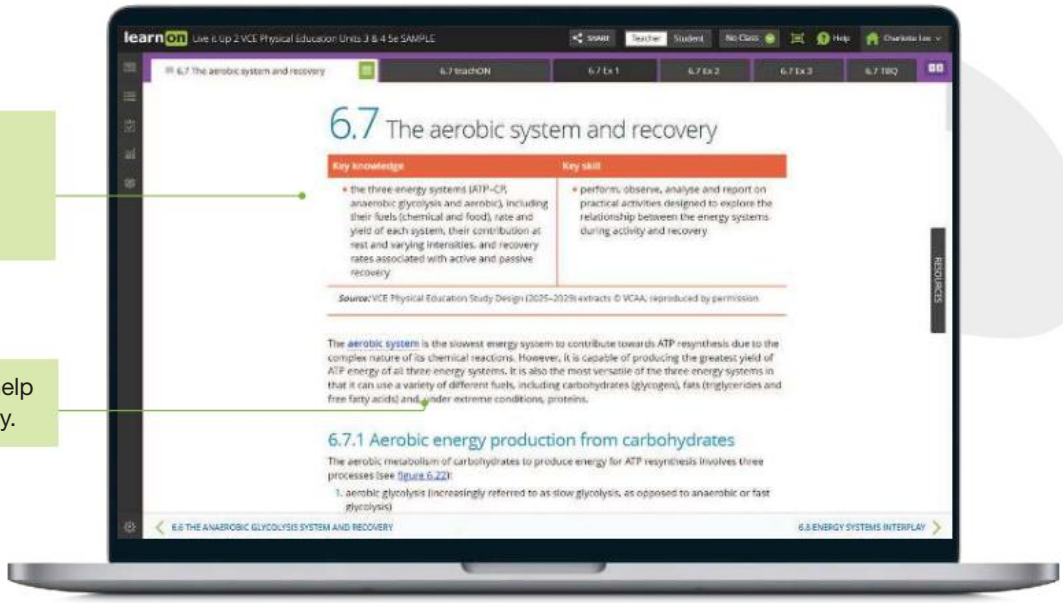


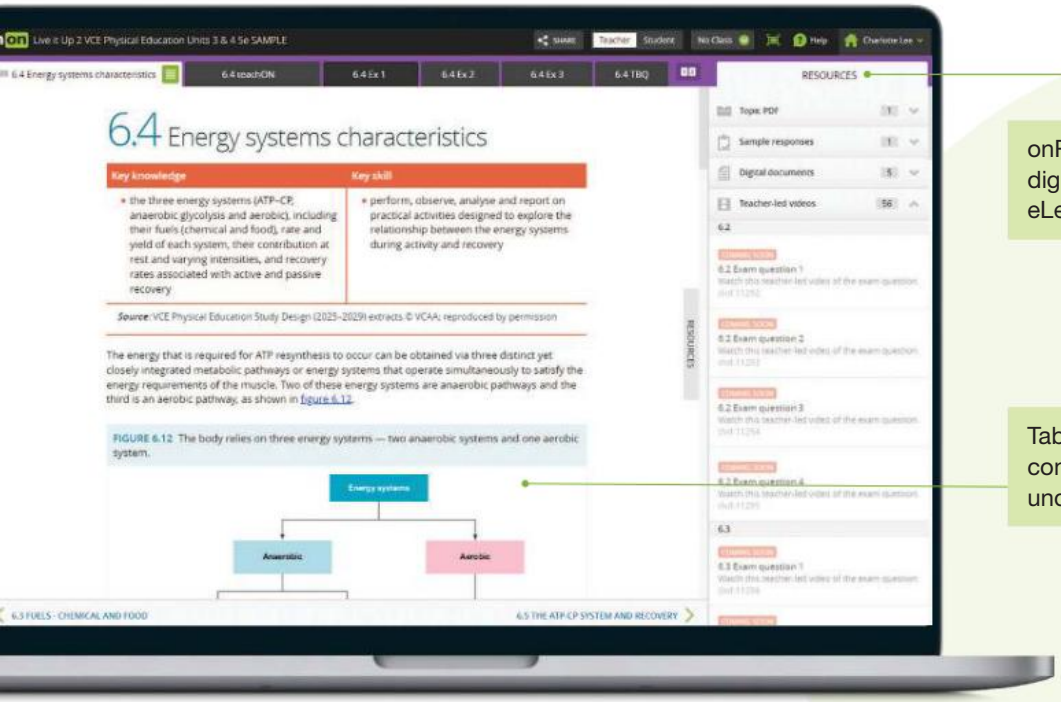
Online, these new editions are the complete package

Trusted Jacaranda theory, plus tools to support teaching and make learning more engaging, personalised and visible.

Each topic is linked to the Key knowledge and Key skills from the VCE Physical Education Study Design.

Interactive glossary terms help develop and support literacy.



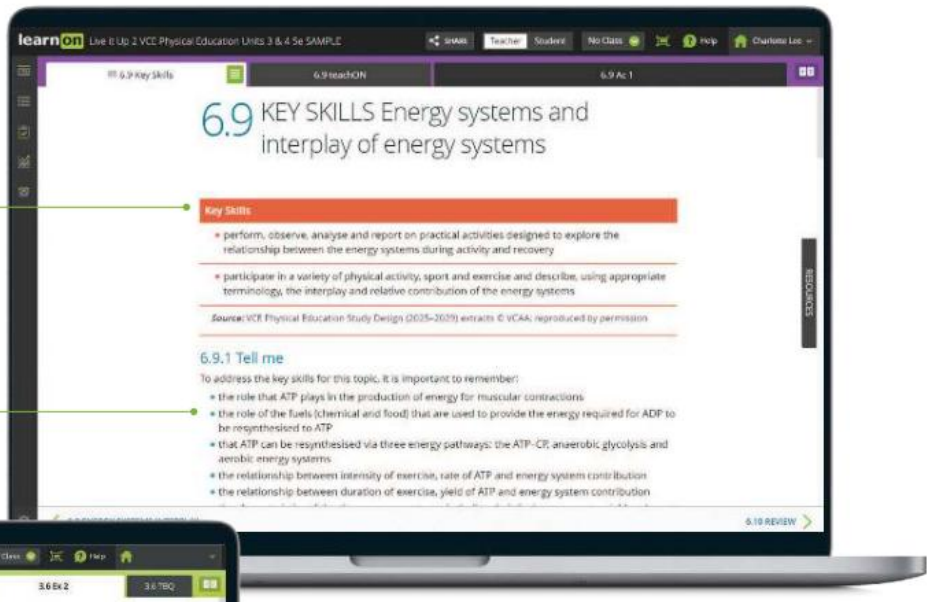


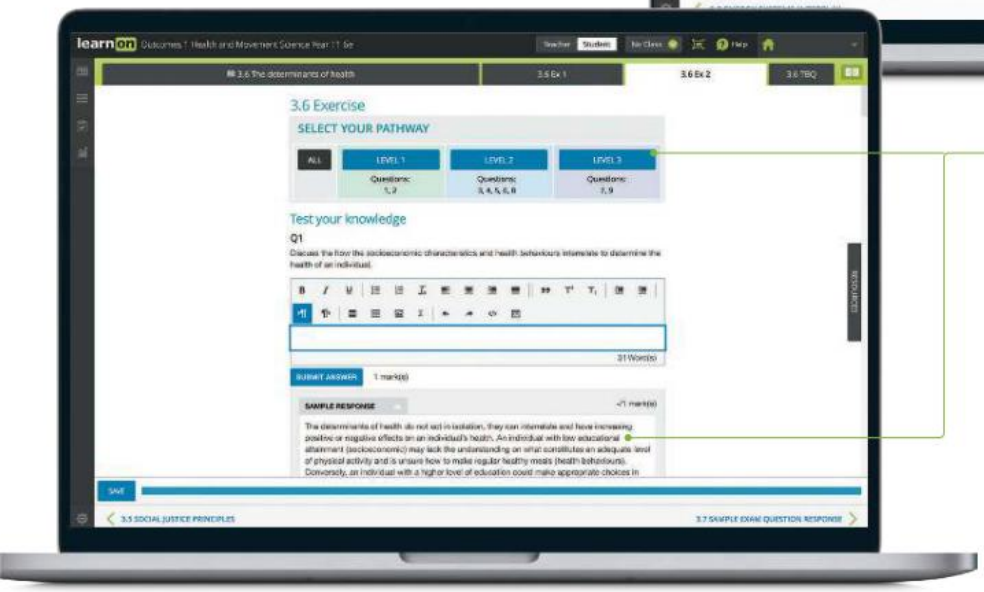
onResources link to targeted digital resources including video eLessons and weblinks.

Tables and images break down content, allowing students to understand complex concepts.

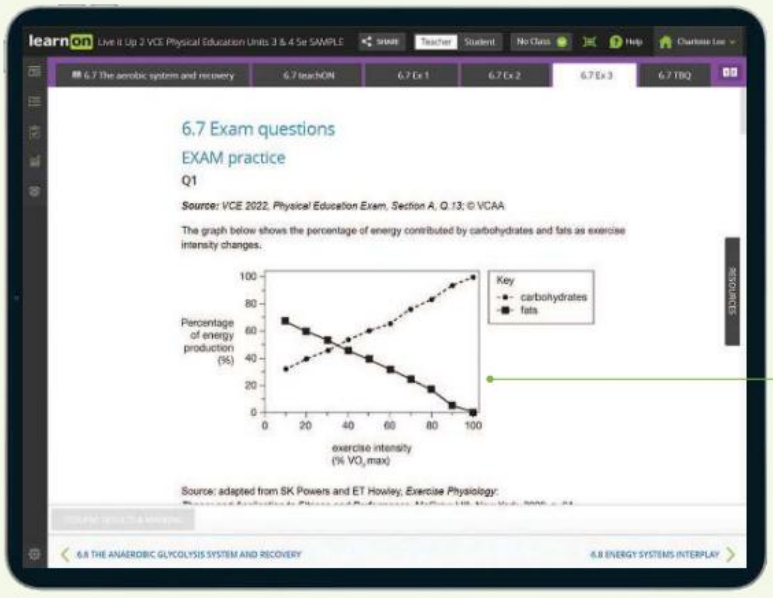
Breakdown and practice of Key skills.

Application of Key skills in each topic.





Online and offline differentiated question sets, with immediate feedback, help students to overcome misconceptions as they occur and to challenge themselves at their own level.

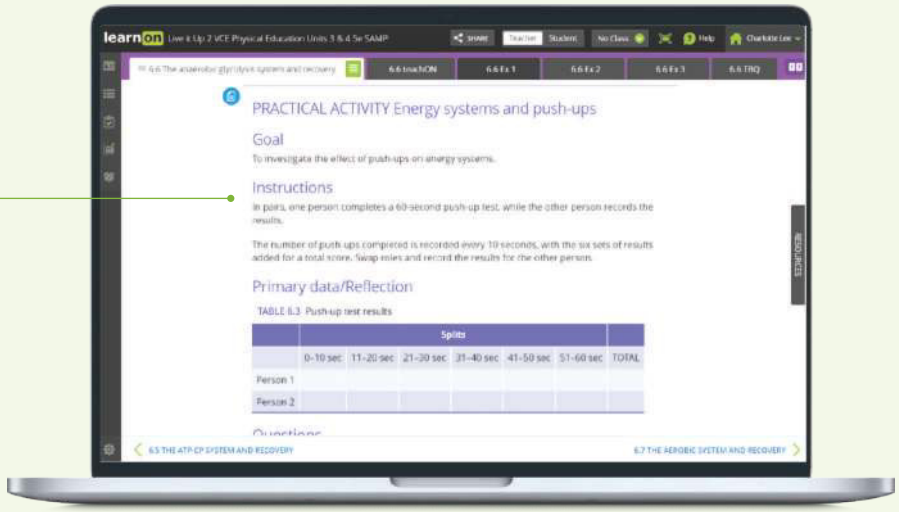


Online and offline exam questions with immediate feedback are available in each subtopic.

Practical activities and reflective folio

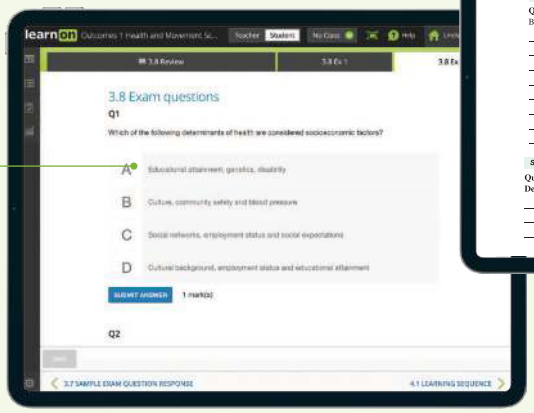
Practical activities in each topic to develop theoretical skills in a practical way.

Digital access to a reflective folio.



Get exam-ready with VCAA questions!

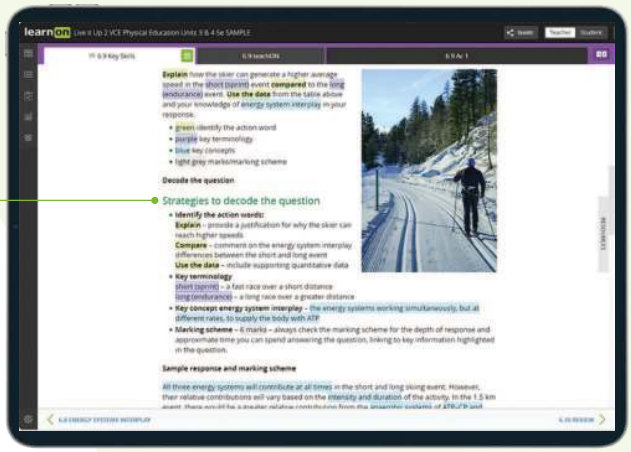
Topic-level review questions are structured with multiple choice and short answer exam questions.



Customisable practice exam question booklets are available in every topic to build student competence and confidence.

Area of Study Review

- For each Area of Study, students can practice Extended Response questions.
- Trial examination and practice school-assessed coursework can be accessed and assigned online to capture valuable student data.



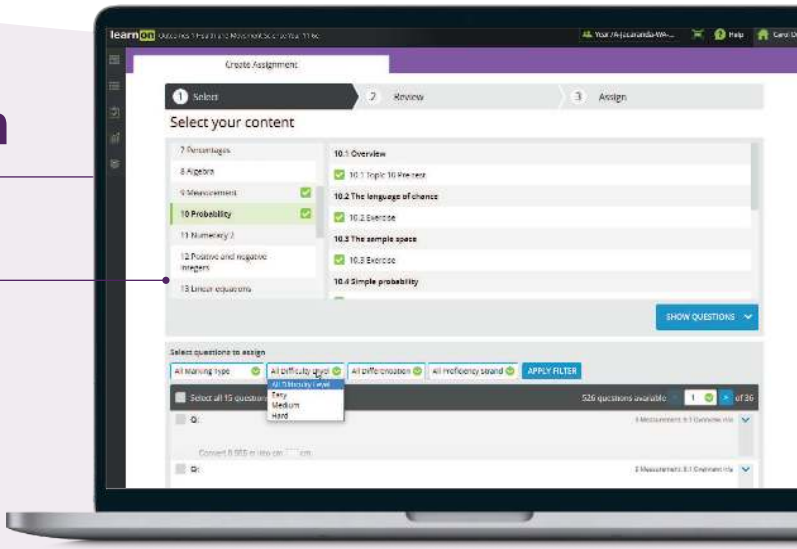
Teaching with learnON

A wealth of enhanced teaching-support resources for every lesson, including:

- work programs and curriculum grids
- teaching advice and additional activities
- quarantined topic tests (with solutions)
- custom exam-builder with question filters

Customise and assign

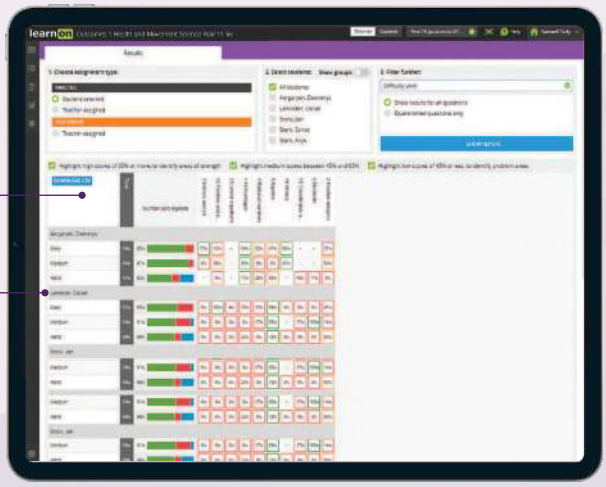
A testmaker enables you to create custom tests from the complete bank of thousands of questions.



Reports and results

Data analytics and instant reports provide data-driven insights into performance across the entire course.

Show students (and their parents or carers) their own assessment data in fine detail. You can filter their results to identify areas of strength and areas for improvement.



Acknowledgements

ACHPER Acknowledgement

The Jacaranda *Live It Up* series is an exciting and valuable resource for teachers, students, and the broader educational environment. It has been created to meet the modern school environment, curriculum and pedagogical models while providing a platform for multi-model learning.

The author team for the Jacaranda *Live It Up* series represents highly experienced, knowledgeable and leading educational experts. The Australian Council for Health, Physical Education and Recreation (ACHPER) Victorian Branch acknowledges Michelle O'Keeffe, Shannon Roscoe, Jeff Rayner, Corinne Barr and Paul Gear for their contribution to the development of this learning resource.

ACHPER Victoria's purpose is to enable all people to lead active and healthy lives. We are the association that unites health and physical education professionals, including but not limited to sports, recreation, physical activity and education technology. We do this by combining to share knowledge, skills, research and understanding and bring these benefits to the broader community.

Kate Simpson

President ACHPER Victoria

The authors and publisher would like to thank the following copyright holders, organisations and individuals for their assistance and for permission to reproduce copyright material in this book.

VCAA Acknowledgement

Selected extracts from the VCE Physical Education Study Design (2025–2029) are copyright Victorian Curriculum and Assessment Authority (VCAA), reproduced by permission. VCE® is a registered trademark of the VCAA. The VCAA does not endorse this product and makes no warranties regarding the correctness or accuracy of its content. To the extent permitted by law, the VCAA excludes all liability for any loss or damage suffered or incurred as a result of accessing, using or relying on the content. Current VCE Study Designs and related content can be accessed directly at www.vcaa.vic.edu.au. Teachers are advised to check the VCAA Bulletin for updates.

The full list of acknowledgements can be found here:

www.jacaranda.com.au/acknowledgements/#2024

Every effort has been made to trace the ownership of copyright material. Information that will enable the publisher to rectify any error or omission in subsequent reprints will be welcome. In such cases, please contact the Permissions Section of John Wiley & Sons Australia, Ltd.

Exam terminology

The following terms are often used in the VCE Physical Education exam. Refer back to this list when answering the activities, practice exam questions and extended response to ensure you understand what each question is asking you to do.

Key term	What does it mean?
Analyse	Examine the components of; look for links, patterns, relationships and anomalies
Apply	Use your knowledge and relate it to the given case study/scenario
Assess	Weigh up the value of outcomes, results, significance, nature or extent of something
Comment	Make relevant remarks about
Compare	Show similarities and/or differences
Contrast	Show differences
Critique	Evaluate in a detailed and analytical way, judge the strengths/weaknesses and suggest improvements
Define	Give the precise meaning of a key term or concept
Describe	Provide a general description
Discuss	Give an overall account of all aspects of a concept
Draw conclusions	Make reasoned decisions or judgements
Evaluate	Make a judgement, weigh up the positives/negatives, strengths and limitations
Explain	Make plain, make clear (may require reasons), give additional detail
How	The way in which something happens
Identify	List, state
Illustrate	Use examples to show understanding
Justify	Give reasons and/or evidence to support a point of view
List	Provide single word responses, or very brief points
Outline	Provide an overview or brief summary, usually within a sentence
Suggest	State ideas
To what extent	Describe the degree or level to which a statement, opinion or contention is correct or valid
What	Provide information about something
Why	Give the reason for something

UNIT 1

AREA OF STUDY 1

How does the musculoskeletal system work to produce movement?

OUTCOME 1

On completion of this unit, the student should participate in and analyse information from a variety of practical activities to explain how the muscular and skeletal systems function and interact to produce movement, and evaluate the use of performance enhancement substances and methods.

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

TOPIC SEQUENCE

1 Structure and functions of the musculoskeletal system 2

2 Injuries and illnesses of the musculoskeletal system 58

3 Performance enhancement of the musculoskeletal system 92

UNIT 1 AREA OF STUDY 1 REVIEW

Extended response — Build your exam skills 130

Practice examination ..... online only

Practice school-assessed coursework ..... online only

1 Structure and functions of the musculoskeletal system

1.1 Overview

Hey students! Bring these pages to life online

Watch videos

Engage with interactivities

Answer questions and check results

Find all this and MORE in jacPLUS

LEARNING SEQUENCE

1.1 Overview
1.2 The structure and function of the skeletal system
1.3 The structure and function of the muscular system
1.4 Muscle fibre characteristics and functions
1.5 Neural control of muscles
1.6 Types of muscular contractions
1.7 Interactions of muscles and bones to produce movement
1.8 Key skills
1.9 Review

1.1.1 Introduction

The skeletal and muscular systems work together to produce movement in physical activity, and one cannot function without the other. The different bones and joints have a number of functions and work with skeletal muscles to form a lever system to create movement.

The bones provide the framework for muscles to attach to. Muscles cross joints, pulling on them to allow contractions to occur.

Knowledge of the different muscle fibre types, the range of muscle contractions and how muscles are stimulated to move by the central nervous system is essential for the developing sportsperson.

In this topic, you will explore the major components of the skeletal and muscular systems and how they interact to produce movement in physical activity, sport and/or exercise.

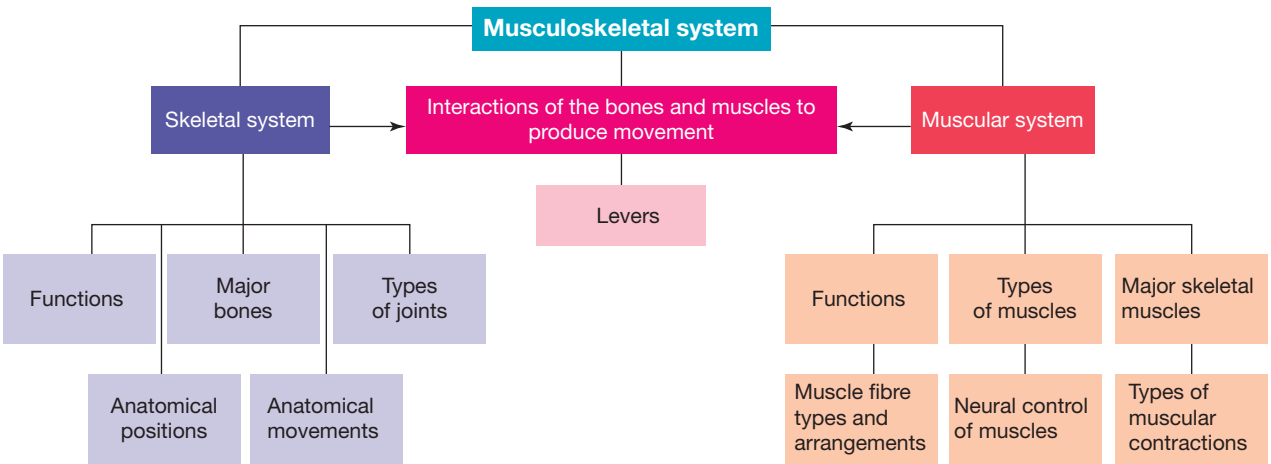
FIGURE 1.1 The bones, muscles and joints work together to form forming a lever system that allows movement to occur.

1.1.2 Key knowledge and Key skills

Key knowledge	Key skills	Subtopic
• structure and function of the skeletal system: – bones of the human body – classification of joints – joint actions	• apply and use anatomical terminology to identify the structures and functions of the muscular and skeletal systems in producing movement	**1.2**
• major muscles of the human body	• apply and use anatomical terminology to identify the structures and functions of the muscular and skeletal systems in producing movement	**1.3**
• characteristics and functions of muscle fibres such as fibre arrangement and type (fast twitch and slow twitch)	• apply and use anatomical terminology to identify the structures and functions of the muscular and skeletal systems in producing movement	**1.4**
• types of muscular contractions (concentric and eccentric and isometric)	• examine different types of muscle contractions and differentiate the role of agonists, antagonists and stabilisers in movement	**1.6**
• concept of reciprocal inhibition (the role of agonists, antagonists and stabilisers)	• examine different types of muscle contractions and differentiate the role of agonists, antagonists and stabilisers in movement	**1.6**
• neural control of muscles including the recruitment (size principle) and activation (all or nothing principle) of motor units in relation to force production	• investigate and describe the relationship between motor unit recruitment, activation and force production in movement	**1.5**
• interactions of muscles and bones to produce movement, including the structure and examples of anatomical lever systems	• participate in and analyse a variety of movements used in physical activity, sport and/or exercise to explain the interaction between bones, muscles, joints and joint actions using examples of lever systems responsible for producing movement	**1.7**

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

1.1.3 Topic preview



1.2 The structure and function of the skeletal system

Key knowledge	Key skill
• structure and function of the skeletal system: – bones of the human body – classification of joints – joint actions	• apply and use anatomical terminology to identify the structures and functions of the muscular and skeletal systems in producing movement

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

1.2.1 Functions of the skeletal system

The musculoskeletal system is made up of the skeletal system (bones, joints, ligaments and tendons) and muscular system (muscles). The skeletal system is made up of 206 bones and encompasses all the bones, every joint and corresponding ligaments.

The **skeletal system** has five main functions:

- body movement (the most important function to understand in Physical Education)
- framework
- protection
- mineral storage
- production of red blood cells.

Body movement

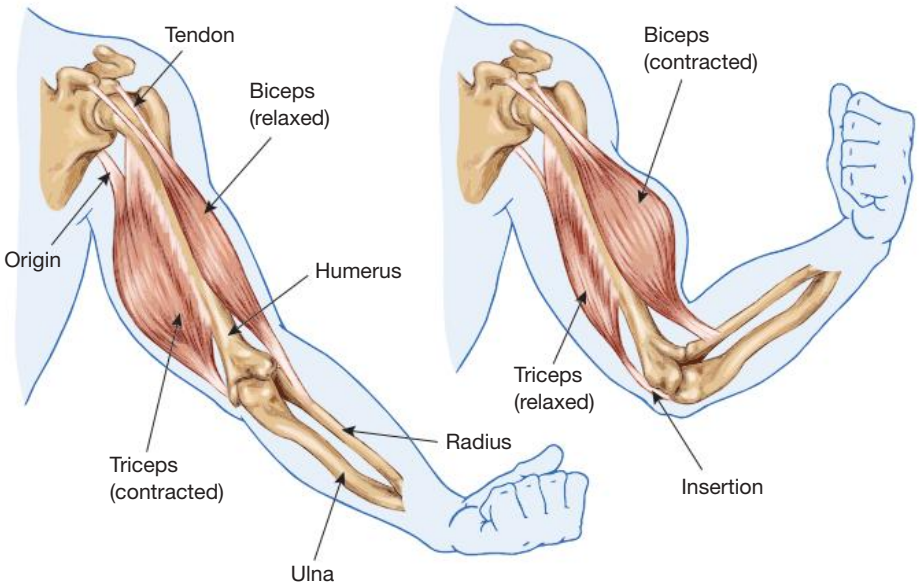
The human body has 206 bones, all of which provide sites for muscle attachment. The bones act as levers and work with the muscular system to create movement. When a muscle contracts, it pulls on the bone to which it is attached and thus movement occurs. Any irregularity on a bone's surface provides a possible site for a muscle attachment. Figure 1.2 illustrates the sites for the triceps muscle attachments.

Framework and protection

The skeleton provides a solid framework for the body and helps battle the forces of gravity. Everyone has a solid skeleton, but the differences in people's posture demonstrate the interdependence of the skeletal and muscular systems in maintaining correct posture.

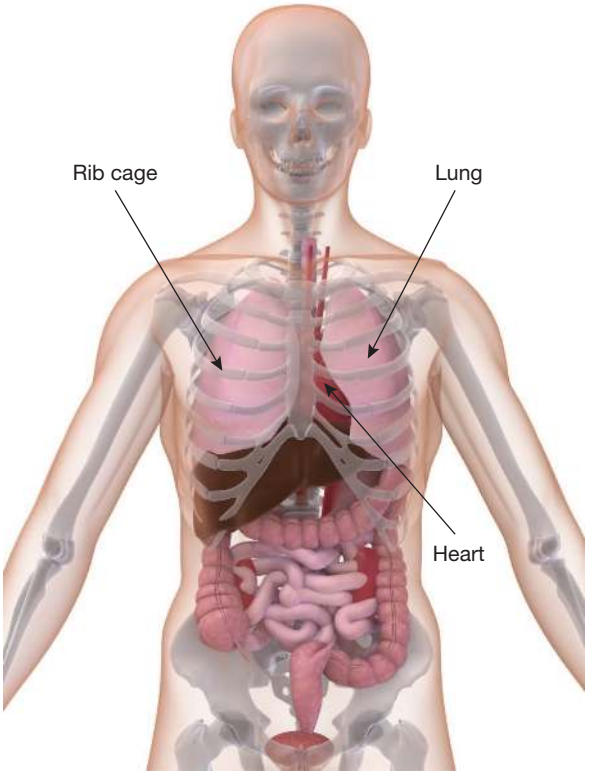
skeletal system a rigid structure made of bones that provides support, protection and sites to which muscles attach to create movement

FIGURE 1.2 Bones offer ready attachments for muscle tendons.



The strong protective skeletal layer provides protection for many vital body organs. This is particularly evident when the rib cage is examined (see figure 1.3). This naturally enclosing shell effectively protects the heart and lungs from all but the most traumatic of injuries.

FIGURE 1.3 The ribs provide protection to the vital organs of the body.



Types of bone tissue

- *Compact bone*, which is found in the shaft or diaphysis of the long bone. This comparatively solid bone surrounds the cavity of the long bone (see figure 1.4), offering an extremely strong structure that gives the body its rigid framework. Collagen is a central ingredient in providing compact bone rigidity and tensile strength (as it is with cancellous bone). In some ways the skeleton is stronger and more durable than concrete.
- *Cancellous bone* (also described as spongy bone, being less dense than compact bone), which provides some of the shock absorption required at the end of long bones or at the edges of more irregular bones.

Mineral storage

Bone tissue efficiently stores a number of minerals that are important for health. **Calcium**, phosphorus, sodium and potassium all contribute to the health and maintenance of bone tissue as well as carrying out other roles in the body. Calcium also assists with muscular activity.

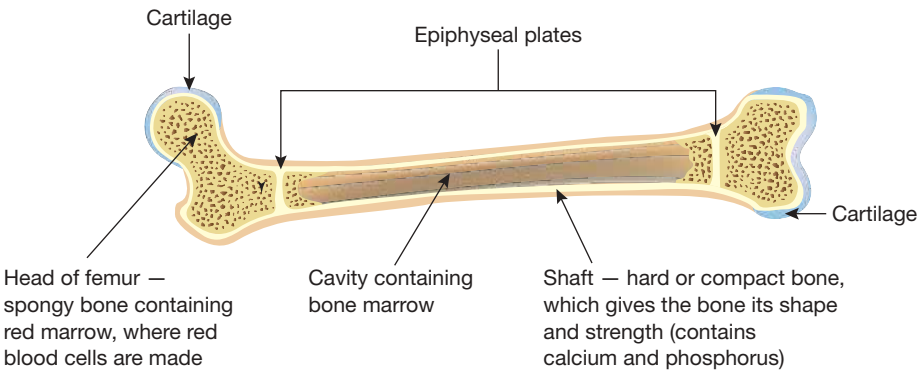
Production of red blood cells

Essential production of new red blood cells occurs within the cavity of long bones. Production levels are high during growth years, diminishing as age increases and the need for high rates of red blood cells decreases. Such cells are essential for oxygen transportation throughout the body. **Haemoglobin**, a protein inside red blood cells, transports oxygen molecules from the lungs to the body. Much of an adult's bone cavity is filled with yellow bone marrow, which is a source of long-term energy (see figure 1.4).

calcium a mineral found mainly in the hard part of bones and which is essential for healthy bones. It is also important for muscle contraction, nerve transmission, enzyme activity and blood clotting.

haemoglobin a substance found in red blood cells that transports oxygen around the body

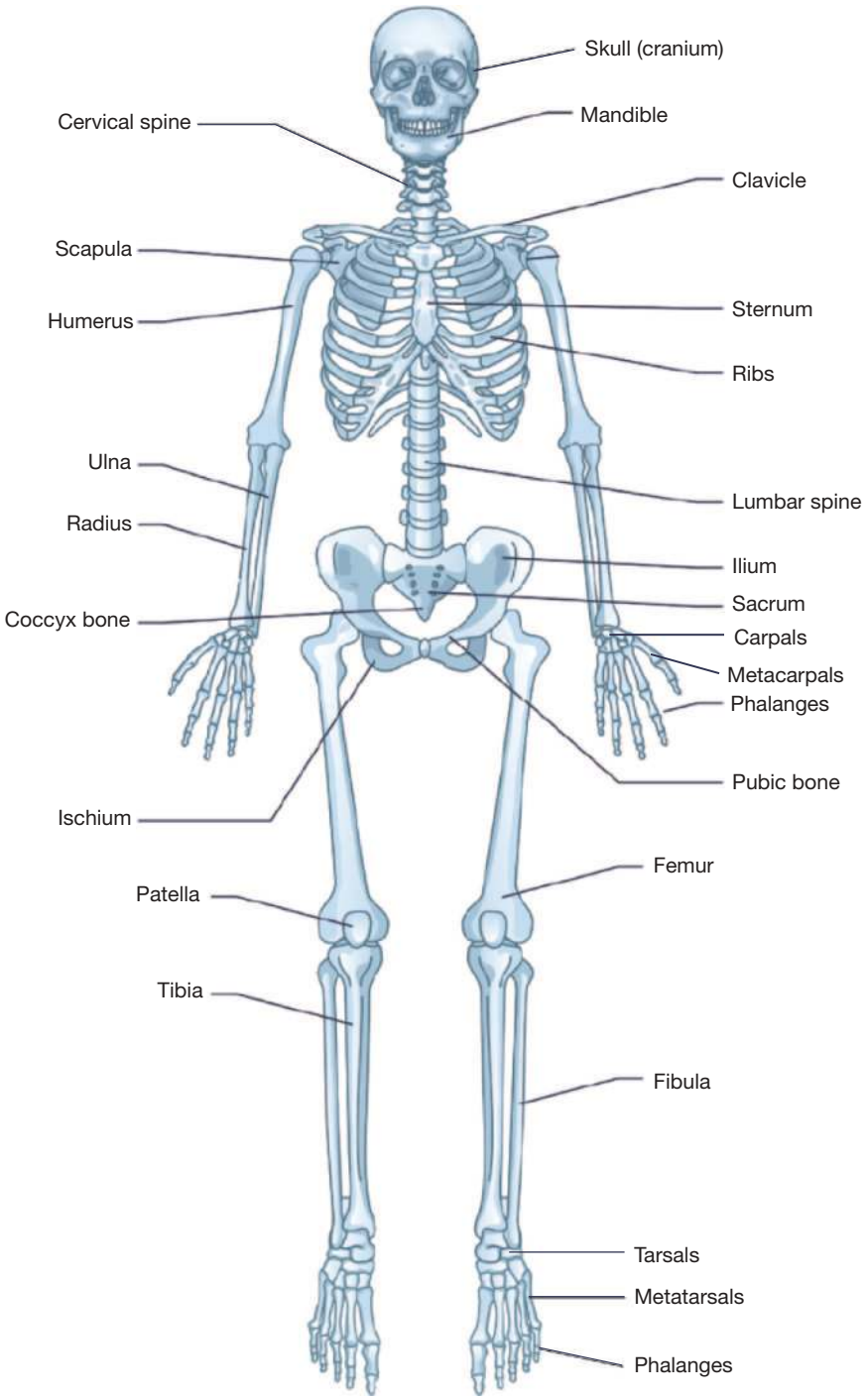
FIGURE 1.4 A long bone



1.2.2 Major bones of the skeletal system

The major bones of the skeletal system are shown in figure 1.5.

FIGURE 1.5 Major bones of the skeletal system



EXAM TIP

Correct anatomical terminology is required when identifying bones. Be sure to use this and not the common names.

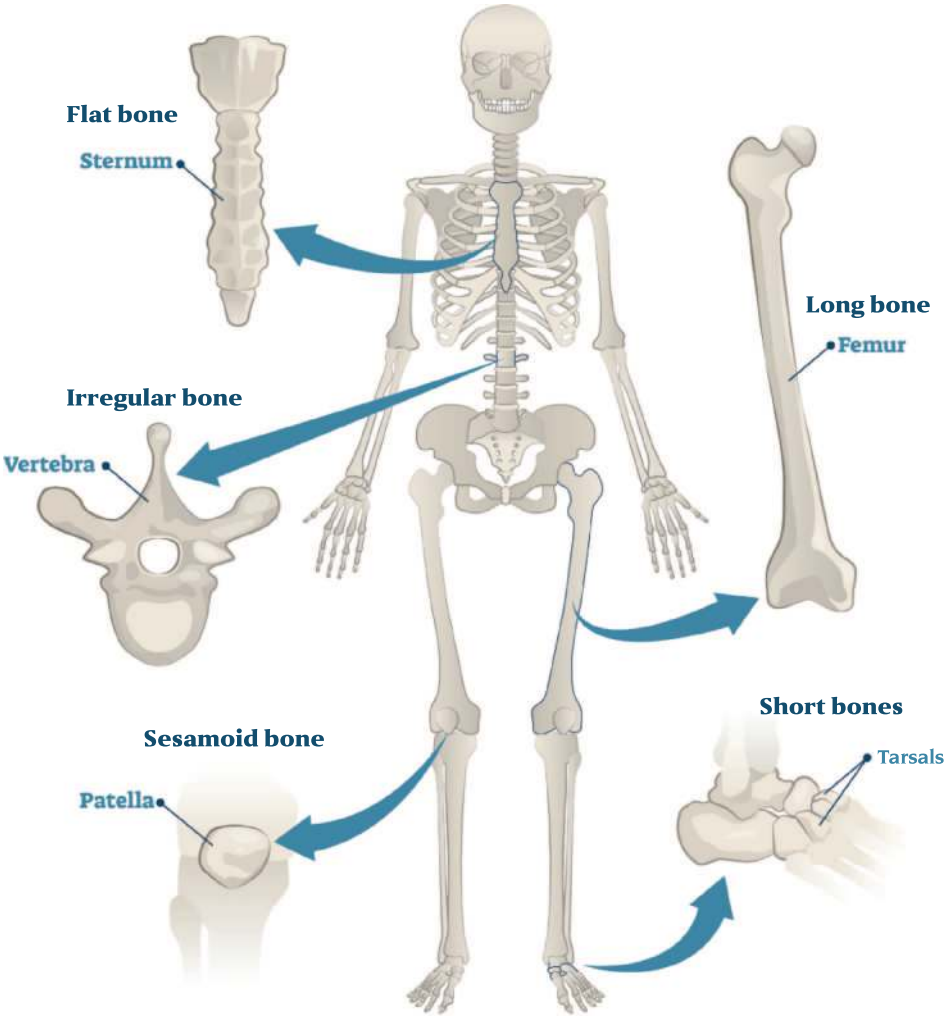
For example, *mandible* not jaw, *scapula* not shoulder blade.

1.2.3 Types of bone

There are five types of bone in the human body, distinguished by their shape.

1. *Short bones* are roughly cubical, with the same width and length; for example, the carpals of the wrist and the tarsals of the foot.
2. *Long bones* are longer than they are wide, and they have a hollow shaft containing marrow (see figure 1.6); for example, femur, phalanges and humerus.
3. *Sesamoid bones* are small bones developed in tendons around some joints; for example, the patella at the knee joint.
4. *Flat bones* provide flat areas for muscle attachment and usually enclose cavities for protecting organs; for example, scapula, ribs, sternum and skull.
5. *Irregular bones* have no regular shape characteristics; for example, vertebrae and bones of the face.

FIGURE 1.6 Examples of bone types



on Resources

Interactivities	Major bones of the skeletal system (int-6616) Common and anatomical names of bones (int-6618)
Weblink	Types of bone
Digital document	Skeleton (doc-41903)

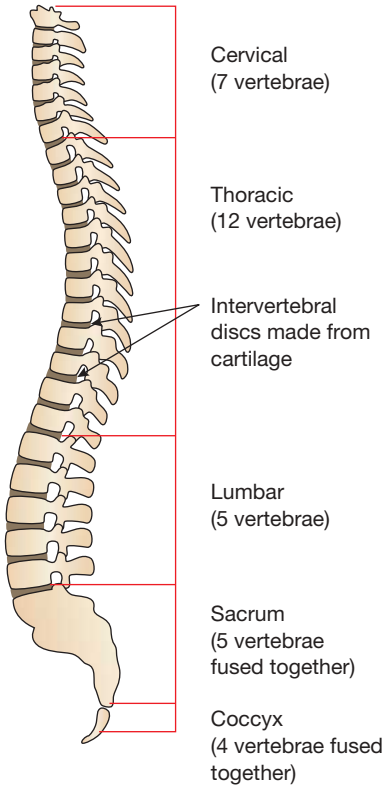
1.2.4 Vertebral column

The **vertebral column** (also called the spine) provides the central structure for the maintenance of good posture. If a person maintains the correct levels of strength and flexibility in all the muscle groups that connect with the vertebral column, then they are likely to avoid postural problems.

The vertebral column has some special features:

- Each vertebra has a hollow centre (see figure 1.6). This is to protect the spinal cord that travels through it, and which controls most conscious movement within the body.
- The **vertebrae** increase in size as they descend from the cervical to the lumbar region (see figure 1.7). This helps them support the weight of the body.
- Movement between two vertebrae is very limited. But the range of movement of the vertebral column as a whole is considerable, allowing bending and twisting.
- Intervertebral discs separate each of the vertebrae in the cervical, thoracic and lumbar regions. They absorb shock caused by movement and allow the vertebral column to bend and twist.

FIGURE 1.7 Side view of the vertebral column showing the five main sections



on Resources

Interactivity Sections of the spine (int-6617)

TABLE 1.1 The sections of the vertebral column

Section	Amount of vertebrae	Function
Cervical	7	Supports the head. The atlas and axis (top two vertebrae) allow the head to move up, down and side to side.
Thoracic	12	Connects the ribcage to the vertebral column
Lumbar	5	Supports the weight of the body and provides attachment for large muscles
Sacrum	5 fused	Fused part of the pelvis
Coccyx	4 fused	Base of the vertebral column (tailbone) and site for muscle attachment

vertebral column (or spine) the column of irregular bones comprised of three distinct curves that provides the body's central structure for the maintenance of good posture

vertebrae the 33 moveable and immoveable bones that make up the vertebral column

epiphyseal plates (or growth plates) the growth centre of developing bones

1.2.5 Bone growth and health

Epiphyseal plates, also known as growth plates, are the centres for bone growth. Found at the ends of the diaphysis or shaft of the long bone (see figure 1.4), these plates are visible under x-ray and may be damaged when injured. The rate of growth of a leg, for example, may diminish if the leg is broken during growth years. However, following injury repair, the leg's rate of growth will usually accelerate until the legs are again growing equally. The majority of bone growth occurs during infancy and adolescence and has usually stopped by early adulthood.

1.2.6 Classification of joints

The skeleton has three major joint types. These joints are classified by how the bones are joined together and by the movement that each joint permits.

- *Fibrous* (immoveable) joints offer no movement. Examples include the skull (see figure 1.8), pelvis, sacrum and sternum.
- *Cartilaginous* (slightly moveable) joints are joined by cartilage and allow small movements. Examples include the vertebrae (see figure 1.9) and where the ribs join the sternum.
- *Synovial* (freely moveable) joints offer a full range of movement and move freely in at least one direction. Examples include the knee or shoulder (see figure 1.10).

FIGURE 1.8 Immoveable fibrous joints form the skull.

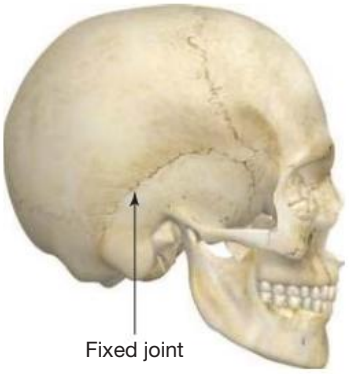


FIGURE 1.9 Slightly moveable (cartilaginous) joints in the spine

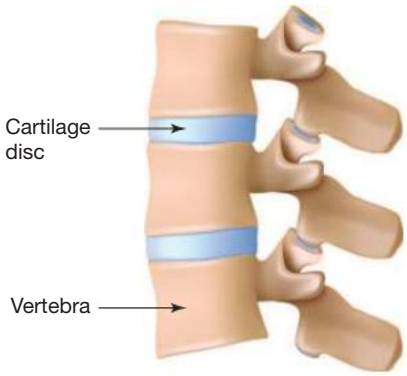
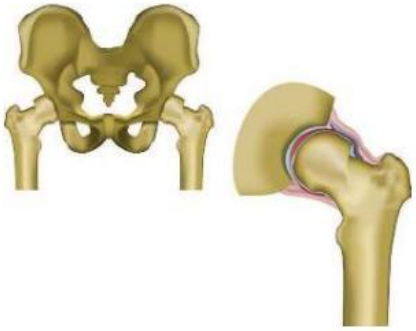


FIGURE 1.10 Freely moveable (synovial) joint of the hip



Connective tissue

Connective tissue plays an important role in the function of both the skeletal and muscular systems. It is classed as soft tissue because it does not have the rigidity of bone, but it does have the flexibility of soft tissue and the strength that collagen provides.

Cartilage

Cartilage is a smooth, slightly elastic tissue found in various forms within the body:

- hyaline cartilage coats the ends of the bones in synovial joints
- discs of cartilage separate the vertebrae of the spine (see figure 1.9)
- the ribs attach to the sternum via cartilage
- the hard part of the ear and the tip of the nose are also cartilage.

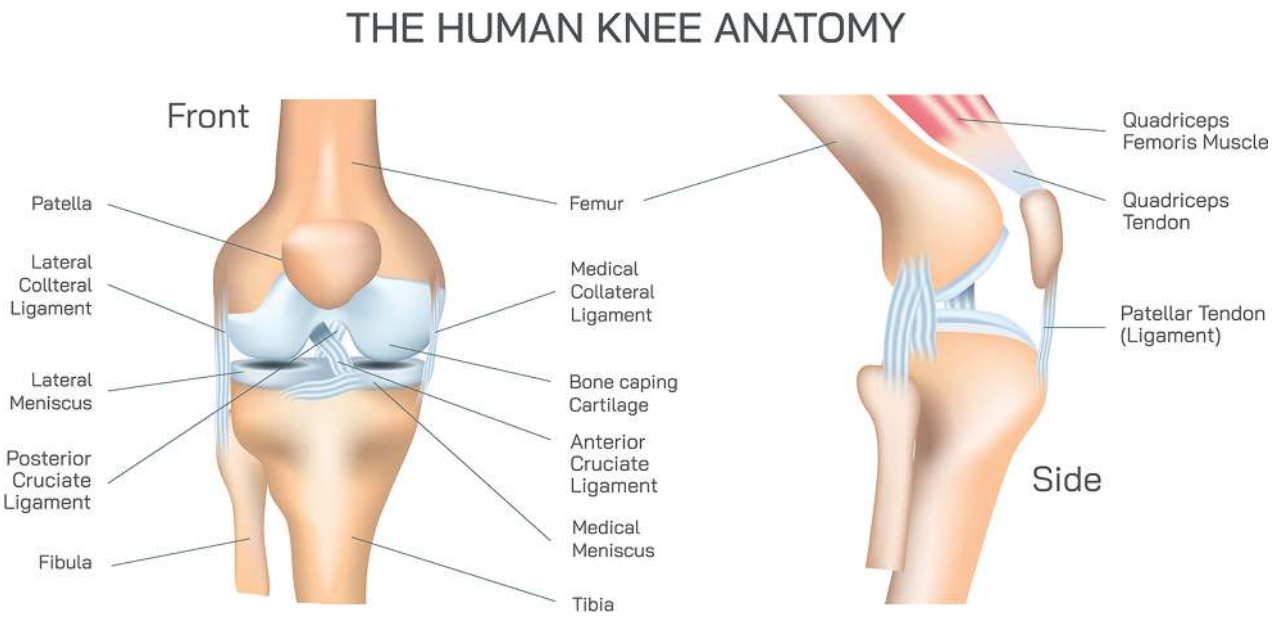
Ligaments

Ligaments cross over joints, joining bone to bone. Their slight elasticity allows small movements from the bones of the joint. The main function of ligaments is to provide stability at the joint, preventing dislocation (see figure 1.11). If ligaments are seriously damaged in an accident, they may not be able to repair themselves and may require surgery.

cartilage a tough, fibrous connective tissue located at the end of bones and between joints. It protects bones by absorbing the impact experienced in movements such as jumping.

ligament a strong fibrous band of connective tissue that holds together two or more moveable bones or cartilage

FIGURE 1.11 Ligaments of the knee joint (side and rear view)

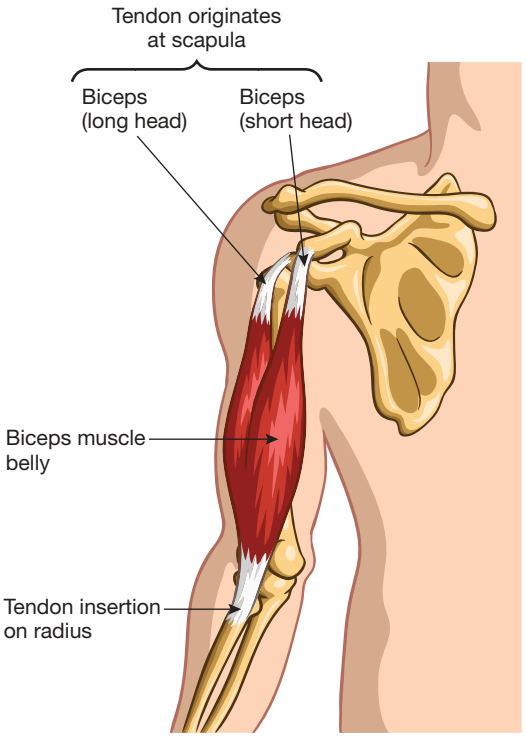


Tendons

Tendons are inelastic and very strong, allowing movement by helping muscles pull through the joint and on the bones. The biceps muscle (see figure 1.12) is an example of a muscle that works through two joints. It has two tendinous origins at the scapula (allowing the humerus to flex away from the body). The tendinous insertion into the radius in the forearm allows the forearm to flex upwards towards the humerus.

tendon a fibrous connective tissue that attaches muscles to bones

FIGURE 1.12 Tendons of the biceps muscle

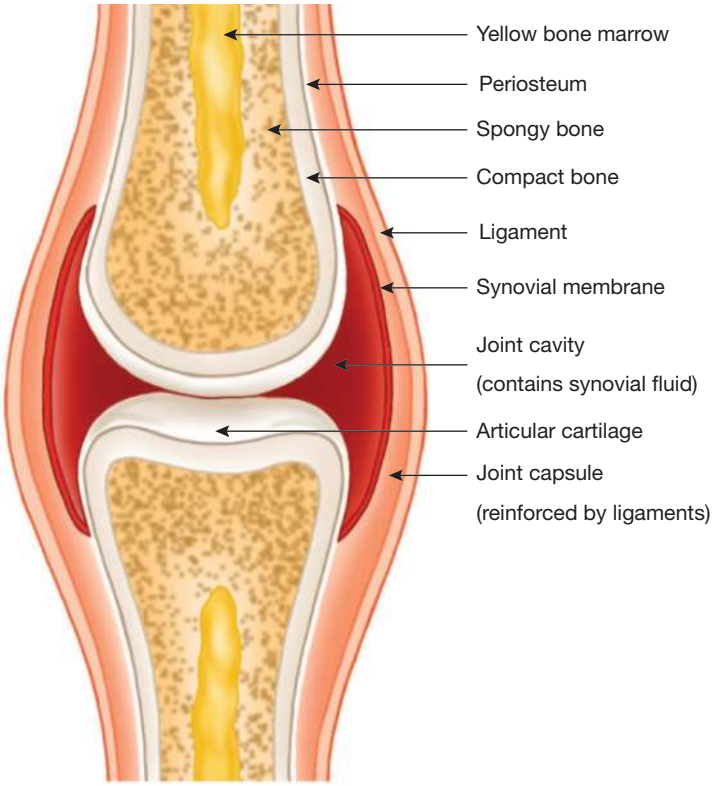


1.2.7 Synovial joints

Synovial joints are the joints most relevant to physical activity as they are directly involved in producing skilled movement. They have the following qualities (see figure 1.13):

- free movement in at least one direction
- cartilage that offers protection and cushioning at the ends of bones and reduces friction
- ligaments that secure bones in place and allow controlled ranges of movement
- enclosure by a joint capsule (a layer of tissue that surrounds the joint and provides stability in the joint by holding it together)
- a synovial membrane that lines the inside of the joint capsule and secretes synovial fluid, promoting lubricated movement by the joint.

FIGURE 1.13 Basic structure of a synovial joint

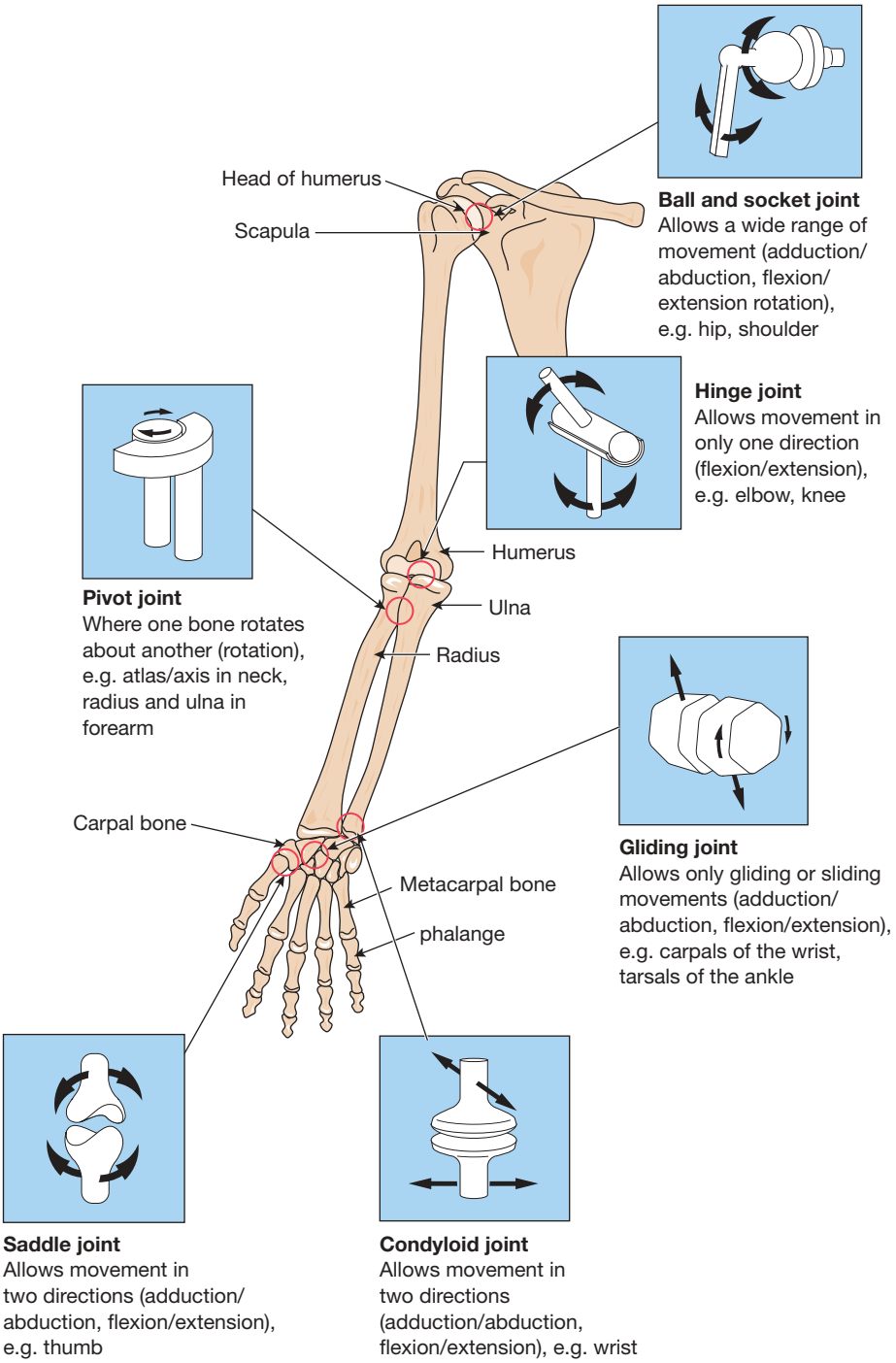


Types of synovial joints

There are six types of synovial joints (see figure 1.14). These joints are classified by the shape of the bones that articulate at the joint as well as the amount and type of movement possible at each joint.

synovial joint a freely moveable joint that allows movement in one or more directions, and has a joint capsule

FIGURE 1.14 Six types of synovial joints



on Resources

Video eLesson Animation of joint movements (eles-2578)

1.2.8 Anatomical position, terms of reference and movements

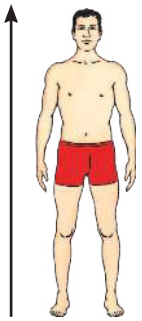
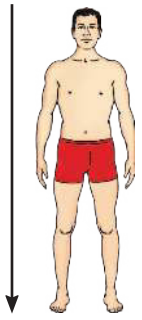
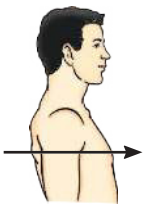
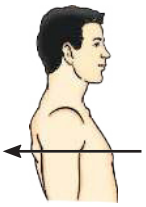
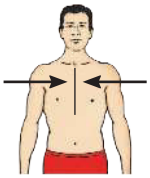
Anatomical position and terms of reference

anatomical position standing erect, facing forward with arms by the side and palms facing forward

When discussing synovial joints and the movements they create, it is also important to understand the anatomical position and common terms of reference. The **anatomical position** is defined as standing erect, facing forward with arms by the side and palms facing forward. The terms of reference shown in table 1.2 help to describe where a body part is in relation to another body part.

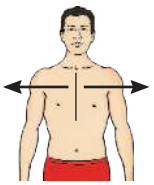
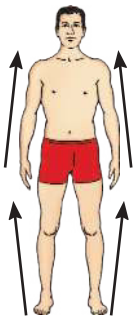
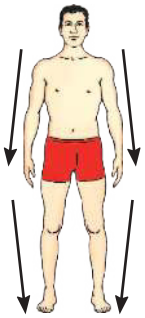
For example, the patella is located on the anterior (front) aspect of the body.

TABLE 1.2 Terms of reference

Term	Definition	Example	
Superior	Towards the head or upper part of the body	The cranium is superior to the sternum.	
Inferior	Towards the feet or lower part of the body	The tarsals are inferior to the femur.	
Anterior	Towards the front of the body	The patella is on the anterior side of the body.	
Posterior	Towards the back of the body	The scapula is posterior to the sternum.	
Medial	Towards the midline of the body	The sternum is medial to the rib cage.	

(continued)

TABLE 1.2 Terms of reference *(continued)*

Term	Definition	Example	
Lateral	Towards the outer side of the body	The fibula is lateral to the tibia.	
Proximal	Closer to the trunk of the body	The femur is proximal to the patella.	
Distal	Further away from the trunk of the body	The phalanges are distal to the humerus.	
Superficial	Towards the surface of the body	The rib cage is superficial to the heart.	
Deep	Towards the inner part of the body	The liver is deep to the skin.	
Prone	Face down	Lying on the stomach	
Supine	Face up	Lying on the back	

on Resources

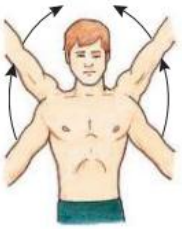
Weblink Anatomical terms of reference

Interactivity Orientation and directional terms (int-6619)

Anatomical movements (joint action)

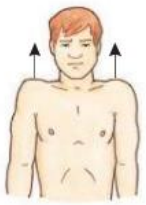
A variety of movements can occur at synovial joints. These are called anatomical movements, and there is a specific term to describe each movement (shown in table 1.3).

TABLE 1.3 Terms for anatomical movements in various activities

Anatomical movement	Definition	Example	
Flexion	Decrease in the angle of the joint	Bending the elbow or knee	
Extension	Increase in the angle of the joint	Straightening the elbow or knee	
Abduction	Movement of a body part away from the midline of the body	Lifting arm out to side (*out* phase of star jump)	
Adduction	Movement of a body part back towards the midline of the body	Returning arm into body or towards midline of the body	
Circumduction	Movement of the end of the bone in a circular motion	Drawing a circle in the air with straight arm	
Rotation	Movement of a body part around a central axis	Turning head from side to side	

(continued)

TABLE 1.3 Terms for anatomical movements in various activities *(continued)*

Anatomical movement	Definition	Example	
Pronation	Rotation of the hand so that the thumb moves in towards the body	Palm facing down	
Supination	Rotation of the hand so that the thumb moves away from the body	Palm facing up	
Eversion	Movement of the sole of the foot away from the midline	Twisting ankle out	
Inversion	Movement of the sole of the foot towards the midline	Twisting ankle in	
Dorsi flexion	Decrease in the angle of the joint between the foot and lower leg	Raising toes upwards	
Plantar flexion	Increase in the angle of the joint between the foot and the lower leg	Pointing toes to the ground	
Elevation	Movement of the shoulders towards the head	Shrugging shoulders	
Depression	Movement of the shoulders away from the head	Returning shoulders to normal position	

EXAM TIP

When determining the anatomical movement, you should include the specific joint where the movement is occurring and an explanation of the movement.

For example, when completing the upward phase of the arms in a jumping jack, the anatomical movement is shoulder abduction, which allows the arms to move away from the midline of the body.

on Resources

Digital document	Anatomical movements (doc-1100)
Weblink	Anatomical terms of movement
Interactivities	Anatomical movement: image match (int-6620) Joints (int-6621)

doc-41904

1.2 PRACTICAL ACTIVITY Skeletal system

Goal

To identify the major bones, joints and joint actions required to assist movement in physical activity

Instructions

Participate in a game of tennis (singles or doubles).

Primary data/Reflection

Write a paragraph about your participation in a game of tennis. Reflect on the main skills required and how the interaction between the bones, joints and joint actions assisted your performance.

Questions

1. Identify all the skills required in a game of tennis.
2. Choose two skills and identify:
   (i) the major bones responsible for helping to create that movement
   (ii) the joints used and the type of each joint
   (iii) the anatomical movement performed.

1.2 Activity

1.2 Quick quiz on | **1.2 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 3, 5	4, 7, 8	6, 9

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. Access and download the **Skeleton** in the digital documents section of the Resources panel. Label the major bones of the skeleton.
2. **List** the five types of bone in the skeletal system and provide one example of each.

3. **Identify** the bones that form each of the following joints:
   a. shoulder
   b. elbow
   c. hip
   d. knee
   e. ankle.
4. **Describe** the three joint types and provide an example of each.
5. Identify and define the anatomical movement taking place in each of the following activities.
   a. The knee when kicking a football
   b. The arm when performing a star jump
   c. The shoulder during an underarm pitch
   d. The shoulders during a volleyball dig

APPLY your understanding

6. Using examples, **explain** the five main functions of the skeletal system.
7. Copy and complete the table below in relation to synovial joints.

Joint	Type of synovial joint	Anatomical movement
Neck		
Shoulder		
Elbow		
Wrist		
Hip		
Knee		
Ankle		

8. Using your knowledge of the anatomical terms of reference, select the correct option in relation to the bones of the human body.
   a. The skull is (superior/inferior) to the sternum.
   b. The scapula is found on the (anterior/posterior) side of the body.
   c. Carpals are found at the (proximal/distal) end of the arm.
   d. The fibula is on the (medial/lateral) side of the body.
   e. A sit-up is performed in the (prone/supine) position.
9. **Explain** the similarities and differences between ligaments, tendons and cartilage.

1.2 Exam questions

Question 1 (1 mark)

Source: *ACHPER 2022, Trial Exam Unit 1, Section A, Q.14;* © ACHPER

The vertebral column is divided into five sections with each section having a specific function.

Which of the following is a function of the thoracic vertebrae?
A. Allows your head to move up and down and side to side
B. Are fused to the pelvis to distribute the weight of the upper body
C. Combine with the ribcage to form protection for the heart and lungs
D. Are fused to provide a site for muscle attachment to allow many different movements to occur

Question 2 (2 marks)

Source: *ACHPER 2019, Trial Exam Unit 1, Section B, Q.9a;* © ACHPER

Briefly **discuss** the role of the skeletal system in the movement of the body during physical exercise.

Question 3 (4 marks)

By referring to types of joints and anatomical movements, **discuss** the similarities and differences of the elbow and shoulder joints.

More exam questions are available in your learnON title.

1.3 The structure and function of the muscular system

Key knowledge	Key skill
• major muscles of the human body	• apply and use anatomical terminology to identify the structures and functions of the muscular and skeletal systems in producing movement

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

1.3.1 Functions of the muscular system

The human body has over 600 muscles. These muscles function to allow a range of physical movements that we either consciously or subconsciously control. These movements range from fine motor skills, such as blinking an eye or writing, to gross body movements such as running or throwing a ball.

Body movement

All the muscles that we can consciously control (**voluntary control**) are attached to bones. Such muscles are also known as voluntary muscles. The central nervous system sends a message to the relevant muscle, and then the muscle pulls the bones to allow the desired movement.

Adequate posture

Muscles are continually in a state of tone that affects their ability to help our body to maintain an upright posture when awake and to function safely during sleep. People with poor muscle tone generally have poor posture and resultant aches and pains, because gravity defeats the muscles' resistance. The muscles of the upper back — such as the trapezius, rhomboids and the latissimus dorsi — strongly influence posture maintenance. Regular exercise helps improve muscle tone, which allows resting muscles to resist being stretched and keeps them in constant readiness.

Essential bodily functions

Involuntary muscles are those over which we have little or no conscious control (**involuntary control**). They function continuously and preserve our ongoing body needs whether we are awake or not. The heart is a muscle over which we generally have little control, and involuntary muscles also control our digestive and respiratory functions.

1.3.2 Types of muscle

Muscles can be classified into three main types:

- smooth
- cardiac
- skeletal.

Smooth muscle

Smooth muscle is found in hollow organs such as the walls of the digestive tract, the bladder and the blood vessels (see figure 1.15). You have no conscious control over smooth muscle contractions (hence why they are called 'involuntary'), which are slow, sustained and rhythmic. The contractions of the smooth muscle in the intestinal walls and stomach, for example, move food through the digestive tract. Such muscles fatigue more slowly than skeletal muscle.

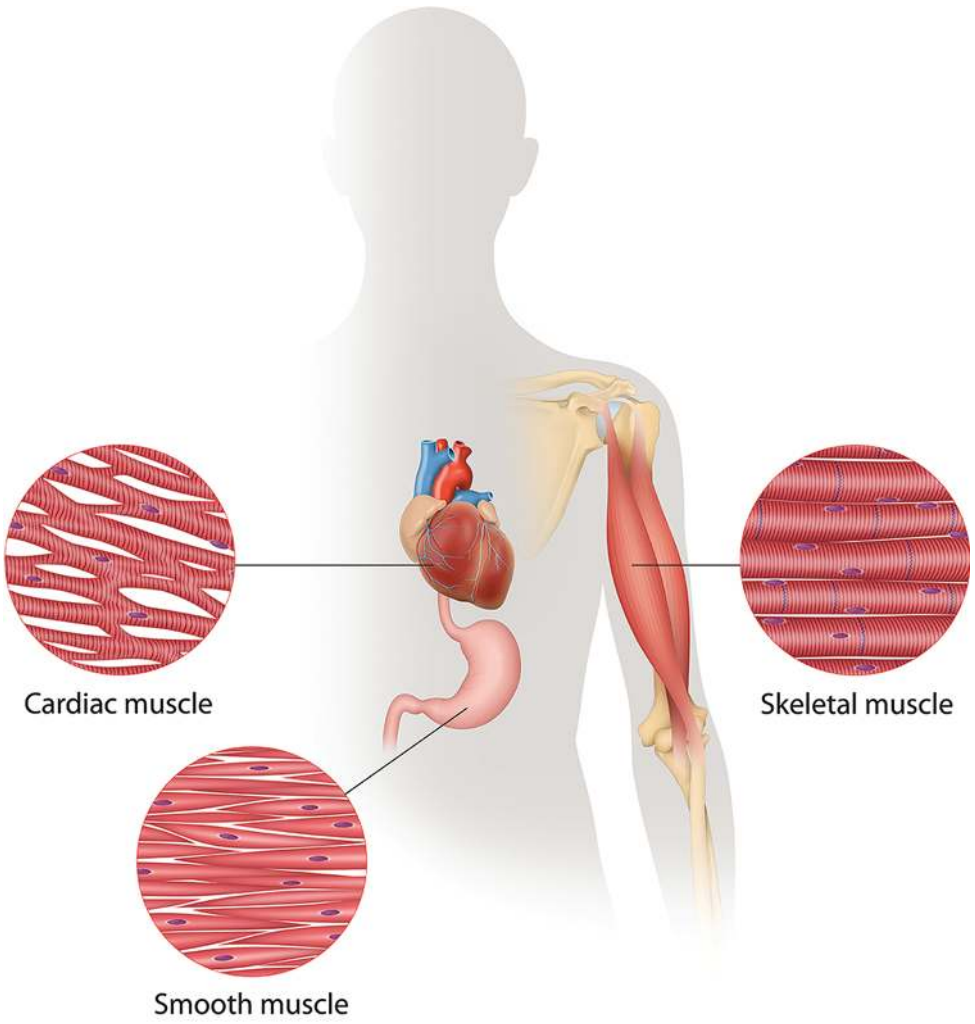
voluntary control refers to having conscious control of the muscle

involuntary control refers to having no conscious control of the muscle

Cardiac muscle

Cardiac muscle is found only in the heart. The muscle fibres are intertwined, which helps the heart push blood into arteries going to the lungs and other body tissues (see figure 1.15). The heart is an involuntary muscle (although some people claim that they can make their heart beat faster or slower at will) and it is difficult to fatigue. When a nerve impulse arrives at the heart, the message is relayed from cell to cell, causing rhythmic contractions and relaxations.

FIGURE 1.15 Smooth and cardiac muscles are involuntary and contract without conscious effort, whereas skeletal muscle is under voluntary control and, when activated, causes body movement.



Skeletal muscle

Skeletal muscle attaches to and causes movement of the skeleton. It is striated, meaning that it has a striped appearance (see figure 1.15). Skeletal muscle is under voluntary control because you are consciously aware of the muscles and can control their contractions. The muscles may also take part in reflex actions, such as a knee-jerk reaction. If you want to throw a netball or kick a soccer ball, your brain sends a message to the muscles concerned and the required physical action results. As skeletal muscle is responsible for human movement, this muscle type will be the focus of the next section.

1.3.3 Major skeletal muscles

To be able to study body movements, it is important to identify the positions and actions of the major muscle groups of the body (see figure 1.16 and table 1.4). Muscles are usually named according to their characteristics or locations. For example: the triceps, which has three points of origin; the pectoralis major, which is a large (major) muscle of the chest or pectoral region; and the quadriceps femoris, which consists of four separate muscles anterior to the femur.

FIGURE 1.16 Muscles of the human body: **(a)** anterior view and **(b)** posterior view

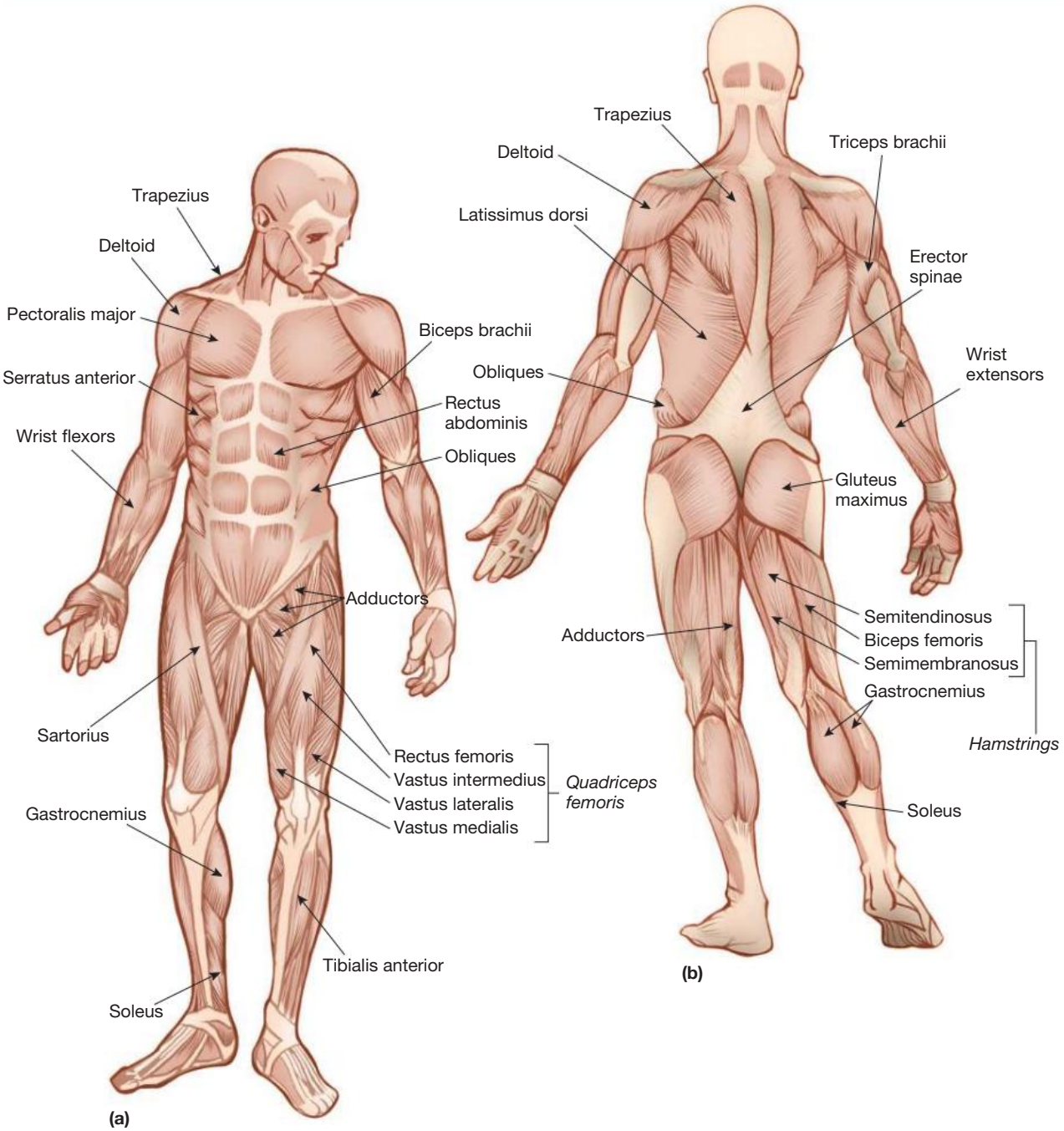


TABLE 1.4 Major muscles and the actions they produce

Major muscle	Action	Example
Shoulder/chest — anterior		
Deltoid	Shoulder abduction Shoulder flexion Shoulder extension	Bowling in cricket
Pectoralis major	Shoulder flexion	Tennis forehand
Serratus anterior	Shoulder abduction	Boxing punch
Shoulder/back — posterior		
Trapezius	Scapula elevation	Shoulder shrug
Latissimus dorsi	Shoulder adduction	Butterfly stroke in swimming
Arm — anterior		
Biceps brachii	Elbow flexion	Pull-up
Wrist flexors	Wrist flexion	Wrist curl
Arm — posterior		
Triceps brachii	Elbow extension	Throwing a javelin
Wrist extensors	Wrist extension	Squash backhand
Trunk		
Abdominals • Rectus abdominis • Obliques	 Trunk flexion Trunk flexion Trunk rotation	Sit-up
Erector spinae	Trunk extension Trunk rotation	Gymnastics back-flip
Pelvis — anterior/medial/posterior		
Sartorius	Hip flexion Knee flexion	Breaststroke kick
Adductors	Hip adduction	Riding a horse
Gluteus maximus	Hip extension Hip abduction	Running
Leg — anterior		
Quadriceps • Rectus femoris • Vastus lateralis • Vastus intermedius • Vastus medialis	 Hip flexion Knee extension Knee extension Knee extension	 Kicking/cycling Jumping Rock climbing
Tibialis anterior	Dorsi flexion	Freestyle kick
Leg — posterior		
Hamstrings • Biceps femoris • Semitendinosus • Semimembranosus	All three muscles — hip extension and knee flexion	Running
Gastrocnemius	Plantar flexion	Calf raises
Soleus	Plantar flexion	Ballet — toe point

on Resources

Interactivity Muscles (int-6623)

Digital document Muscle chart (doc-1101)

EXAM TIP

You should use correct anatomical terminology when identifying muscles (e.g. *gastrocnemius* not calf). You also need to be able to identify the action that each muscle performs.

For example, the *gastrocnemius* assists with *plantar flexion* to perform a calf raise.

doc-41905

1.3 PRACTICAL ACTIVITY Muscular system

Goal

To determine the major muscles required and their actions in a range of movements

Instructions

With a partner, complete each movement to determine the muscle and actions involved.

a. Wide-grip push-up (floor to straight arms)
b. Sit-up
c. Kicking a football
d. Forward swing in baseball batting
e. Vertical jump
f. Star jump

Primary data/Reflection

Draw each of the movements performed. Annotate each image responding to the questions below, identifying the major muscles and the action that occurs to create movement.

Questions

For each movement performed:

1. Name the muscle/s involved
2. Identify the anatomical action occurring.

1.3 Activity

1.3 Quick quiz on

1.3 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 3, 4	2, 5, 6	

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Outline** the three functions of the muscular system.
2. **Describe** the three types of muscle and **identify** if they are under voluntary or involuntary control.
3. Access the **Muscle chart** in the digital documents section of the Resources panel. Label the major muscles in the body.
4. **List** the major muscles of the following muscle groups:
   a. hamstrings
   b. quadriceps
   c. abdominals.

APPLY your understanding

5. **Discuss** the relationship between muscle tone and adequate posture.
6. Complete the actions listed in the table below to determine the muscle responsible. Write your answer in the table.

Movement created	Muscle responsible
Trunk flexion	
Shoulder adduction	
Elbow extension	
Hip flexion	
Shoulder elevation	
Trunk extension	
Ankle (dorsi) flexion	
Knee flexion	
Hip adduction	

1.3 Exam questions

Question 1 (1 mark)

Source: *ACHPER 2021, Exam Unit 1, Section A, Q.7;* © ACHPER

The hamstrings are responsible for:

A. extension of the lower leg.
B. flexion of the lower leg.
C. flexion of the hip.
D. adduction of the hip.

Question 2 (2 marks)

Describe how muscles create movement. Support your answer with an example.

Question 3 (3 marks)

Source: *ACHPER 2022, Trial Exam Unit 1, Section B, Q.6a;* © ACHPER

Outline how each of the three types of muscles are used by a 1500-metre freestyle swimmer.

More exam questions are available in your learnON title.

1.4 Muscle fibre characteristics and functions

Key knowledge	Key skill
• characteristics and functions of muscle fibres such as fibre arrangement and type (fast and slow twitch)	• apply and use anatomical terminology to identify the structures and functions of the muscular and skeletal systems in producing movement

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

1.4.1 Common features of muscles

Skeletal muscles all have features that distinguish what they can do; in particular, movements that they make and force they can generate. It is important to understand the microscopic structure of skeletal muscle and how these structures assist with creating movement.

Most muscles have certain common features:

- nervous control — nerve stimuli control muscle action
- excitability — muscles receive and respond to a stimulus to initiate movement
- contractility — muscles contract and become thicker
- extensibility — muscles have the capacity to stretch when a force is applied
- elasticity — muscles can return to their original size and shape once stretched
- atrophy — muscles can decrease in size (waste) as a result of injury, illness or lack of exercise
- hypertrophy — muscles can increase in size (growth) with an increase in activity.

1.4.2 Muscle fibre arrangement

Muscle fibres are organised in different ways according to the shape (or arrangement) and function of the muscles (see figure 1.17). These arrangements determine the force or speed that a muscle can develop. The main arrangements of major skeletal muscles used in physical activity include fusiform, pennate and convergent muscles.

Fusiform muscles

Fusiform muscle fibres run the length of the muscle belly in the same direction as the tendon. They are designed for mobility because they produce contractions over a large range, yet they produce low force (e.g. sartorius and biceps).

Pennate muscles

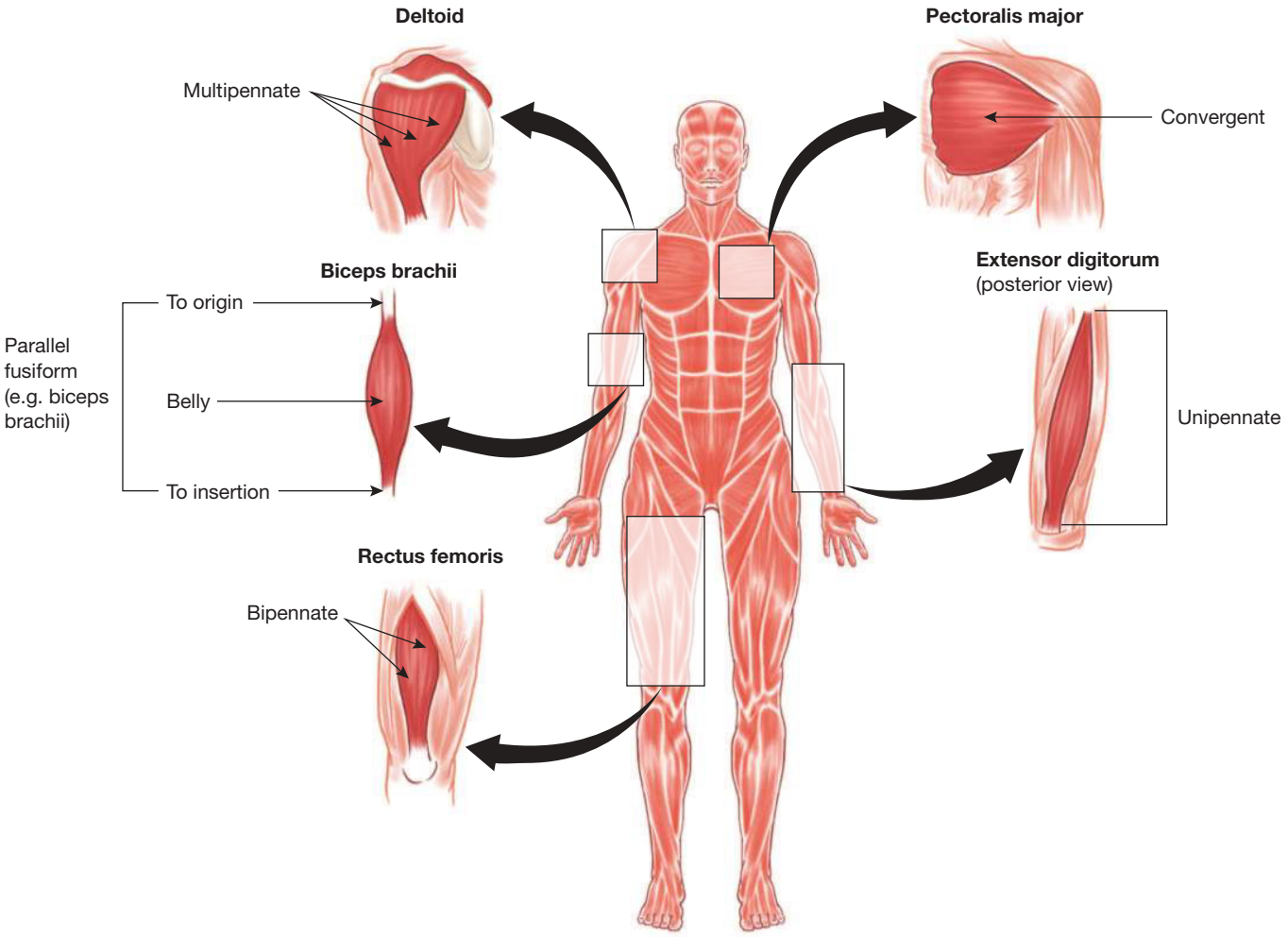
Pennate muscle fibres run at angles to the tendons. These muscles do not provide as much mobility as the fusiform muscles because they are designed for strength and power. There are three categories of pennate muscles:

- unipennate muscles — fibres are only found on one side of a central tendon (e.g. the semimembranosus in the hamstrings and the tibialis anterior)
- bipennate muscles — fibres run off either side of a central tendon (e.g. the rectus femoris in the quadriceps)
- multipennate muscles — fibres branch out from several tendons (e.g. the deltoid). This arrangement enables the body to generate the greatest force.

Convergent muscles

Convergent muscle fibres radiate from the main tendon. These muscles are a compromise between fusiform and pennate muscles because they are capable of producing strength and power while retaining their mobility (e.g. the pectoralis major).

FIGURE 1.17 Skeletal muscle fibre arrangement



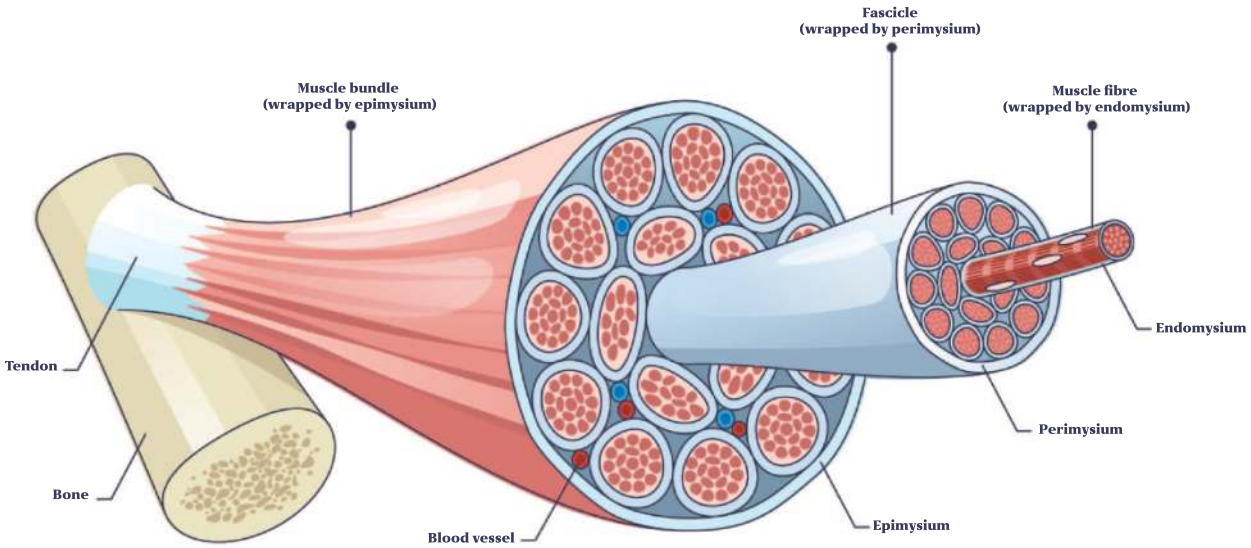
1.4.3 Structure of skeletal muscles

- Skeletal muscle is covered with a layer of connective tissue called the *epimysium*. The epimysium thickens as it reaches the ends of the muscle to form tendons that usually attach to bone.
- Skeletal muscle consists of thousands of muscle fibres that run the length of the muscle and are arranged in bundles called *fasciculi*. (A single bundle is called a fasciculus.)
- Each individual muscle fibre is surrounded by connective tissue called the *endomysium*, which binds the fibres together to form the bundles.
- The fasciculi are surrounded by a layer of connective tissue called the *perimysium*, which helps bind the fasciculi together (see figure 1.18)

CONCEPT CONNECTOR

Using craft supplies such as coloured paper or modelling clay, build your own sarcomere. Make a sarcomere in a relaxed state and then adjust it to be in a contracted state to see how the sliding filament theory works.

FIGURE 1.18 The muscle belly in cross-section



The muscle fibre

Each muscle fibre is surrounded by a cell membrane called the *sarcolemma* (see figure 1.19). Underlying the sarcolemma is a gel-like fluid called sarcoplasm. This fluid contains:

- *mitochondria*, which are the site of aerobic energy production
- myoglobin, which carries oxygen to the mitochondria
- fat, carbohydrate and protein (energy nutrients)
- adenosine triphosphate (ATP, an immediate energy source)
- enzymes, which are chemicals that speed up energy production
- actin and myosin **myofilaments** (contractile proteins).

Each muscle fibre is made up of long strands called *myofibrils*. Each myofibril consists of many individual units, called sarcomeres, which are responsible for contracting the muscle.

Sarcomeres

A **sarcomere** is a contractile unit, and each one is designated by a line at either end called a Z line. Each sarcomere consists of two protein myofilaments called actin and myosin. Actin is a thin filament that attaches to the Z line. Myosin is a thick filament situated between each of the actin filaments. The myosin filaments have cross bridges (oar-like structures) that are attracted to the actin filaments. Figure 1.19 illustrates the several bands and zones that help define the sarcomere:

- the **I band**, where only actin is found
- the **A band**, where both actin and myosin are found. It equates with the length of the myosin filaments.
- the **H zone**, where only myosin is found. It is the gap between the ends of the actin.

Sliding filament theory

This theory explains what happens in each sarcomere as a muscle contracts. As its name suggests, the myofilaments (actin and myosin) slide across each other.

- At rest, there is little contact between the actin and the myosin.
- When a nerve impulse arrives at the neuromuscular junction, calcium is released.
- In the presence of calcium, the myosin filaments can now attach to the actin.
- The breakdown of ATP enables the cross bridges on the myosin to attach to the actin filaments and pull them into the centre of the sarcomere in a 'rowing' action (see figure 1.20) and the sarcomere contracts.

myofilament individual protein filaments of myosin (thick filament) and actin (thin filament) that make up a myofibril

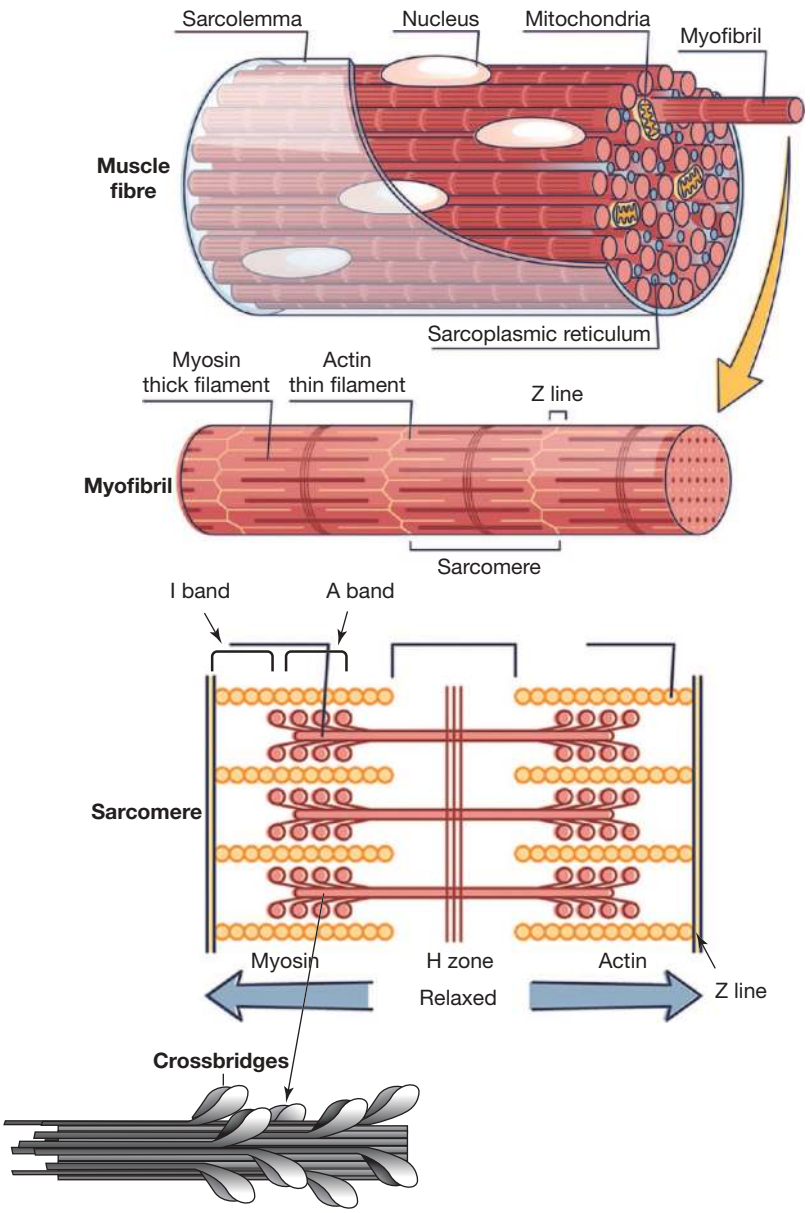
sarcomere the smallest unit of muscle contraction

- The cross bridges continue to detach and reattach themselves from the actin filaments, shortening the sarcomere.
- The structural rearrangement of actin and myosin filaments change, whereby Z lines move closer together, the I band reduces in width, the A band remains the same length and the H zone may disappear.
- Every sarcomere along the muscle fibre shortens, leading the whole muscle to contract.
- The muscle will relax when the actin and myosin filaments lose contact with each other — that is, when the cross bridges detach from the actin.

Muscle tone

Not all the myosin filaments detach themselves from the actin. Some may stay in contact, so the muscle is never completely relaxed — the muscle is then said to have 'tone'. The advantage of muscle tone is that the actin and myosin are already partly connected, so they can be activated quickly when a muscle contraction is ready to occur. It also helps us to maintain good posture!

FIGURE 1.19 Arrangement of sarcomeres within the muscle fibre



1.4.4 Muscle fibre types

There are two distinct types of muscle fibres within the body's muscular system: fast-twitch fibres and slow-twitch fibres. The relative proportions of these fibre types are genetically determined, but on average most muscles contain about 50 per cent of each fibre type (i.e. 50 per cent fast-twitch and 50 per cent slow-twitch). Each fibre is better suited to a different intensity of physical activity.

Fast-twitch fibres can be further categorised into two types on the basis of various structural and functional characteristics, so that skeletal muscle fibres can now be classified into three types (see table 1.5):

- type 1 slow-twitch oxidative fibres
- type 2A fast-twitch oxidative fibres
- type 2B fast-twitch glycolytic fibres.

TABLE 1.5 Characteristics of fast- and slow-twitch muscle fibres

Characteristic	Slow-twitch	Fast-twitch oxidative	Fast-twitch glycolytic
Also known as	Type 1	Type 2A	Type 2B
Colour	Red	Pinkish	White
Used for	Aerobic	Anaerobic (long-term)	Anaerobic (short-term)
Fibre size	Small	Medium	Large
Motor neuron size	Small	Large	Very large
Resistance to fatigue	High	Medium	Low
Force production	Low	Medium	High
Speed of contraction	Slow	Fast	Very fast
Hypertrophy potential	Low	High	High
Mitochondrial density	High	High	Low
Capillary density	High	High	Low
Myoglobin content	High	High	Low
Oxidative capacity	High	Medium	Low
Glycolytic capacity	Low	High	High
Major fuel	Triglycerides	Creatine phosphate/ glycogen	Creatine phosphate/ glycogen

Type 1 muscle fibres

Characteristics of type 1 muscle fibres:

- slow-twitch oxidative
- contain large amounts of myoglobin, and large numbers of mitochondria and blood capillaries
- red in colour, split ATP (adenosine triphosphate, the basic source of energy for muscle cell metabolism and movement) at a slow rate and have a slow contraction velocity
- resistant to fatigue, and have a high capacity to generate ATP by oxidative metabolic processes
- suited to low-intensity, longer duration, aerobic work.

Athletes who have a larger proportion of slow-twitch fibres are suited to events such as marathons, triathlons, long-distance cycling and cross-country skiing.

FIGURE 1.20 Cross-country skiers have a larger proportion of slow-twitch muscle fibres.

Type 2A muscle fibres

Characteristics of type 2A muscle fibres:

- fast-twitch oxidative
- contain an large amount of myoglobin, and large numbers of mitochondria and blood capillaries
- pinkish in colour and have a very high capacity for generating ATP by oxidative metabolic processes
- split ATP at a very rapid rate and have a fast contraction velocity
- relatively resistant to fatigue
- classed as partially aerobic and are suited to events that require both aerobic and anaerobic elements.

Athletes who have a larger portion of type 2A fast-twitch fibres are suited to events such as middle-distance running and swimming.

Type 2B muscle fibres

Characteristics of type 2B muscle fibres:

- fast-twitch glycolytic
- contain a low myoglobin content, relatively few mitochondria and blood capillaries, and large amounts of glycogen
- white in colour and geared to generate ATP by anaerobic metabolic processes
- fatigue easily
- split ATP at a fast rate, and have a fast contraction velocity
- suited to high-intensity, short-duration, anaerobic work.

Athletes who have a larger proportion of type 2B fast-twitch fibres are suited to events that require explosive actions, such as sprinting, throwing and weight-lifting.

FIGURE 1.21 (a) Body builders develop their fast-twitch muscle fibres to a high degree. **(b)** Tour de France cyclists benefit from having a high percentage of slow-twitch fibres in their leg muscles to help them in this gruelling 21-day endurance event.

EXAM TIP

When asked to compare the characteristics of each muscle fibre type (fast twitch and slow twitch), you must reference each of the fibre types.

For example, fast-twitch fibre types are suited to high-intensity activities, such as sprinting, because these fibres can contract quickly. Slow-twitch muscle fibres contract slowly and are therefore more suited to endurance events such as marathons.

on Resources

Interactivity Characteristics of fast- and slow-twitch muscle fibres (int-6628)

Digital document Muscle fibre types (doc-1102)

doc-41906

1.4 PRACTICAL ACTIVITY Major muscles and fibre type arrangement

Goal

To identify major muscles, muscle fibre arrangements and their role in movement

Instructions

Participate in a weight-training session that includes a variety of muscles and fibre arrangements. Prior to participation, predict in which exercises you will only lift lighter weights and in which exercises you will be able to lift heavier weights. For each exercise, record the amount of weight that can be lifted by each muscle for 10 repetitions.

- Bicep curl
- Leg extension
- Shoulder press
- Chest press
- Calf raise

Primary data/Reflection

Review your predictions prior to participation — were your predictions correct? Explain how the differences between the muscles and their fibre arrangements affected the amounts of weight that each muscle could lift.

Question

1. Complete the following table.

Exercise	Muscle/s	Muscle fibre arrangement	Action
Bicep curl			
Leg extension			
Shoulder press			
Chest press			
Calf raise			

1.4 Activity

1.4 Quick quiz on | **1.4 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 3, 5, 6	2, 4	7, 8

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Outline** the main features of all muscles.
2. The deltoid is an example of a muscle that displays a multipennate fibre arrangement. **Discuss** why multipennate muscles produce greater force than fusiform muscles.
3. Name the two protein myofilaments, and **identify** where they are found and which filament attaches to the cross bridges.
4. **Describe** muscle tone and the advantage of having it.
5. Download and view the table of **Muscle fibre types** in the digital documents section of the Resources panel. Complete this table.

APPLY your understanding

6. **Outline** the differences between the three types of muscle fibre.
7. **Explain** what happens to the following structures in a sarcomere during a muscle contraction. Draw a picture to illustrate your explanation.
   a. Z lines b. A band c. I band d. H zone
8. Consider the following sports and decide, giving reasons, whether fast-twitch fibres, slow-twitch fibres or a combination of both would be more important:

Sport	Fibre type	Justification
Weightlifting		
Athletics — a long jumper		
Tour de France		
Athletics — a decathlon		

1.4 Exam questions

Question 1 (1 mark)

Fusiform muscles are suited for mobility as they produce contractions over a large range, but with minimal what?

A. Effort
B. Force
C. Resistance
D. Yield

Question 2 (3 marks)

Explain the sliding filament theory.

Question 3 (4 marks)

Source: *ACHPER 2022, Trial Exam Unit 1, Section B, Q.6b;* © ACHPER

Compare the 50-metre freestyle and 1500-metre freestyle swimming events by discussing the difference between slow-twitch and fast-twitch muscle fibres.

More exam questions are available in your learnON title.

1.5 Neural control of muscles

Key knowledge	Key skill
• neural control of muscles including the recruitment (size principle) and activation (all or nothing principle) of motor units in relation to force production	• investigate and describe the relationship between motor unit recruitment, activation and force production in movement

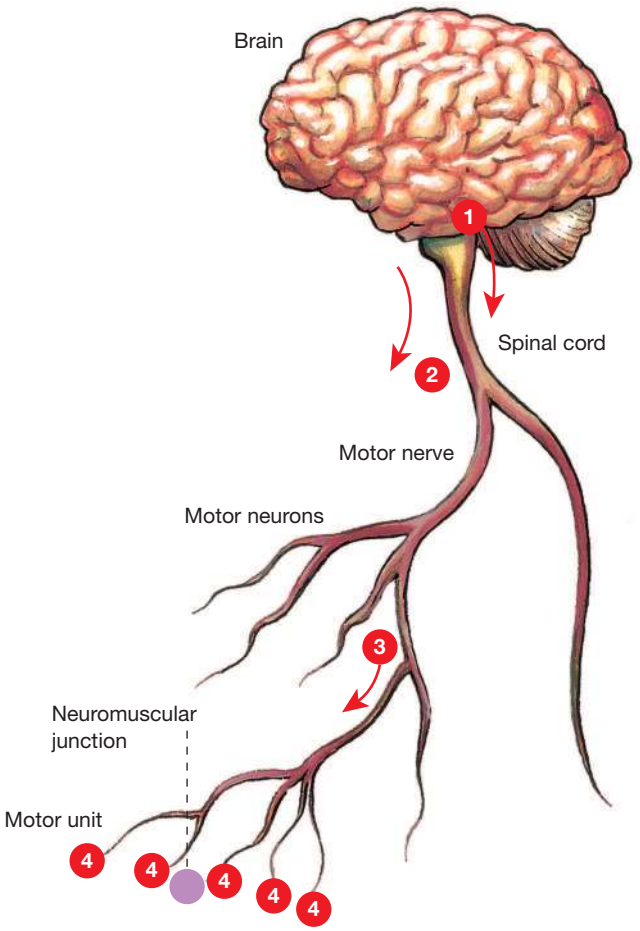
Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

1.5.1 Neural control of muscles: initiation of muscular activity

Muscles create movement by pulling on the bones to which they attach. In order to do this, messages are sent from the brain to the muscles to initiate movement.

- To enable conscious control of muscles, the brain must send electrical nervous messages to the muscles.
- These messages or signals travel down the spinal cord to the motor nerves that branch from the spinal cord to the relevant muscles.
- Leaving the spinal cord, the motor nerve separates into smaller motor neurons that then divide a number of times to attach to individual muscles.
- Where the nerves meet the muscle fibres, there is a gap (called a neuromuscular junction or the synaptic cleft) across which the nerve impulse has to travel.
- A neurotransmitter, which is a chemical compound called acetylcholine, helps the nerve impulse make this jump.
- The muscle will continue to contract for as long as the brain sends messages and the relevant energy sources last (see figure 1.22).

FIGURE 1.22 Nervous control of muscular movement



Stages of nervous control of muscle action

1. Brain initiates message.
2. Nervous impulse branches from spinal cord to motor nerve.
3. Message passes into motor neurons.
4. Message branches off to arrive at all muscle fibres controlled by that nerve; travels across gap at neuromuscular junction (aided by acetylcholine) and all connected muscle fibres contract.

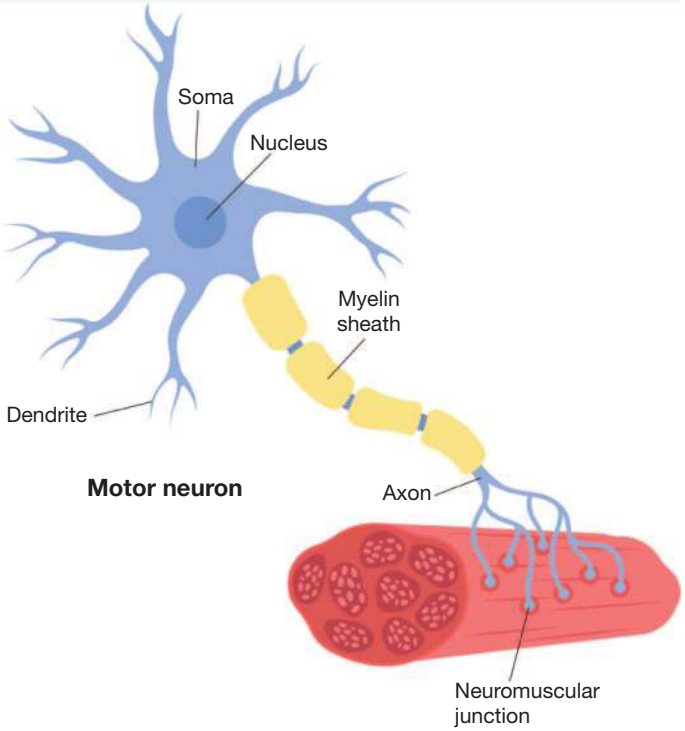
on Resources

Interactivity Nervous control of muscles (int-6624)

Motor units

A motor unit consists of one motor neuron and the muscle fibres it stimulates. One motor neuron does not stimulate the entire muscle. Instead, a number of motor units may be required to assist a muscle contraction. The number of fibres within each **motor unit** varies according to the precision of the movement required. Generally, muscles (such as those in your hand) that perform precise, controlled movements such as writing, typing or throwing darts have small motor units, where one motor neuron may be responsible for stimulating only a few fibres. Muscles such as the quadriceps that perform gross movements, such as running or kicking a ball, have large motor units, where one motor neuron may stimulate thousands of fibres (see figure 1.23).

FIGURE 1.23 A motor unit can stimulate a few fibres for a precise movement or many fibres for a large movement.



Activation of a muscular contraction

Skeletal muscles can generate a range of contractions varying from strong maximal contractions to complete relaxation. However, for a contraction to occur, there must be a strong enough nerve impulse to innervate (stimulate) the muscle fibres.

The 'all or nothing' principle

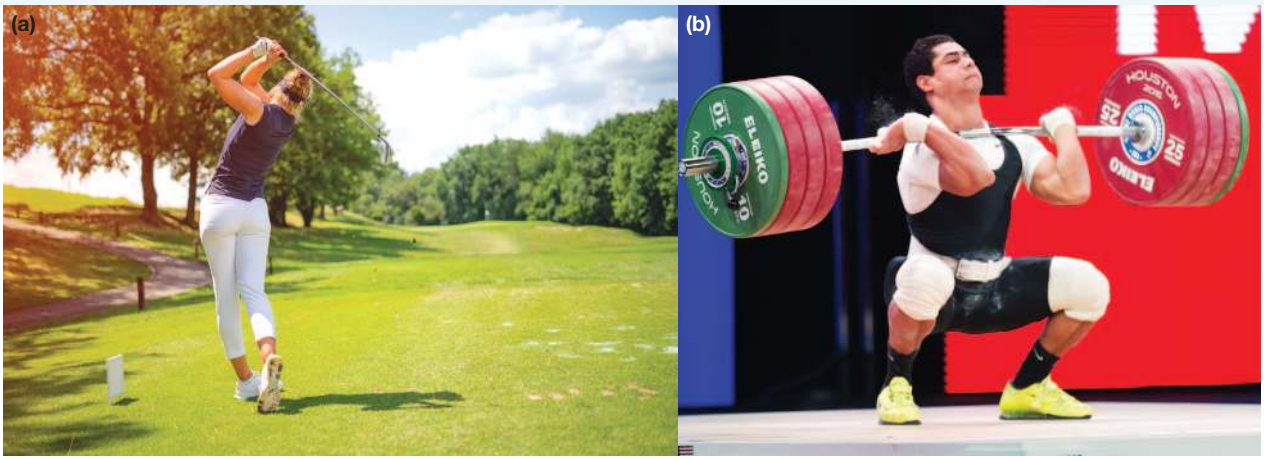
The **'all or nothing' principle** states that the nerve impulse will not stimulate the muscle fibres until it reaches a certain threshold level. Once the nerve impulse reaches this threshold, all fibres of the motor unit will contract at the same time and maximally. If the impulse is too weak, no fibres will contract at all. However, the intensity of muscular contractions can vary in two ways:

- *By varying the number of motor units stimulated.* Not all the motor units within a muscle need to be recruited at one time for a muscle contraction. If you require a large degree of strength (e.g. lifting a heavy weight), then more nerve impulses are sent, activating more motor units and therefore contracting more muscle fibres. If you require a minimal degree of strength (e.g. putting a golf ball), then fewer impulses are sent, contracting fewer fibres.
- *By varying the frequency at which the impulses arrive at the motor unit.* The greater the frequency of nerve impulses, the greater the contractions in the muscle. If you require a large degree of strength (e.g. for performing a vertical jump), then impulses will be sent at a faster rate to the muscles involved.

motor unit consists of one motor neuron and the muscle fibre it stimulates. (Each neuron may stimulate a number of muscle fibres.)

'all or nothing' principle states that if the nerve impulse meets a certain threshold, maximal action occurs in the muscle fibre. If the stimulation is less than threshold, no muscle action occurs in the muscle fibre.

FIGURE 1.24 (a) A smaller amount of motor units are stimulated to complete a golf putt in comparison to **(b)** weightlifting, where a larger amount of motor units are required for an explosive contraction.



Recruitment of motor units: size principle

The **size principle**, which is also known as the Henneman principle, states that the recruitment of motor units within a skeletal muscle commences with small motor units and progresses to large motor units. Small motor units are recruited first at low muscle forces (e.g. walking). An increase in muscle force, from walking to sprinting, leads to the recruitment of larger motor units (See figure 1.24).

Small motor units are:

- slow contracting
- easily excitable and recruited
- fatigue resistant
- used for prolonged activities (walking, posture control).

Large motor units are:

- fast contracting
- less easily excitable and recruited
- rapidly fatigable
- used for high force activities (sprinting, hitting, jumping).

Motor unit activation, recruitment and force production

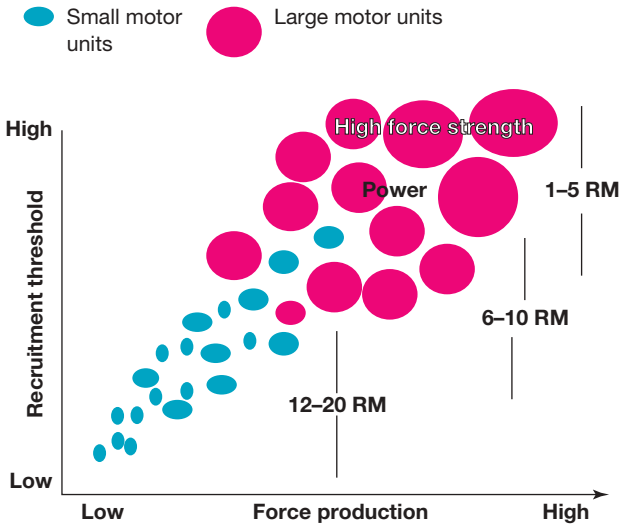
Each person's muscle strength reflects their ability to produce force to overcome a load or to produce a movement. The development of muscle force is dependent on a number of factors:

- the number and type of motor units activated
- the size of the muscle
- the initial length of muscle that is being activated
- the angle of the joint
- the muscle's speed of action.

More force can be generated when more motor units are activated. Fast-twitch motor units produce more force because each fast-twitch motor unit has a larger cell body and more axons, and innervates from 300 to 800 muscle fibres. Conversely, a slow-twitch motor unit has a small cell body and innervates from 10 to 180 muscle fibres. Large muscles have more muscle fibres, so they can produce more force than smaller muscles.

size principle states that the recruitment of motor units in skeletal muscles starts with small motor units to large motor units

FIGURE 1.25 Motor unit recruitment



EXAM TIP

The relationship between motor unit activation and recruitment will determine how much force a muscle can produce. When applying this to physical activity, sport and/or exercise in an exam question, you must refer to the 'all or nothing' principle and the size principle. A muscle will only contract if the nerve impulse going to the muscle fibres reaches a threshold. Once that threshold is reached, smaller motor units will be recruited first and, as an increase in muscle force is required, larger motor units will be recruited for a more forceful, faster contraction.

For example, a block in cricket requires lower force than hitting a six; therefore, smaller motor units will be recruited to complete this skill.

doc-41907

1.5 PRACTICAL ACTIVITY Motor unit recruitment

Goal

To investigate the relationship between motor unit recruitment and the production of force

Instructions

Complete a golf drive and a golf putt.

Primary data/Reflection

Write a brief comparison of the muscular effort and, hence, force production required to successfully complete a golf drive for distance versus a golf putt for accuracy.

Question

1. With reference to the size principle, compare the motor unit recruitment for a golf drive versus a golf putt.

1.5 Activity

1.5 Quick quiz on

1.5 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
2, 3	1, 5	4, 6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Describe** how a nervous impulse moves from the brain to a muscle site to initiate a movement.
2. **Define** the term *motor unit*. **Discuss** the differences in amount of fibres of each motor unit.

APPLY your understanding

3. **Identify** the factors that influence force production.
4. The size principle states that slower contracting, fatigue-resistant muscles are recruited initially for lower force and more prolonged activities. **Explain** why this is more efficient for the body.
5. **Compare** and **contrast** the characteristics of small and large motor units.
6. **Explain** the relationship between muscle fibre recruitment and force production when throwing for distance.

1.5 Exam questions

Question 1 (1 mark)

Source: *ACHPER 2022, Trial Exam Unit 1, Section B, Q.9;* © ACHPER

Identify the neurotransmitter responsible for initiating a muscle contraction.

A. Actin
B. Acetylcholine
C. Myosin
D. Sarcoplasm

Question 2 (2 marks)

Source: *ACHPER 2021, Trial Exam Unit 1, Section B, Q.7b;* © ACHPER

Outline the relationship between muscle activation and the 'all or nothing' principle.

Question 3 (4 marks)

Source: *ACHPER 2023, Exam Unit 1, Section B, Q.7;* © ACHPER

In the game of cricket, fielders may need to throw the ball anywhere from 1 metre up to 90 metres from the boundary line back to the cricket pitch.

With clear reference to the varying distances that could be thrown in a game of cricket (as mentioned above), **discuss** how the force produced by a muscle can be increased when performing an overhand throw.

More exam questions are available in your learnON title.

1.6 Types of muscular contractions

Key knowledge	Key skill
• types of muscular contractions (concentric, eccentric and isometric) • concept of reciprocal inhibition (the role of agonists, antagonists and stabilisers)	• examine different types of muscle contractions and differentiate the role of agonists, antagonists and stabilisers in movement

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

1.6.1 Types of muscular contractions

A muscle contraction occurs in response to a stimulus and relates to the generation of force within a muscle. While we often think of a contraction as the shortening of a muscle, this is not the only way a contraction can occur. There are three main types of muscular contractions:

- concentric
- eccentric
- isometric.

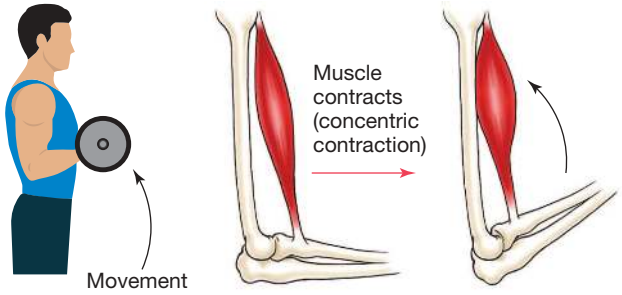
concentric contraction when the muscle length shortens as the force is being produced

eccentric contraction when the muscle length lengthens as the force is being produced

isometric contraction when a force is developed but there is no change in the muscle length

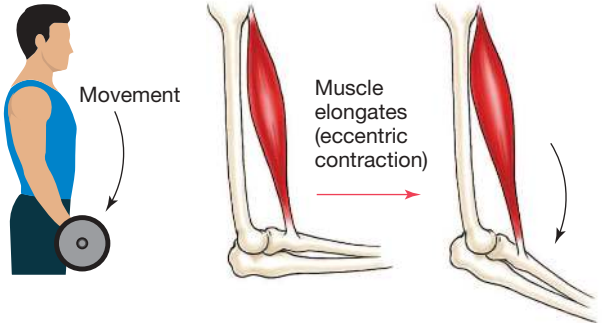
Concentric contraction

A **concentric contraction** is when muscles develop sufficient tension to overcome the resistance of the body segment. The muscle length shortens and causes joint movement to create the contraction (concentric contraction) — for example, the biceps curl where the biceps muscle shortens to lift the dumbbell from the straight arm position.



Eccentric contraction

Eccentric contraction occurs when the muscle lengthens while the force is developed to decelerate the motion of a joint. This occurs in activities that resist gravity. Eccentric contraction will slow the limb or trunk movement to allow for controlled movement of the joint/s — for example, lowering the body during a sit-up, lowering the body during a squat or even gently setting down an object. The process is similar to a drawbridge, where the bridge must be lowered with control while working against the effect of gravity.



Isometric contraction

An **isometric contraction** produces the most amount of force of any type of muscular contraction, and therefore causes the muscle to tire more quickly. The muscle generates a force, but the muscle length remains unchanged. Many sports rely on performers using isometric contractions (see figure 1.26). Examples include the rugby scrum, rock climbing, amateur wrestling holds, the position out on the trapeze in sailing, and the grip on a playing stick or racquet.

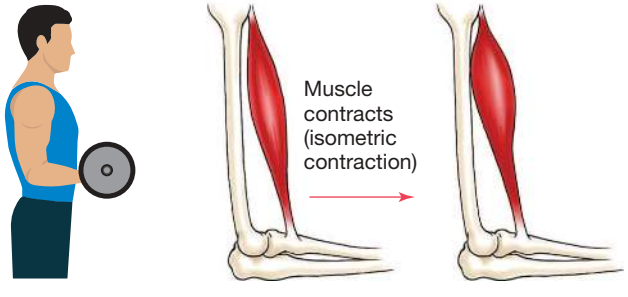


FIGURE 1.26 Isometric muscle contractions are important in many sports.

EXAM TIP

When identifying the type of contraction of a muscle during an activity, include an example using the definition to support your answer.

For example, when performing a plank, the abdominals contract isometrically because they are developing tension to hold the body in position, but the muscle length does not change.

1.6.2 Skeletal muscle action and control

Muscle action

Skeletal muscles create movement by pulling on the bones to which they are attached. They have a more rigid attachment to a bone at one end, and they are attached across a joint to another bone that is usually more moveable.

Muscle origin

- The muscle's point of attachment to the more stationary bone is called the **origin** (or the fixed end) and tends to be closer (or more proximal) to the main mass of the body. The origin of a muscle is often quite widespread because it helps 'anchor' the muscle.

Muscle insertion

- The muscle's more moveable point of attachment is called the **insertion** (the moving end) and tends to be located away (or more distal) from the mass of the body. It usually attaches to the bone near the joint that is to be moved by the muscle, and adheres in most cases by means of a strong non-elastic tendon (see figure 1.27).

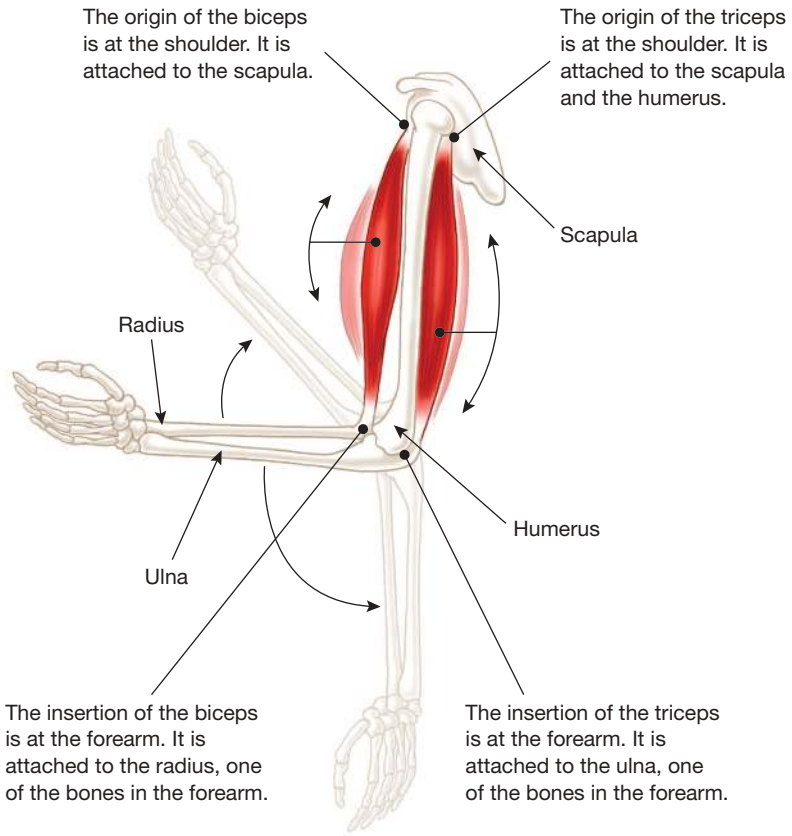
Muscle contraction

- When a muscle contracts, the origin and insertion are drawn together, shortening the muscle. The bones attached to the muscle produce movement in a specific direction. This movement is called the muscle's action. For example, the action of raising your arm by your side (abduction) is caused by the contraction of the deltoid muscle, where the insertion of the muscle at the humerus moves towards the muscle's origin at the scapula.

origin the fixed point of attachment that is closer (or proximal) to the body's midline

insertion usually attached to the bone that moves most when the muscle contracts. It is further (or distal) from the body's midline.

FIGURE 1.27 Skeletal muscles — insertions and origins



Muscle control

Skeletal muscles work in pairs or groups to produce movement — that is, as a muscle contracts on the front side of the body (anterior), usually the muscles at the back (posterior) with the opposite action relax. For example, when the quadriceps muscle group (anterior) contracts to kick a football or to push from the ground when acceleration is required during a team game, the hamstrings muscle group (posterior) must relax or stretch.

During a particular movement, a muscle performs one of the following four roles:

- **agonist** (or prime mover). This muscle causes the major action. There is usually more than one prime mover in a joint action, and there are prime mover muscles for all moveable joints.
- **antagonist**. This muscle must relax and lengthen to allow a movement to occur. It causes an opposite action to that caused by the agonist. Generally, muscle flexors and extensors work in an agonist–antagonist relationship. For example, when a person bends their elbow, the flexor (biceps) is the agonist while the extensor (triceps) is the antagonist. These roles can be reversed. For example, when a person straightens their elbow (as when serving in tennis), the extensor (triceps) is the agonist while the flexor (biceps) is the antagonist. This pairing of actions can also be seen with other movements such as adduction and abduction.
- **synergist** (or assistant). This muscle assists the agonist to produce the required movement to reduce any excessive or unnecessary movements. During elbow flexion, for example, the biceps is the agonist and it is assisted by the brachialis and brachioradialis.
- **stabiliser** (or fixator). These muscles ensure that the joint remains stable while the agonist and antagonists are working. The muscle will shorten just slightly during contraction, causing only minimal movement to allow the action to be performed more effectively. When someone shoots a goal in netball, for example, the abdominals and the erector spinae muscles contract to stabilise the body and to enable the arms and shoulders to perform the skill.

agonist the muscle that causes the major action (prime mover)
antagonist the muscle that relaxes and lengthens to allow movement to occur
synergist the muscle that assists the agonist to produce the required movement
stabiliser the group of muscles that ensures that the joint remains stable during movement

on Resources

Weblink How muscles work

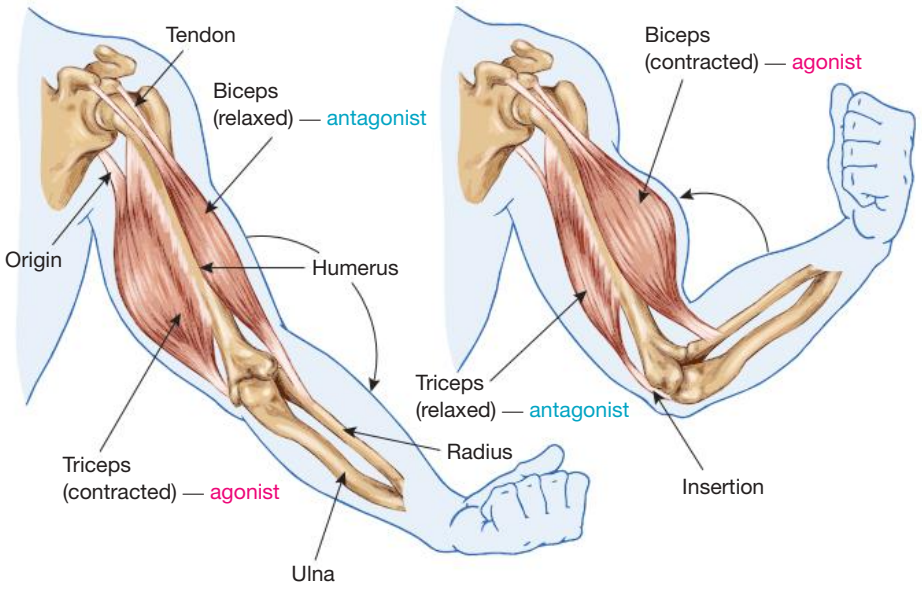
Interactivities Muscle control roles (int-6625)
Muscle action: agonist and antagonist (int-6627)

Coordinated movement: reciprocal inhibition

The process of the agonist muscle contracting and its opposing muscle, the antagonist, relaxing is called **reciprocal inhibition** (see figure 1.28). Efficient movement involves a process of give and take on each side of the joint. When you perform major movements, such as kicking a soccer ball, a coordinated sequence of these muscle actions must occur. This depends on the nervous system, because the muscles need to be stimulated to contract in the proper sequence with exact timing and with the most appropriate degree of force to provide a smooth, controlled movement. This is why beginners at a task often appear jerky — for example, either overhitting or underhitting a ball.

reciprocal inhibition the process of one muscle contracting (agonist) while the other muscle relaxes (antagonist) to create movement

FIGURE 1.28 Reciprocal inhibition: when one muscle is contracting, the opposite muscle in the pair is relaxing.



on Resources

Interactivity Reciprocal inhibition (int-9313)

doc-41908

1.6 PRACTICAL ACTIVITY Muscular contraction

Goal

To investigate the different types of muscle contractions and how muscles work together to produce movement

Instructions

Participate in a game of volleyball.

Primary data/Reflection

As you moved through each of the different positions on the volleyball court (front court/back court), consider the skills required, the types of muscular contraction and the muscle/s required to complete each movement.

Question

1. Complete the following table.

Type of contraction	Volleyball skill	Justification	Agonist muscle	Antagonist muscle
Concentric				
Eccentric				
Isometric				

1.6 Activity

1.6 Quick quiz on | **1.6 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 4, 6	3	5, 7

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Outline** the difference between origin and insertion. Provide an example.
2. **Define** the following terms:
   a. agonist
   b. antagonist
   c. synergist
   d. stabiliser.
3. Name and **describe** the three types of muscle contraction. Provide an example of each.
4. For each movement, **state** the agonist and antagonist in each exercise.
   a. A push-up
   b. A biceps curl
   c. A leg extension
   d. A sit-up

APPLY your understanding

5. **Explain** the process of reciprocal inhibition. Provide an example of a muscle pair that clearly demonstrates this process.
6. Holding the 'plank' or 'bridge' position to develop your core strength is an example of what type of contraction?
7. **Explain** what happens to the muscle length and angle of the knee joint during a concentric contraction of the hamstring.

1.6 Exam questions

Question 1 (1 mark)

The downward phase of a biceps curl would be an example of what type of contraction?

A. Eccentric
B. Concentric
C. Isometric
D. Isoinertial

Question 2 (5 marks)

The following image depicts a physiotherapist measuring the angle of movement during flexion of the left leg at the knee joint.

a. **State** what type of muscle contraction is occurring in the hamstring muscle group during flexion of the knee. **(1 mark)**
b. **State** the agonist muscle group which is mainly responsible for extending the knee. **(1 mark)**
c. **Describe** the role of the agonist and antagonist during flexion of the knee. Your response must refer to the muscle groups. **(3 marks)**

Question 3 (2 marks)

Explain how skeletal muscles must work in pairs to produce movement.

More exam questions are available in your learnON title.

1.7 Interactions of muscles and bones to produce movement

Key knowledge	Key skill
• interactions of muscles and bones to produce movement, including the structure and examples of anatomical lever systems	• participate in and analyse a variety of movements used in physical activity, sport and/or exercise to explain the interaction between bones, muscles, joints and joint actions using examples of lever systems responsible for producing movement

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

1.7.1 Levers

Throughout this topic, we have investigated the structure and functions of the skeletal and muscular systems and their contribution to movement. One cannot function without the other, hence they are more commonly known as the musculoskeletal system. So how does the musculoskeletal system create movement?

In order for movement to occur, the musculoskeletal system uses leverage. Leverage describes the action or advantage of using a lever. A **lever** refers to a rigid structure that rotates around a fixed point. It allows for the application of increased 'force' and/or 'speed'.

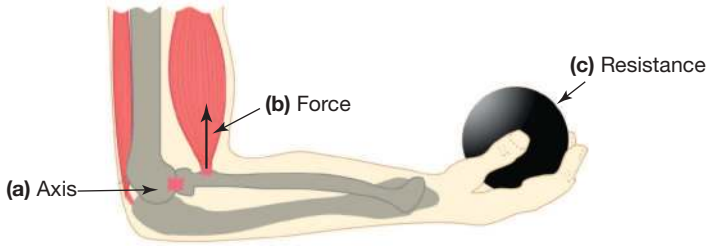
A lever is made up of three components: the axis, the force and the resistance. In the human body these are represented by:

- *axis:* the joint in the body that the lever moves around
- *force:* the muscles that contract to generate the force to move the lever
- *resistance:* the bone of the body and whatever is being held or moved by the bone.

Levers can be categorised as first class, second class or third class. A lever's class is determined by the location of the axis, force and resistance in relation to each other. The majority of levers in the human body are third-class levers and will be the focus of this subtopic.

lever a rigid structure that rotates around a fixed point

FIGURE 1.29 During a biceps curl, the axis is the elbow joint **(a)**, force is the biceps insertion point **(b)** and resistance is the lower arm and weight to be moved **(c)**.



1.7.2 Third-class levers

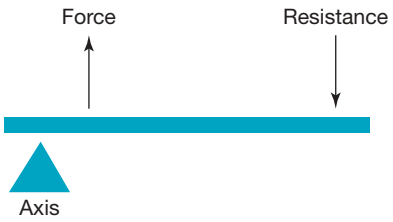
In a third-class lever, the force is located between the axis and the resistance or load to be moved.

How does a third-class lever in the body create movement?

Bones act as levers and work with the muscles to create movement. The bone creates an attachment point for the muscle. When a muscle contracts, the origin (fixed point) and insertion (moveable point) are drawn together. The muscle pulls on the bone, that is the insertion point attached across a joint, producing movement in a specific direction (see figure 1.29).

The force (muscular effort) is applied between the axis (joint) and the resistance (bone and/or equipment to be moved), allowing the desired anatomical movement to occur.

FIGURE 1.30 The majority of levers in the human body are third-class levers.



1.7.3 Why are levers important in physical activity, sport and/or exercise?

Third-class levers are built to amplify speed. As the force (muscle insertion) is close to the axis (joint), the resistance (body part or object to be moved) is further away from the axis, thus increasing the range of motion a lever can produce. From a performance perspective, this will increase the speed at which the end of the lever can move.

Levers can be used to improve performance via the use of equipment. The longer the lever (and resistance arm), the increased range of motion and therefore increased speed. This allows for an increased distance to be achieved. This is known as a mechanical disadvantage. In Unit 3 you will further investigate the mechanical advantage of a lever and how it can improve performance.

Levers in action

In the kicking action, the quadriceps (force) will contract, pulling on the tibia to cause knee extension (axis) to straighten the lower leg to move the foot (resistance) and kick the ball towards its target (see figure 1.31).

Sports that use equipment, such as racquets, sticks or bats, increase the length of the lever. The hockey stick creates a longer lever, increasing the resistance arm, allowing for the ball to be struck with increased speed. This increases its capacity to travel faster and further. In this example, the shoulder is the axis, the force is created by the deltoid moving the upper arm and stick forward, and the resistance is the ball (see figure 1.32).

FIGURE 1.31 Cortnee Vine demonstrating levers in action during the 2023 FIFA Women's World Cup

FIGURE 1.32 Hockey sticks and similar equipment increase the length of the lever.

EXAM TIP

When identifying the components of a lever, you must indicate the specific body part — a joint is the axis, the muscle that attaches over the joint is the force and the body part to be moved is the resistance.

For example, in a hamstring curl, the axis is the knee joint, the force is the hamstring attaching to the tibia and the resistance is the foot.

doc-41909

1.7 PRACTICAL ACTIVITY Levers in action

Goal

To understand the interaction of the bones, joints and muscles and how they work as part of a lever system to create movement

Instructions

Play a game of hockey. Make sure you complete a range of push passes, drives and penalty hits to discover the different ways the body can act as a lever to move the ball.

Primary data/Reflection

Draw the following actions that occur in a hockey game and indicate where the three components of a third-class lever are:

- push pass
- field hit
- running
- goalkeeper using their hands to block a high ball.

Question

1. Choose one of the actions in your reflection and outline the interactions of the bones, joints and muscles as a lever to create movement.

1.7 Activity

1.7 Quick quiz on

1.7 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 3	5	4

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Define** the term *lever*.
2. **Name** the three components of a lever and link them to structures in the musculoskeletal system.
3. **Identify** the most common lever in the human body. State the order of the components of this type of lever.

APPLY your understanding

4. Using an example of a biceps curl, **explain** how the skeletal and muscular systems use leverage to move the weight.
5. For each of the following actions, **indicate** where the axis, force and resistance are:
   a. tennis forehand
   b. shot-put at point of release
   c. cover drive in cricket
   d. smash in volleyball
   e. triceps extension.

1.7 Exam questions

Question 1 (1 mark)

Levers in the human body are comprised of an axis, force and resistance. The axis is which structure?

a. Bone b. Muscle c. Joint d. Tendon

Question 2 (2 marks)

Source: Adapted from *ACHPER 2021, Trial Exam Units 3 & 4, Section B, Q.4.c;* © ACHPER

Soccer goalkeepers are allowed to pick a ball up, within the goalkeeping area, and throw it back into play. The throw involves taking two to three steps and then releasing the ball with a straight arm.

Many elite goalkeepers can throw the ball over half the length of the pitch.

With reference to levers, **explain** why the goalkeepers can throw the soccer ball such a large distance.

Question 3 (3 marks)

Baseball is an example of a sport that uses leverage to improve performance. On the image, **label** the three components of a lever.

More exam questions are available in your learnON title.

1.8 Key skills

Key skills

- apply and use anatomical terminology to identify the structures and functions of the muscular and skeletal systems in producing movement
- examine different types of muscle contractions and differentiate the role of agonists, antagonists and stabilisers in movement
- investigate and describe the relationship between motor unit recruitment, activation and force production in movement
- participate in and analyse a variety of movements used in physical activity, sport and/or exercise to explain the interaction between bones, muscles, joints and joint actions using examples of lever systems responsible for producing movement

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

1.8.1 Tell me

To address these key skills, it is important to remember the following:

- correct anatomical names for the major bones and muscles in the body
- understand how joints are classified
- understand, identify and explain the various types of anatomical movements
- understand how muscle contraction works and the link with motor unit recruitment
- understand and identify the various types of muscle contractions and the roles of agonists, antagonists and stabilisers.

1.8.2 Show me

Practice question (10 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

Source: *ACHPER 2021, Trial Exam Unit 1 Section B, Q.1;* © ACHPER

The person in the picture above is performing a push-up.

a. **Identify** and **explain** the type of muscular contraction occurring at the *pectoral muscles* during the upward phase of the push-up. (2 marks)

b. **Identify** and **explain** the type of muscular contraction occurring at the *abdominal muscles* throughout the push-up. (2 marks)

c. **Identify** the type of synovial joint located at the *elbow*. (1 mark)

d. **Name** the two anatomical movements which occur at the joint identified in *part c*. (2 marks)

e. **Identify** the three bones that *articulate* at the elbow to create the joint. (1 mark)

f. In reference to the image of the person performing a push up, **provide** two *examples* of anatomical movements being used. (2 marks)

Decode the question

Strategies to decode the question

- **Identify the action words:**
  Identify — determine the key characteristics or features
  Explain — to make the meaning of something clear and understandable
  Name — a word used to identify something
- **Key terminology** — *pectoral muscles*, *abdominal muscles*, *elbow*, *part c*, *articulate*, *examples*
- **Key concepts** — type of muscular contraction, type of synovial joint, anatomical movements, joint, bone
- **Marking scheme** — 10 marks — Always check the marking scheme for depth of response required, linking to key information highlighted in the question.

Sample response and marking scheme

a. This is a concentric contraction as the *pectoral muscles would be shortening* during the effort.
Award 1 mark for identifying the muscular contraction type and **award 1 mark** for explaining the type of contraction.

b. This is an isometric contraction as the *abdominal muscles will remain under tension and will not change in length* for the duration of the push up.
Award 1 mark for identifying the muscular contraction type and **award 1 mark** for explaining this type of contraction.

c. Hinge joint
Award 1 mark for identifying the correct synovial joint.

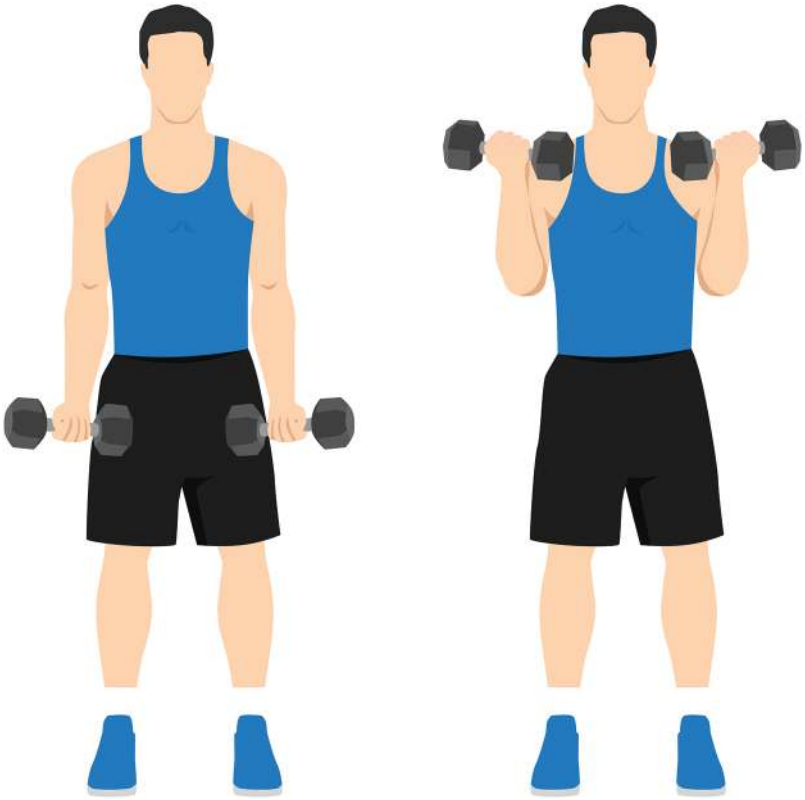
d. flexion, extension
Award 1 mark for each correct anatomical movement identified.

e. ulna, radius, humerus
Award 1 mark if all three bones are identified correctly.

f. Sample responses may include:
The person doing the push-up has their feet in a position of dorsiflexion.
The person doing the push-up has their hands in a position of pronation.
The person doing the push-up has their arms in a position of extension at the elbow.
The person doing the push-up has their legs in a position of extension at the knee.
Award 1 mark for each example of an anatomical movement being used. You must refer to two different anatomical movements to receive two marks.

1.8.3 Let me do it

Question 1 (6 marks)



a. **Identify** and **describe** the action of the elbow joint when the weight is lowered. **(2 marks)**

b. **List** the bones in the lower and upper arm that are involved in the movement identified in part **a**. **(2 marks)**

c. **Describe** the process of reciprocal inhibition referring to the biceps curl as an example. **(2 marks)**

1.9 Review

Hey students! Now that it's time to revise this topic, go online to:

Review your results

Watch teacher-led videos

Practise exam questions

Find all this and MORE in jacPLUS

1.9.1 Summary

Skeletal system

- The skeletal system has five main functions:
  - body movement
  - framework
  - protection
  - mineral storage
  - production of red blood cells.
- Bones act as levers and work with the muscular system to create movement.
- There are five types of bones: long bones, short bones, flat bones, irregular bones and sesamoid bones.
- The vertebral column provides the central structure for the maintenance of good posture.

Joints and anatomical movements

- The major joint types within the skeleton are:
  - fibrous (immoveable)
  - cartilaginous (slightly moveable)
  - synovial (freely moveable).
- Connective tissue includes cartilage, ligaments and tendons.
- Synovial joints are classified into six main types via the shape of the bones they articulate and the movements they allow:
  - ball and socket
  - hinge
  - pivot
  - saddle
  - gliding
  - condyloid.
- The anatomical position is standing erect, facing forward with arms by the sides and palms facing forward. Terms of reference help to describe where a body part is in relation to another body part.
- Anatomical movements include flexion, extension, abduction, adduction, circumduction, rotation, pronation, supination, eversion, inversion, dorsi flexion, plantar flexion, elevation and depression.

Muscular system

- The muscular system has three main functions:
  - to allow movement
  - to maintain adequate posture
  - to maintain essential bodily functions.
- The three types of muscle are smooth (involuntary), cardiac (involuntary) and skeletal (voluntary).
- Muscles are usually named from their various characteristics or locations.
- Muscle fibres are organised in different ways according to the shape (or arrangement) and function of the muscles. The main arrangements of major skeletal muscles used in physical activity are fusiform, pennate and convergent muscles.

- There are two different categories of muscle fibre:
  - fast-twitch fibres
  - slow-twitch fibres.
- Skeletal muscle consists of thousands of muscle fibres that run the length of the muscle. Each muscle fibre is made up of myofibrils. Each myofibril consists of many individual units, called sarcomeres, which contain actin and myosin and are responsible for contracting the muscle.
- Messages are sent from the brain to the muscles to initiate movement. A motor unit consists of the motor neuron plus the muscle fibres it stimulates.
- Skeletal muscles create movement by pulling on the bones to which they are attached. During a particular movement, a muscle performs one of four roles: agonist (prime mover), antagonist (relaxing muscle), synergist (assistant) or stabiliser (fixator).
- The process of the agonist muscle contracting and its opposing muscle, the antagonist, relaxing is called reciprocal inhibition.
- Muscle contractions are classified according to the movement they cause: concentric, eccentric and isometric.
- The skeletal and muscular systems work together via a lever system to create movement. A lever is a rigid structure that rotates around a joint and has three components: an axis, force and resistance.
- The most common lever in the human body is a third-class lever where the joint is the axis, the force is the muscle and the resistance is the bone of the body or whatever is being moved by the bone.

on Resources

Interactivity Structure and functions of the skeletal system quiz (int-6622)

1.9.2 Key terms

agonist the muscle that causes the major action (prime mover)
'all or nothing' principle states that if the nerve impulse meets a certain threshold, maximal action occurs in the muscle fibre. If the stimulation is less than threshold, no muscle action occurs in the muscle fibre.
anatomical position standing erect, facing forward with arms by the side and palms facing forward
antagonist the muscle that relaxes and lengthens to allow movement to occur
calcium a mineral found mainly in the hard part of bones and which is essential for healthy bones. It is also important for muscle contraction, nerve transmission, enzyme activity and blood clotting.
cartilage a tough, fibrous connective tissue located at the end of bones and between joints. It protects bones by absorbing the impact experienced in movements such as jumping.
concentric contraction when the muscle length shortens as the force is being produced
eccentric contraction when the muscle length lengthens as the force is being produced
epiphyseal plates (or growth plates) the growth centre of developing bones
haemoglobin a substance found in red blood cells that transports oxygen around the body
insertion usually attached to the bone that moves most when the muscle contracts. It is further (or distal) from the body's midline.
involuntary control refers to having no conscious control of the muscle
isometric contraction when a force is developed but there is no change in the muscle length
lever a rigid structure that rotates around a fixed point
ligament a strong fibrous band of connective tissue that holds together two or more moveable bones or cartilage
motor unit consists of one motor neuron and the muscle fibre it stimulates. (Each neuron may stimulate a number of muscle fibres.)
myofilament individual protein filaments of myosin (thick filament) and actin (thin filament) that make up a myofibril
origin the fixed point of attachment that is closer (or proximal) to the body's midline
reciprocal inhibition the process of one muscle contracting (agonist) while the other muscle relaxes (antagonist) to create movement
sarcomere the smallest unit of muscle contraction

size principle states that the recruitment of motor units in skeletal muscles starts with small motor units to large motor units
skeletal system a rigid structure made of bones that provides support, protection and sites to which muscles attach to create movement
stabiliser the group of muscles that ensures that the joint remains stable during movement
synergist the muscle that assists the agonist to produce the required movement
synovial joint a freely moveable joint that allows movement in one or more directions, and has a joint capsule
tendon a fibrous connective tissue that attaches muscles to bones
vertebrae the 33 moveable and immoveable bones that make up the vertebral column
vertebral column (or spine) the column of irregular bones comprised of three distinct curves that provides the body's central structure for the maintenance of good posture
voluntary control refers to having conscious control of the muscle

1.9 Exam questions

1.9 Section A — Multiple choice questions

Question 1 (1 mark)

Source: *ACHPER 2020, Exam Unit 1, Section A, Q.1;* © ACHPER

What is the joint action at the elbow joint, as the body is lowered, when performing a push-up?

A. Abduction
B. Adduction
C. Extension
D. Flexion

Question 2 (1 mark)

Source: *ACHPER 2021, Exam Unit 1, Section A, Q.11;* © ACHPER

In relation to synovial joints in the human body, which of the following statements is correct?

A. Synovial joints allow limited movement.
B. An example of a synovial joint is a saddle joint, such as the hip joint.
C. A pivot joint allows for rotational movement, usually one bone around another.
D. Types of synovial joints include saddle, sliding and pivot.

Question 3 (1 mark)

Source: *ACHPER 2022 Exam Unit 1, Section A, Q.4;* © ACHPER

Identify the muscle fibre arrangement in the deltoid muscle.

A. Multipennate
B. Bipennate
C. Parallel
D. Unipennate

Question 4 (1 mark)

Source: *ACHPER 2022, Exam Unit 1, Section A, Q.6;* © ACHPER

During a muscle contraction, myosin filaments attach to and pull the _____ in the cross bridges.

A. thick filaments
B. actin filaments
C. A-bands
D. H-zone

Question 5 (1 mark)

Source: *ACHPER 2021, Exam Unit 1, Section A, Q.3;* © ACHPER

Slow-twitch muscle fibres are best suited to:

A. anaerobic activities.
B. high intensity, long duration activities.
C. aerobic activities.
D. low intensity, short duration activities

Question 6 (1 mark)

Source: *ACHPER 2023 Exam Unit 1, Section A, Q.4;* © ACHPER

When a threshold is reached, the motor units of a skeletal muscle will contract, causing muscular movement. This is known as:

A. reciprocal inhibition.
B. all or nothing principle.
C. motor unit recruitment.
D. size principle.

Question 7 (1 mark)

Source: *ACHPER 2021, Exam Unit 1, Section A, Q.13;* © ACHPER

When referring to the size principle:

A. recruitment of motor units starts with smaller motor units and progresses to larger motor units.
B. when electrical impulses reach a certain threshold, all of the fibres in a motor unit will contract maximally.
C. as force increases, there will be an increase in smaller motor units being recruited for force production.
D. recruitment of motor units starts with larger motor units and progresses to smaller motor units.

Question 8 (1 mark)

Source: *ACHPER 2020, Exam Unit 1, Section A, Q.7;* © ACHPER

Biceps brachii is responsible for:

A. extension of the lower arm.
B. circumduction of the lower arm.
C. flexion at the elbow.
D. rotation at the shoulder.

Question 9 (1 mark)

Source: *ACHPER 2020, Exam Unit 1, Section A, Q.8;* © ACHPER

Reciprocal inhibition is:

A. the way in which muscle pairs work together to enable movement.
B. the preferential recruitment of muscle fibres during an activity.
C. the capacity by which muscle fibres respond to the strength of the stimulus.
D. the relative strength of muscles resulting from muscle arrangement type.

Question 10 (1 mark)

Source: *ACHPER 2019, Exam Unit 1, Section A, Q.8;* © ACHPER

When the triceps contracts concentrically:

A. the shoulder flexes.
B. the elbow flexes.
C. the elbow extends.
D. the shoulder extends.

1.9 Section B — Short answer questions

Question 1 (5 marks)

Answer the following questions.

a. **Name** and **describe** the anatomical movement responsible for raising the athlete up from the floor to the position shown in the image. **(2 marks)**

b. Which agonist muscle group is mainly responsible for raising the athlete up from the floor to the position shown in the image? **(1 mark)**

c. **Identify** and **describe** the type of contraction required to hold the position above. **(2 marks)**

Question 2 (9 marks)

Source: *ACHPER 2020, Exam Unit 1, Section B, Q.3;* © ACHPER

A synovial joint is a specialised joint which allows movement and has a joint capsule.

a. Which type of synovial joint is the shoulder? **(1 mark)**

b. Identify the three bones which make up the shoulder joint. **(3 marks)**

c. The shoulder is the most mobile joint in the body. Name two possible anatomical movements at the shoulder joint. **(2 marks)**

d. Using an example, discuss the role of shoulder joint ligaments and tendons in producing movement for physical activity. **(3 marks)**

Question 3 (4 marks)

Source: *ACHPER 2023, Exam Unit 1, Section B, Q.1c;* © ACHPER

The image below demonstrates a person performing a squat. Their stabilising muscles are the abdominals.

Using the example of a squat, discuss the role of the stabilising muscles.

Question 4 (8 marks)

Source: *ACHPER 2021, Exam Unit 1, Section B, Q.8;* © ACHPER

Keiko is a 20-year-old sprinter who competes in the 100-metre and 200-metre events.

She recently undertook some physiological testing to get a better understanding of factors which may improve her performance. Keiko's muscle-fibre type results are outlined in the table below.

Muscle fibre characteristics	Keiko's results
Phosphocreatine stores	High
Capillary density	Low
Oxidative enzymes	Low
Contraction speed	High
Mitochondrial density	Low

Referring to information from the table, discuss whether Keiko is suited to her chosen event.

Question 5 (6 marks)

Source: *ACHPER 2022, Exam Unit 1, Section B, Q.7;* © ACHPER

a. **Describe** the term *motor unit*. **(1 mark)**

b. **Explain** how muscles are activated with reference to the 'all or nothing' principle. **(2 marks)**

c. Using the example of tennis, **describe** the difference in motor unit recruitment between a forehand drive and a volley at the net. **(3 marks)**

Continue to build your exam skills

Access the Unit 1 Area of Study 1 Review at the end of Topic 3. This includes:

- Practice extended response
- Practice examination
- Practice school-assessed coursework.

2 Injuries and illnesses of the musculoskeletal system

2.1 Overview

Hey students! Bring these pages to life online

Watch videos

Engage with interactivities

Answer questions and check results

Find all this and MORE in jacPLUS

LEARNING SEQUENCE

2.1 Overview
2.2 Injuries and illnesses of the musculoskeletal system
2.3 Physiological strategies to prevent musculoskeletal injuries
2.4 Physical aids to support the musculoskeletal system
2.5 Key skills
2.6 Review

2.1.1 Introduction

An inherent risk of participation in physical activity, sport and/or exercise is injury to muscles and bones. The type of injury sustained by an individual varies according to the cause of injury. This could be as simple as rolling an ankle while walking on an uneven surface, or as complex as sustaining a concussion after a heavy collision with an opponent in a team sport.

Along with injuries, musculoskeletal illnesses such as arthritis and osteoporosis can reduce the functionality and mobility of an individual and their capacity to remain physically active.

There are several ways that an individual can minimise the risk of injury and maintain optimal functioning of the musculoskeletal system. Being physically fit, training appropriately for the activity and wearing protective equipment can all reduce the incidence of common injuries. After an injury, the use of taping, braces and a rehabilitation program will assist an individual to continue to be physically active.

FIGURE 2.1 Injuries can occur when participating in physical activity, sport and/or exercise. What can an individual do to reduce this risk?

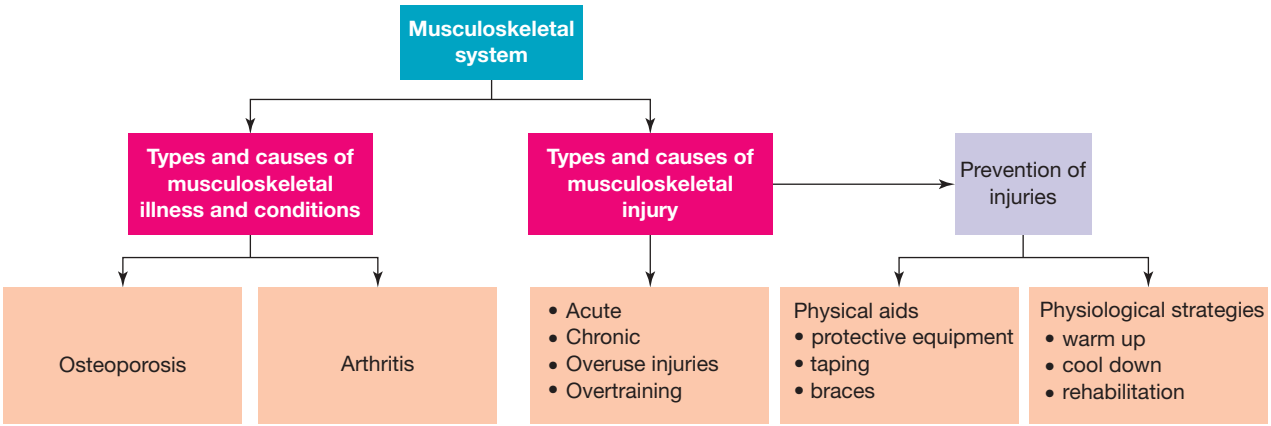
In this topic, you will explore the causes of injuries and illnesses that affect the musculoskeletal system, ways to minimise the risk of sustaining an injury and how to optimise functionality to remain physically active.

2.1.2 Key knowledge and Key skills

Key knowledge	Key skills	Subtopic
• causes of potential acute and chronic injuries and illness associated with the musculoskeletal system such as overtraining, arthritis and osteoporosis	• explore a variety of causes of musculoskeletal injuries	**2.2**
• physiological strategies to prevent musculoskeletal injuries such as warm up, cool down and rehabilitation	• implement and describe the correct application of physical aids and physiological strategies in a variety of sporting activities to maintain optimal functioning of the musculoskeletal system	**2.3**
• the role of physical aids that support the musculoskeletal system such as protective equipment, taping and braces	• implement and describe the correct application of physical aids and physiological strategies in a variety of sporting activities to maintain optimal functioning of the musculoskeletal system	**2.4**

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

2.1.3 Topic preview



2.2 Injuries and illnesses of the musculoskeletal system

Key knowledge	Key skill
• causes of potential acute and chronic injuries and illness associated with the musculoskeletal system such as overtraining, arthritis and osteoporosis	• explore a variety of causes of musculoskeletal injuries

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

Australians are encouraged to be physically active for good health. Current guidelines recommend that Australians be active on most, if not all, days of the week (see topic 7).

People who lead sedentary lifestyles and do not engage in sufficient physical activity are at a greater risk of ill health and possible death from a range of chronic illnesses and diseases. But as people engage more in physical activity, sport and/or exercise, there is greater potential for them to develop a **musculoskeletal injury**.

musculoskeletal injury any damage that occurs to the structures of the muscular or skeletal systems of the body

Injuries of the musculoskeletal system are a common occurrence during physical activity. Sports injuries can occur via accidents, poor training practices, improper equipment, clothing and footwear, as well as not being in the proper condition to participate in the selected physical activity. Once an injury is sustained, it affects the ability of the individual to effectively participate in sport and/or physical activity and can lead to further damage if not treated properly.

All areas of the body are at risk of suffering an acute injury. Injuries are largely preventable and a variety of measures can be taken to reduce this risk; these are discussed in lessons 2.3 and 2.4. If not treated correctly, such injuries may become chronic or progress to a form of overuse injury.

2.2.1 Causes of injuries

An **acute injury** is one that occurs quickly and for which pain and loss of function is immediate. Acute injuries are classified according to how the injury occurred; either via a **direct** (external force) or **indirect** (internal force) mechanism (see figure 2.2).

Acute injuries can be further classified by the structure that is injured (e.g. bone, ligament, muscle, joint) and the nature of the injury (e.g. fracture, sprain, strain) (see table 2.1). For example, a netballer who changes direction suddenly may sprain their ankle.

acute injury an injury that occurs quickly and for which pain and loss of function is immediate

direct injury an injury caused by external force

indirect injury an injury caused by internal force

FIGURE 2.2 This acute injury could have been sustained through a collision with an opposition player (direct injury) or by quickly changing direction (indirect injury).

TABLE 2.1 Types of acute injuries

Type of acute injury	Caused by	Possible mechanism	Likely injury
Direct	External force	• Collisions between people • Direct contact with equipment	• Bruise • Cork • Fracture • Cut • Concussion
Indirect	Internal force	• Overstretching connective tissue • Losing balance	• Sprain • Strain • Tear

Specific examples of these injuries are presented in tables 2.2 and 2.3.

Chronic injuries tend to start out as acute in nature, and then recur as a result of re-injury through a prolonged weakness or insufficient rehabilitation following the previous injury. Recurring hamstring strains in AFL players are chronic injuries.

chronic injury an injury that recurs due to weakness or insufficient rehabilitation

Resources

Interactivity Injury types and definitions (int-6630)

2.2.2 Acute injuries: soft and hard tissue

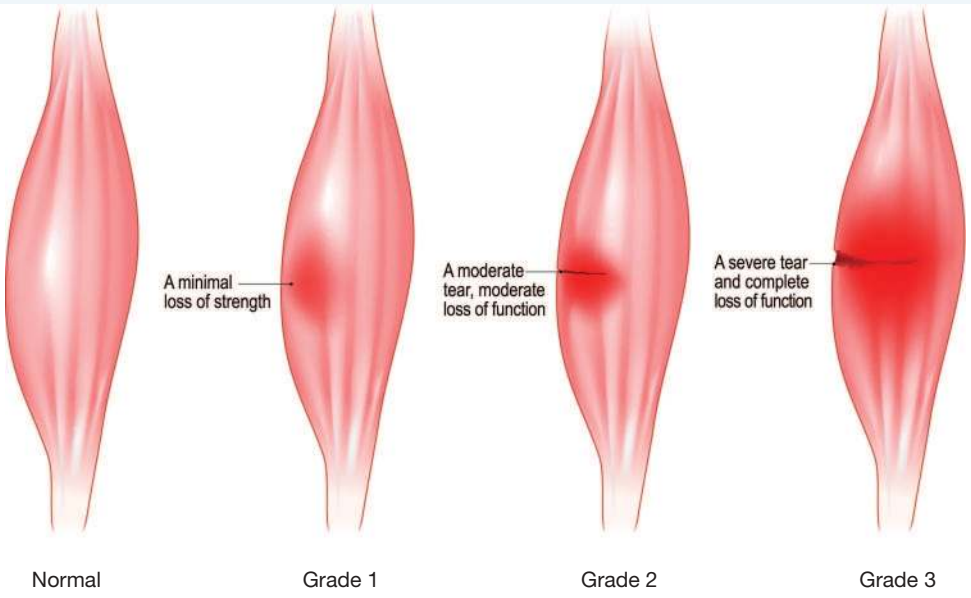
Soft-tissue injuries include any damage to skin, muscles, tendons and ligaments.

- A *tear* occurs when connective tissue — such as muscles, tendons and ligaments — is excessively stretched or ruptured. A tear can be either a:
  - *strain:* muscle or tendon (e.g. strained hamstring)
  - *sprain:* ligament (e.g. sprained ankle).

FIGURE 2.3 Pain experienced in the lower leg when running can be due to a muscle strain.

These injuries occur when the connective tissue fibres cannot cope with the stress being placed on them (e.g. when a muscle contracts too quickly during the sudden acceleration in a sprint take-off) or when a joint is overextended (e.g. during a side push on the knee during a football tackle). Strains and sprains are classified by the number of fibres torn and thus the severity of the injury (see figure 2.4).

FIGURE 2.4 Grades of tears for muscle strain

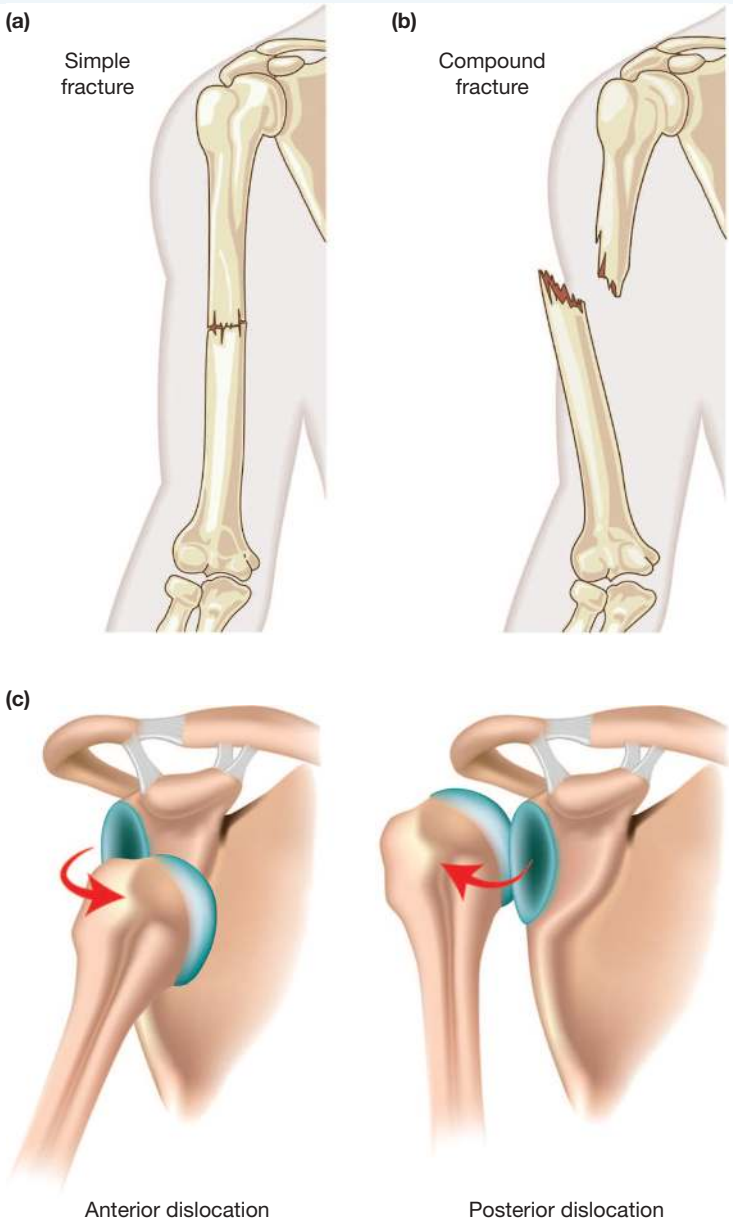


- A *contusion* (or bruise) is caused by bleeding into the soft tissue. This generally results from a direct blow to the site via a collision with a player or piece of equipment (e.g. being hit by a cricket ball) or from a heavy fall.

Hard tissue injuries involve the bones and joints of the skeleton. The most common injury to bones is a fracture.

- A *fracture* is a break to the bone and it can be closed or open (compound), where the bone has broken through the skin (see figure 2.5). A fracture can be caused by direct trauma to the area such as a blow, or an indirect trauma such as falling on an outstretched hand. Signs and symptoms of a fracture can include pain, swelling, bruising, tenderness, difficulty moving or deformity.
- *Dislocations* occur at a joint and involve the bones forming the joint being displaced. They damage both the hard tissue of bone and the surrounding connective tissue. Dislocations generally result from excessive movement of a joint; for example, falling awkwardly when landing a gymnastics routine. Signs and symptoms include pain, swelling, tenderness, deformity or loss of movement. A partial dislocation is known as a subluxation.

FIGURE 2.5 (a) A simple fracture **(b)** a compound fracture **(c)** a dislocated shoulder



Tables 2.2 and 2.3 summarise the types of sporting injuries that may occur to different body structures and their possible causes.

TABLE 2.2 Types of soft-tissue injuries

Type of injury	Structure injured	Possible cause
Sprain	Ligament	Excessive movement forcing the joint past its maximum range of motion, or external violence such as a side push on the knee during a football tackle
Strain	Muscle or tendon	Overstretching of muscle or tendon generally during sudden acceleration or deceleration
Contusion (bruise or haematoma) or a cork	Muscle, tendon, skin	Direct blow from a collision with a player or piece of equipment, or from a heavy fall
Open wound — cut, abrasion, laceration	Skin	Direct blow from a collision with a player or piece of equipment

TABLE 2.3 Types of hard-tissue injuries

Type of injury	Structure injured	Possible cause
Fracture	Bone	Direct trauma such as a blow; indirect trauma such as falling on an outstretched hand
Dislocation/subluxation	Joint	Excessive movement of the joint

2.2.3 Overuse injuries

Overuse injuries are caused by excessive and repeated use of the same muscle, bone or joint, and are usually diagnosed by the presence of inflammation and pain. These injuries tend to be prolonged, taking a long time to recover (such as shin splints and stress fractures). Overuse injuries may occur via:

overuse injury an injury caused by excessive and repeated use of the same muscle, bone or joint

- internal causes (e.g. muscle imbalance, anatomical problems such as poor posture)
- external causes (e.g. training errors, incorrect technique, or uneven surfaces or hard running tracks).

The main examples of overuse injuries seen in athletes are summarised in table 2.4.

TABLE 2.4 Types of overuse injuries

Overuse injury	Signs and symptoms	Possible causes
Shin splints	Initial pain may be caused by slight inflammation in the muscles; over time, pain can become constant and extremely uncomfortable.	• Poor posture • Excessive training during an adolescent growth spurt or the beginning of a training program • Fallen arches in the feet • Biomechanically incorrect gait • Muscle fatigue in the lower limbs • A strength imbalance between anterior and posterior muscles in the lower leg
Osteitis pubis: irritation and/or overuse of the joint between the pubic bones of the pelvis	• Gradual onset of groin pain with an increasing level of discomfort • Pain when kicking, running, twisting or completing turning movements • Pain when contracting abdominal muscles • Significant loss of kicking strength or length • Reduction in maximum running speeds	A combination of: • high running loads • frequent changing of direction at pace • the kicking action • muscle imbalance (abdominals)

(continued)

TABLE 2.4 Types of overuse injuries *(continued)*

Overuse injury	Signs and symptoms	Possible causes
Stress fracture	• Tenderness and swelling in a particular area • Pain that increases over time	• High-impact sports or activities • Increasing the amount or intensity of an activity too quickly • Weakened bones • Feet problems — flat feet or high arches
Patellar tendonitis	• Patellar tendon inflamed and tender • Pain is often felt at the end of a session or when the athlete has cooled down	• Running, jumping or high-impact activities • Growth spurt
Tennis or golfer's elbow	• Recurring pain on the outside of the upper forearm just below the bend of the elbow; occasionally pain radiates down the arm towards the wrist • Difficulty extending the forearm fully because of inflamed muscles, tendons and ligaments • Pain caused by lifting or bending the arm or grasping even light objects such as a coffee cup	• Poor technique • Equipment • Sudden increase in training/activity

2.2.4 Overtraining

Overtraining is often a cause of overuse injuries. Examples of overtraining include insufficient recovery time between bouts of physical activity; excessive training volume (several sessions every day of the week); and inappropriate increases in the frequency, duration and/or intensity of physical activity.

The key to avoiding overtraining is prevention. Structuring sessions to include adequate rest and recovery, and including gradual increases in training loads is vital to preventing injury.

overtraining when an individual trains in a way that does not allow their body to recover sufficiently; symptoms can include a decrease in physical performance, increased fatigue, persistent muscle soreness, mood disturbances and a feeling of being 'burnt-out'

TABLE 2.5 The various signs and symptoms of overtraining that can lead to increased risk of injury

Physiological symptoms	Psychological symptoms	Miscellaneous symptoms
• Persistent feelings of fatigue • Chronic muscle soreness • Increased or decreased morning resting heart rate (beyond normal variation) • Increased heart rate during sub-maximal exercise at a given workload (beyond normal values) • Earlier onset of fatigue during exercise bouts • Decreased performance during strength and power testing • Decreased coordination and disturbances in rhythm of movement	• Decreased concentration span • Decreased motivation levels • Increased irritability and anger • Depression • Increased anxiety levels • Increased fear of competition • Increased sensitivity to emotional stress • Increasing tendency to give up and believe that the challenge is too difficult • Increased susceptibility to demoralising influences before and during competition	• More frequent illnesses • Loss of appetite • Increase in overuse injuries • Insomnia • Lack of enjoyment of training and competition

EXAM TIP

When discussing musculoskeletal injuries, a clear link needs to be made to the physical activity, the body part injured, the type of injury sustained and possible causes.

For example, a gymnast may suffer an ankle sprain from landing awkwardly after dismounting from the balance beam.

2.2.5 Common sports injuries

An athlete can expect to suffer a number of different sports injuries during their career. The severity of each injury will vary greatly in terms of injury damage, recovery and rehabilitation. Some sports lend themselves to specific types of injuries. Table 2.6 shows the types of sporting injuries and their causes.

TABLE 2.6 Acute sports injuries

Area of body	Cause of injury	Signs of injury
Head		
Concussion	Blow to the head or heavy fall	Loss of consciousness; vomiting; loss of memory; headache or drowsiness
Chest		
Winded	Heavy blow to the chest or abdomen	Gasping for breath; pain; nausea
Abdomen		
Stitch	Possible causes: • air bubbles in the duodenum • spasm of the diaphragm	Pain in the side of the abdomen
Shoulder		
Dislocation	Falling on an outstretched arm	Shoulder and arm in abnormal frontal position; resultant damage to ligaments and joint capsule; severe pain at point of injury; swelling
Broken clavicle (collarbone)	Falling on an outstretched arm	The need to support the elbow of the broken side
Elbow		
Dislocation	Falling on an outstretched hand	Deformity at elbow causing loss of movement; swelling; extreme pain
Hand/finger		
Dislocated fingers	Direct blow to the hand/finger, usually caused by an object such as a ball or stick	Deformity; swelling; localised pain
Thigh		
Cork (haematoma)	Direct contact with an object or body	Weakness in strength and power of the muscle; reduced range of motion; localised pain and swelling
Strain in quadriceps/hamstrings	Sudden overstretching or contraction of muscle	Sudden and severe localised pain when muscle is contracted; reduced mobility, strength and power
Knee		
Patella dislocation	Forceful twist of knee while bearing weight	Deformity and loss of function of knee; extreme pain; swelling

(continued)

TABLE 2.6 Acute sports injuries *(continued)*

Area of body	Cause of injury	Signs of injury
Rupture of anterior cruciate or ligament sprain	Falling awkwardly and twisting knee	Sound of 'pop' or 'crack' in the knee; immediate pain in knee, which is sore to touch; some restricted movement
Torn cartilage (menisci)	As for sprain	Swelling may be evident or occur later; other signs as for sprain
Ankle		
Sprain	Twisting the ankle or playing on uneven surfaces	Immediate pain in ankle, which is sore to touch; restricted movement; swelling
Achilles tendon rupture	Extremely powerful contraction of the calf muscles	Deformity of the Achilles tendon; a lump in the middle of the calf muscle; loss of movement of foot; pain

on Resources

Interactivity Acute sports injuries (int-6631)

2.2.6 Illnesses of the musculoskeletal system

As well as injuries to the musculoskeletal system during physical activity, sport and exercise, there are many illnesses affecting both the muscular and skeletal systems that can impact on the ability of an individual to engage in regular physical activity.

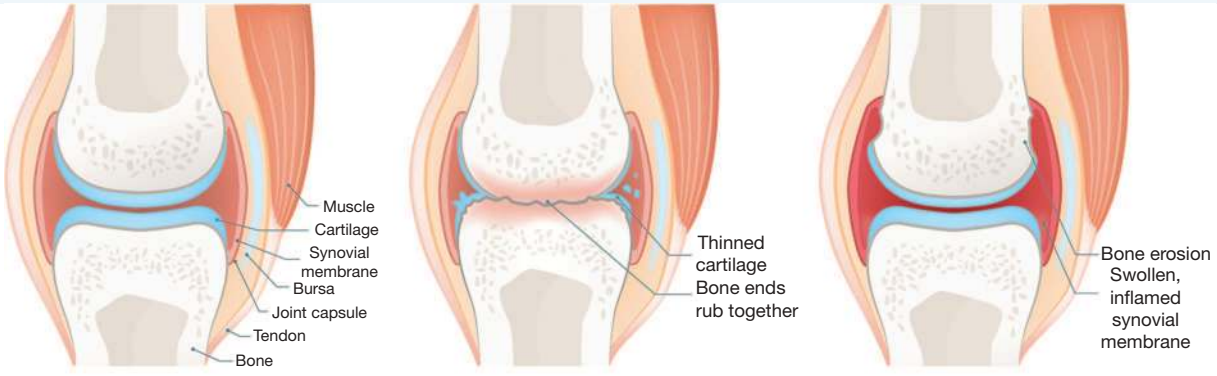
The Australian Institute of Health and Welfare (AIHW) estimates that in 2020–2021, 6.9 million Australians (27 per cent of the population) reported they were affected by a musculoskeletal condition. These conditions affect bones, muscles, joints and ligaments, and often limit the capacity and mobility of an individual via reduced joint function, pain and psychological distress. Common conditions in Australia include arthritis (including osteoarthritis, juvenile arthritis and rheumatoid arthritis) and osteoporosis.

Arthritis

Arthritis is characterised by inflammation of the joints in the body, causing pain and stiffness. It can impinge on the joint via weakness, instability and deformity around the joint structure (see figure 2.6). Arthritis is estimated to affect 3.6 million Australians (15 per cent) (AIHW, 2018). Arthritis more commonly affects females than males and its prevalence increases with age, especially after the age of 45. Arthritis can restrict the ability of an individual to engage in daily activities such walking, preparing food and general hygiene.

arthritis a condition characterised by inflammation of a joint, causing pain and stiffness

FIGURE 2.6 Normal and arthritic joints



There are over 100 forms of arthritis but the most significant ones affecting an individual's ability to participate in physical activity are shown in table 2.7.

TABLE 2.7 The most common types of arthritis

Type	Who is affected?	Symptoms	Areas affected	Causes
Juvenile arthritis	Children under 16 years old (less than 1% of Australian children)	• Severe swelling • Tenderness • Stiffness and pain in and around the affected joint/s	Generally larger joints, such as the knees, ankles, wrists or elbows	Currently not fully understood
Osteoarthritis	• People between 40 and 55 years old • Women (generally) • Athletes	• Grating sensation due to cartilage on the end of the bones wearing away • Swelling • Tenderness • Pain in and around the affected joint/s	Mostly weight-bearing joints, including the hip, knee or ankle	• Age • Physical inactivity • Excess body weight • Joint trauma • Repetitive stress on a joint
Rheumatoid arthritis	• Any age, but more likely in people over 60 • Women (generally)	• Pain • Swelling • Stiffness • Deformity	Smaller joints such as the hands and feet	The immune system attacking the tissues lining the joints (autoimmune response)

For all forms of arthritis, regular physical activity is beneficial. The benefits include improving the mobility and flexibility of joints, increasing muscle strength, and improving posture and balance. Physical activity also decreases pain, feelings of fatigue and tiredness, and muscle tension and stress. Engaging in physical activity also results in an improvement in overall health and maintenance of a healthy body weight. Excess body weight can contribute to the symptoms of arthritis, especially in the weight-bearing joints of the body.

The type of physical activity chosen should take into consideration the individual's condition and limitations. Lower-impact exercises are often more comfortable as they put less force on the joints. These exercises might include:

- flexibility exercises (e.g. stretches, to maintain or improve the mobility of joints and muscles)
- muscle strengthening (e.g. resistance training with weights to develop strong muscles to support the joints and connective tissue)
- aerobic activities (e.g. brisk walking and swimming to improve heart and lung health)
- non weight-bearing exercises (e.g. water-based activities, such as swimming, water exercise classes, hydrotherapy).

on Resources

Weblink Arthritis Australia

Osteoporosis

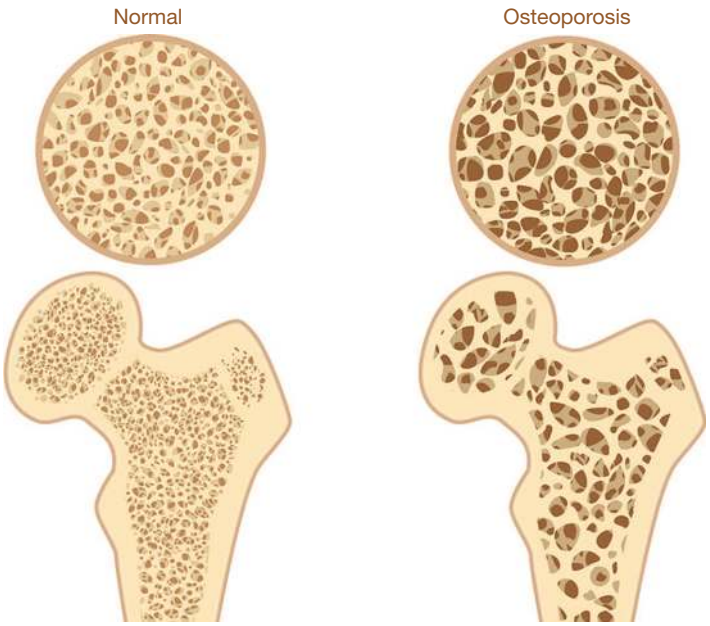
Osteoporosis is a musculoskeletal condition characterised by the thinning and weakening of a bone, making it very fragile. This occurs when the bone loses minerals, in particular calcium, quicker than the body can replace them. This loss impairs the density of the bone and increases the risk of fracture in comparison to a normal bone (see figure 2.7).

osteoporosis a condition in which the bones become weak and thin, and therefore brittle

Osteoporosis affects 3.8 per cent of the Australian population. It is more common in women than men and has a higher incidence in people over the age of 55 (AIHW). It is often called the 'silent disease' as it has little to no symptoms and people may not know they have it until a fracture occurs. Once a fracture occurs, sufferers may have mobility concerns, especially if the fracture occurs in the spine, pelvis or lower limbs.

Osteoporosis is a largely preventable condition. Risk factors for developing osteoporosis include sedentary behaviour and lack of exercise, as well as nutritional concerns such as poor calcium intake and vitamin D deficiencies. Participation in regular physical activities (particularly those that place 'stress' on the bone, such as weight-bearing activities) helps to maintain and/or improve bone density and strengthen the muscles that attach to these bones. Stronger bones and muscles improve posture and balance, and reduce the likelihood of falls and subsequent breaks in the bones.

FIGURE 2.7 A normal bone compared with a bone affected by osteoporosis



Osteoporosis is a largely preventable condition.

Risk factors for developing osteoporosis include:

- sedentary behaviour
- lack of exercise
- poor calcium intake
- vitamin D deficiencies.

Participation in regular physical activities (particularly those that place 'stress' on the bone, such as weight-bearing activities) helps to maintain and/or improve bone density and strengthen the muscles that attach to these bones. Stronger bones and muscles improve posture and balance, and reduce the likelihood of falls and subsequent breaks in the bones.

FIGURE 2.8 (a) Eating foods rich in Vitamin D and calcium and **(b)** doing weight-bearing activities can help reduce the risk of developing osteoporosis.

on Resources

Weblink Osteoporosis Australia

Table 2.8 summarises a range of risk factors and musculoskeletal conditions.

TABLE 2.8 Summary of risk factors and preventative measures for a range of musculoskeletal conditions

Musculoskeletal conditions	Description	Risk factors	Preventative measures
Rheumatoid arthritis	Chronic disease of the joints causing pain, swelling, stiffness, and irreversible damage and deformity	• Age • Gender (female) • Family history • Tobacco use	• Regular participation in physical activity • Not smoking • Nutrient dense, balanced diet
Osteoarthritis	Degenerative condition resulting from overuse of a joint where cartilage wears away, causing bones to rub together	• Increasing age (after 45 years) • Physical inactivity • Overweight/obesity • Joint trauma from previous injury • Repetitive stress on a joint	• Regular participation in physical activity • Maintenance of healthy body weight
Osteoporosis	Characterised by thinning and weakening of the bone, making it very fragile	• Sedentary behaviour • Physical inactivity • Poor calcium intake • Vitamin D deficiency • Increasing age (after 55 years) • Gender (female)	• Regular participation in weight-bearing activities • Nutritious diet, including calcium and foods high in Vitamin D

on Resources

Digital document Risk factors and preventative measures for musculoskeletal conditions (doc-18669)

doc-41910

PRACTICAL ACTIVITY Potential injuries

Goal

To identify potential injuries that may occur in team sports

Instructions

Participate in a game of soccer as a class. Throughout the game, consider the movements that occur and the potential for injury to occur.

Primary data/Reflection

Write a brief paragraph about your participation in the soccer game. Include instances where there may have been the potential for an injury to occur. For example, changing direction quickly to defend the ball could have resulted in a sprained ankle.

Questions

1. List four movements required to participate in a game of soccer.
2. For each movement, outline how an injury might occur.

2.2 Activity

2.2 Quick quiz on | **2.2 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 3, 5, 6, 9	2, 7, 8, 10, 11	4

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Outline** the three classifications of injuries.
2. **Discuss** the difference between direct and indirect injuries. Provide examples.
3. **Describe** the difference between a strain and a sprain.
4. Is a dislocation an injury to hard tissue or soft tissue? **Explain**.
5. **Define** overtraining and include two possible causes.
6. **Outline** the difference between the three most common types of arthritis.
7. Osteoporosis is largely a preventable condition. **Discuss** this statement.

APPLY your understanding

8. **Apply** the following questions to cricket, netball and tennis.
   a. **Identify** injuries that are most likely to occur in these sports.
   b. Provide examples of how these injuries might occur.
   c. **Identify** the injuries as direct/indirect and soft/hard tissue injuries.
9. Read the following scenarios and **state** which type of injury is most likely to have occurred.
   a. A 100-metre sprinter begins his race accelerating from the blocks and feels a sharp pain in his Achilles tendon.
   b. A basketballer jumps for a rebound but lands heavily and twists her ankle.
   c. A tennis player feels discomfort in the elbow during a five-set match.
   d. A footballer hears a crack as his leg collides with an opposing player's leg while disposing of the football.
   e. Two hockey players collide heads when going for the ball, and one complains of a headache.
   f. A netballer trips over her opponent's feet in the goal circle, puts her arms out to slow her fall and hurts her shoulder.
10. **Compare** the similarities and differences between arthritis and osteoporosis.
11. For each of the musculoskeletal illnesses and conditions outlined in this topic, **suggest** ways to prevent these conditions occurring.

2.2 Exam questions

Question 1 (2 marks)
There are two types of acute injuries caused by either external or internal forces. What are these known as?

Question 2 (2 marks)
What is the difference between an open and a closed fracture?

Question 3 (1 mark)
Localised internal bleeding resulting from a collision or contact with another player is known as:
A. contusion.
B. laceration.
C. blister.
D. tendonitis.

2.3 Physiological strategies to prevent musculoskeletal injuries

Key knowledge	Key skill
• physiological strategies to prevent musculoskeletal injuries such as warm up, cool down and rehabilitation	• implement and describe the correct application of physical aids and physiological strategies in a variety of sporting activities to maintain optimal functioning of the musculoskeletal system

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

Sustaining an injury is one of the risks involved in participating in competitive sport, physical activity and/or exercise (see figure 2.9). Factors such as age, gender, health, physical fitness, skill level, sports equipment and the environment can all influence the potential for injury. It is estimated that up to 50 per cent of sporting injuries are preventable. A proactive approach to **sports injury prevention** will reduce the likelihood of injury occurring.

sports injury prevention
strategies that include any processes completed by a coach, athlete or sports administrator to minimise the risk of injury

There is a correlation between the characteristics of certain sports and the increased risk of injury to athletes. High-risk characteristics include:

- high levels of physical contact
- high-impact activity
- heavy physical demands requiring maximal exertion
- high training volume (e.g. swimming and gymnastics, which require six to nine sessions per week)
- long seasons of competition or no breaks between seasons.

Physical preparation is the key to preventing injury. Through appropriate preventative strategies, the individual is better placed to participate in their sport, physical activity and/or exercise, and reduce their risk of injury. Preventative actions include:

- performing pre-participation screening
- developing physical fitness appropriate to the activity
- developing correct skills and techniques
- completing adequate warm up, stretching and cool down procedures
- rehabilitating previous injuries.

Individuals need to be aware of these to ensure that they are in peak condition to participate in their chosen physical activity, sport or exercise.

FIGURE 2.9 Risk of injury is increased with high-risk characteristics, such as high levels of physical contact, long seasons and high-impact activity.

2.3.1 Pre-participation screening

Pre-participation screening should be undertaken by all individuals prior to commencing or increasing their physical activity, whether it is a health and fitness program or competitive sport. Pre-participation screening can take the form of questionnaires and/or physical examinations. Questionnaires are the most common form of screening and are designed to ask about the medical history of athletes. They may include questions relating to current medical conditions, allergies, family histories and previous injuries. Physical examinations provide data on parameters such as height, weight and blood pressure.

Figure 2.10 is an example of an adult pre-participation screening questionnaire produced by Exercise and Sports Science Australia (ESSA), Sports Medicine Australia, AUSactive and Exercise is Medicine Australia. This form is specifically designed to identify individuals with underlying health conditions or who are at high risk of something going wrong during exercise.

FIGURE 2.10 Pre-participation screening tool

To be completed by a young person 16-17 years old

PRE-EXERCISE SCREENING SYSTEM FOR YOUNG PEOPLE

YOUNG PERSON TOOL (PSS-YP)

Important Information: This tool is part of the Pre-Exercise Screening System and should be used in conjunction with the PSS User Guide which covers how to use the information collected and to address the aims of each stage. This does not constitute medical advice. These guidelines and the PSS (together 'the material') is not intended for use to diagnose, treat, cure or prevent any medical conditions, is not intended to be professional advice and is not a substitute for independent health professional advice. Exercise & Sport Science Australia, Fitness Australia, Sports Medicine Australia and Exercise is Medicine (together 'the organisations') do not accept liability for any claims, howsoever described, for loss, damage and/or injury in connection with the use of any of the material, or any reliance on the information therein. While care has been taken to ensure the information contained in the material is accurate at the date of publication, the organisations do not warrant its accuracy. No warranties (including but not limited to warranties as to safety) and no guarantees against injury or death are given by the organisations in connection with the use or reliance on the material. If you intend to take any action or inaction based on the guidelines and/or the PSS, it is recommended that you obtain your own professional advice based on your specific circumstances.

Child/Young Person's Details:

Full Name: _____

Date of Birth: _____ Age: _____ Gender: *Male* *Female* *Prefer not to say* *Other*

Pre-exercise screening results will be kept as confidential files and shared only among individuals involved in the event of urgent medical care, and/or with the consent of the young person and/or parent/guardian.

STAGE 1 (COMPULSORY)

To be completed with an exercise professional or individual who is responsible for the medical care of the young person.

These questions are part of a system designed for young people participating in exercise. The aim is to identify any young person with medical conditions or warning signs that may put them at a higher risk of an unwanted event during activity or exercise sessions. Unwanted events may include something unexpected during exercise leading to illness, physical harm or death.

Please tick your response

Do you have, or previously had:	YES	DON'T KNOW	NO
1. A heart condition?			
2. A close relative who has died suddenly from a heart condition before the age of 50?			
3. Uncontrolled epilepsy or seizures/convulsions?			
4. Fainting or dizzy spells with physical activity/exercise?			
5. Diabetes?			
6. An asthma attack requiring immediate medical attention at any time over the last 12 months?			
7. Anaphylactic reactions?			
8. Surgery in the last month?			
9. Any other conditions that may require special consideration for you to exercise?			
IF YOU ANSWERED 'YES' or 'DON'T KNOW' to any of the 9 questions above, please discuss with the exercise leader or the person administering this form prior to undertaking exercise.			
IF YOU ANSWERED 'NO' we recommend you proceed to Stage 2 with the exercise leader or those providing medical care.			
10. Over the past seven days, on how many days were you physically active for a total of 60 minutes or more per day?	Number of days:		

Young Person - I hereby acknowledge that:

- To the best of my knowledge, all of the information I have supplied within this screening tool is correct.
- I will inform the exercise leader or person administering this form if there are any changes to the answers above.

Name: _____ Signature: _____ Date: _____

Parent/Guardian Consent (*required if young person 15 years old or younger) - I hereby acknowledge that:

- To the best of my knowledge, all of the information supplied within this tool is correct.
- I will inform the exercise leader or those providing medical care immediately if there are any changes to the information provided.

Name: _____ Signature: _____ Date: _____

PRE-EXERCISE SCREENING SYSTEM FOR YOUNG PEOPLE - YOUNG PERSON TOOL (PSS-YP) V1 2021

Exercise is Medicine Australia · AUSactive · Sports Medicine Australia · ESSA Exercise & Sports Science Australia

on Resources

Weblinks ESSA — Pre-exercise screening systems
PAR-Q questionnaire

2.3.2 Physical preparation of athletes

Training should always ensure athletes achieve appropriate fitness levels that are specific to the sport. Athletes and coaches must correctly apply the principles of training — particularly those of specificity, appropriate progressive overload, intensity and frequency — during both the pre-season and in-season training. It is important that the athlete's preparation is thorough, but not so demanding as to cause overtraining. As discussed in 2.2.4, adequate recovery between training sessions is vital for the athlete to benefit from the session as well as prevent injury from occurring. Fatigue is one of the most common causes of injury, but physically fit athletes do not fatigue as quickly. Fitness testing in the pre-season phase will allow the coach to identify the strengths and weaknesses of individual athletes, and prepare specialised training for each individual.

2.3.3 Warm up

Prior to engaging in any form of physical activity, sport and/or exercise, an individual should complete a **warm up** to not only prepare the body for the work it is about to do, but also to reduce the risk of sustaining an injury. Physiologically, a warm up:

- increases heart rate and respiratory rate, resulting in increased delivery of oxygen to working muscles
- increases blood flow to muscles, resulting in an increase in muscle temperature and an increase in oxygen delivery to the muscle cells
- increases elasticity of the muscle fibres (and tendons) due to the increase in muscle temperature
- increases enzyme activity within the muscle cells due to increased muscle temperature, facilitating improved energy release within the muscle.

Psychologically, it prepares the mind for competition by increasing focus, attention and concentration.

A warm up allows the body to transition from rest to exercise and meet the higher demands of the conditioning phase of the activity. The length and type of activity being undertaken should determine the type of warm up conducted.

Phases of a warm up

- The *general phase* (beginning of the warm up) should include low to moderate intensity cardiovascular, whole body activities that are continuous in nature, such as jogging, cycling or swimming.
- Within this phase an individual should also include *dynamic stretching*, such as leg kicks, side swings, lunges and arm swings, where the body is actively moving through a full range of motion to target the specific joints and muscles used in the main exercise. The aim of this is to loosen and increase the mobility of the joints, muscles and connective tissue.
- The *sport/activity-specific phase* should include activities that involve agility, speed and acceleration and are directly related to the muscles, joints and body parts about to be used in the activity. These activity-related movements prepare the body for the intensity required in the main exercise and could involve activities such as:
  - run-throughs
  - high knee-lift running
  - horizontal ladder stepping
  - skill drills that replicate the specific movement patterns performed during the sport or activity (e.g. kicking a football).

warm up activities and exercise undertaken at the beginning of a training session with the aim of preparing the body both physiologically and psychologically for the training session that follows

FIGURE 2.11 Activities that can be completed in a warm up

By warming up the muscles, the risk of injury is reduced, particularly muscle strains and tears. This is because there is an increased range of motion around the joint and decreased stiffness of the surrounding connective tissue.

There is no set duration for a warm up; however, the athlete should be guided by how they feel. A general guideline is that the warm up should produce mild sweating without fatigue. The length of the warm up is related to weather temperature and, in warmer conditions the time needed for an adequate warm up is generally much less than in cooler conditions.

2.3.4 Cool down

The **cool down** assists the body to recover from exercise via completion of a low-intensity version of the activity just participated in (see figure 2.12). It is a gradual reduction in the intensity of the activity being performed, followed by a period of static and proprioceptive neuromuscular facilitation (PNF) stretching of the major muscles used in the activity. This is also known as an active recovery and assists the individual to return to pre-exercise levels at a faster rate.

Static stretching involves taking a joint through its full range of motion (that can be comfortably tolerated) and holding it for a minimum of 10 seconds.

cool down low-intensity activity completed at the end of a training session or competition that allows the body to recover faster by increasing the breakdown of metabolic waste products, such as lactic acid, and preventing venous pooling, gradually returning the body to its resting physiological state

FIGURE 2.12 Stretching is an important part of the cool down procedure.

Proprioceptive neuromuscular facilitation (PNF) involves fully lengthening the muscle and isometrically contracting it against a resistance for a period before stretching again. This process is repeated until a full stretch is achieved.

The main aims of the cool down are to:

- prevent venous pooling (accumulation of blood in the veins)
- ensure that metabolic waste products, such as lactic acid, are broken down and removed from the blood at a faster rate
- reduce the potential for muscle soreness
- allow the body to return to its resting physiological state faster.

The length of a cool down can vary depending on the athlete and type of activity undertaken. It is the first stage in the recovery process.

EXAM TIP

A warm up and cool down have different components to meet the purpose of the injury prevention. Make sure you outline each phase with an example of an activity that specifically relates to the physical activity it is designed for.

For example, a warm up for a freestyle swimmer should include swimming laps of the pool at a low to moderate intensity for 5 minutes followed by dynamic stretching that focuses on the upper body, such as forward and backward arm circles.

2.3.5 Rehabilitation

Rehabilitation is an important part of recovery once an injury is sustained. It is the process of returning to optimal functioning as well as reducing the chance of re-injury. Recovery times can vary depending on the type and severity of injury. A mild ankle sprain may only take a week, whereas a complete tear of a ligament can take months to fully recover.

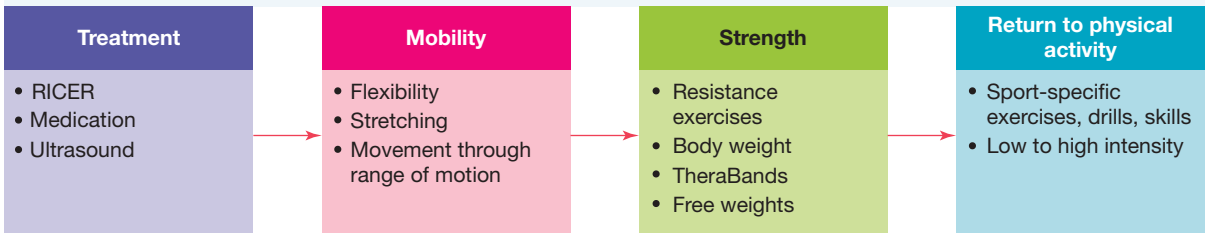
Several medical professionals can assist an individual with rehabilitation. These can include doctors, physiotherapists, chiropractors, podiatrists, sports physicians and massage therapists.

Components of a rehabilitation program can include the following:

- *Treatment.* After initially sustaining an injury, the focus is on the healing process. This includes the application of Rest, Ice, Compression, Elevation and Referral (RICER) to manage pain and inflammation (if present). Medication and techniques such as ultrasound may also be used in this phase.
- *Mobility.* Once an individual is no longer in pain or discomfort, focus moves to increasing the mobility of the injured site. This can include specific stretching exercises to increase the range of motion of a joint or the flexibility of a muscle. It is also important to maintain the mobility of joints and muscles outside the injured area. For example, shoulder mobility is important if the wrist is injured.
- *Strength.* Once mobility returns, increasing the strength of the injured site through resistance exercises using bodyweight, TheraBands or free weights assists the individual to return to physical activity.
- *Return to physical activity.* The final part of the rehabilitation process is to gradually engage in physical activity such as sport-specific exercises, skills or drills. This should progress from low-intensity activities, such as walking and jogging, through to high-intensity sprinting and agility work to determine readiness to return to full activity. This process may be supported by taping or wearing a brace (see subtopic 2.4).

rehabilitation the process of returning to optimal functioning as well as reducing the chance of re-injury

FIGURE 2.13 The components of a rehabilitation program



Before returning to physical activity an individual should answer 'yes' to the following questions:

- Is the injured area pain free?
- Can the injured area be moved through its full range of motion?
- Is there enough strength to comfortably complete the activity?
- Are you mentally prepared to return to physical activity and not anxious about re-injuring the site?

To prevent re-injury, the individual should continue their rehabilitation once they have returned to their chosen physical activity until full strength and function is restored. Continually monitoring and strengthening the injured site will reduce the risk of re-injury.

FIGURE 2.14 Improving mobility and range of motion of an injured body part is an important part of rehabilitation.

doc-41911

PRACTICAL ACTIVITY The importance of warming up and cooling down

Goal

To understand the importance of a warm up or cool down as part of an injury-prevention strategy

Instructions

Design a warm up or cool down to teach the class. Make sure you include all phases of the warm up or cool down. Explain to the class how each activity you have included will help reduce the risk of injury.

As a guide, this session should be 10–15 minutes long.

Primary data/Reflection

Review your design of the warm up or cool down session. Consider the appropriateness of the exercises and suggest changes you could make in the future.

Questions

1. Outline the different components required in a warm up.
2. Discuss how each component can prevent injury.

2.3 Activity

2.3 Quick quiz on | **2.3 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 3, 5	4	6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **List** the factors that can contribute to an athlete sustaining an injury.
2. **Outline** the role of pre-participation screening.
3. **Identify** two physiological benefits of completing a warm up.
4. **Describe** the aims of rehabilitation and list the components that are essential for effective rehabilitation.
5. Stretching is an important component in both a warm up and a cool down. **Outline** the difference in the stretching recommended for a warm up compared to a cool down.

APPLY your understanding

6. The figure below shows the top ten most injury-prone sports based on hospitalisation data for 2020–21. Choose three sports from this list.
   a. **List** all the injuries that could occur in the three sports.
   b. **Identify** all the risks that you think could contribute to injuries sustained in the three sports.
   c. **Outline** injury prevention measures for each injury identified.
   d. **Justify** why cycling is the most injury-prone sport.

1. Cycling	6. Rugby
2. Wheeled motor sports	7. Equestrian activities
3. Roller sports	8. Basketball
4. Soccer	9. Other football
5. Australian Rules football	10. Snow sports

Source: https://www.aihw.gov.au/reports/sports-injury/sports-injury-in-australia/contents/sports-participation-and-injury-rates, 2020–21

2.3 Exam questions

Question 1 (1 mark)

A strategy that is encouraged prior to engaging in any form of physical activity that could decrease the likelihood of injury is:

A. completing a warm up and cool down.
B. preventative screening.
C. being aware of the signs and symptoms of overtraining.
D. completing a rehabilitation program.

Question 2 (3 marks)

List two aims of conducting a cool down and suggest what activities could be completed.

Question 3 (2 marks)

In cooler weather, the length of time spent completing a warm up should be shorter or longer than in warmer weather? **Explain** why.

More exam questions are available in your learnON title.

2.4 Physical aids to support the musculoskeletal system

Key knowledge	Key skill
• the role of physical aids that support the musculoskeletal system such as protective equipment, taping and braces	• implement and describe the correct application of physical aids and physiological strategies in a variety of sporting activities to maintain optimal functioning of the musculoskeletal system

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

2.4.1 Protective equipment

Most sporting activities use protective equipment designed to reduce the risk of injury to participating athletes, especially the effect of impact and collisions (see figure 2.15). Some safety equipment is compulsory but much of it is used voluntarily. It is important that all protective equipment:

- is worn during training and games
- fits correctly
- is specific and appropriate for the sport, size and age of athlete
- is regularly checked and maintained.

FIGURE 2.15 Protective equipment should be worn when there is a risk of injury from impact.

Protective equipment can cover all parts of the body. It is designed to feel comfortable for the athlete and to not interfere with sporting activity. Protective equipment can be used as a preventative measure prior to an injury occurring or on return to sport where there may be risk of aggravating an old injury. Table 2.9 outlines a range of protective equipment that can be worn across a wide variety of sports.

TABLE 2.9 Protective equipment used in a variety of sports

Protective equipment	Sports used in (examples)	Potential injury prevented
Mouthguard	• Boxing • Collision sports (e.g. hockey, netball, basketball) • Football codes (AFL, soccer, rugby)	Dental injury: • Teeth knocked out, chipped, broken, displaced • Mandible (jaw) injury
Goggles/glasses	• Skiing • Squash • Swimming	Eye injury
Helmet/face shield	• Baseball/softball • Cycling • Cricket (wicketkeeper, slips) • Fencing • Football codes (soft helmet) • Gridiron • Hockey (goalie) • Horse racing (jockey) • Ice hockey • Snowboarding	• Broken jaw, facial bones • Skull fracture • Facial lacerations • Concussion
Lower leg/shin padding	• Baseball/softball (catcher) • Cricket • Hockey • Soccer • Volleyball	• Lower limb contusion • Broken bones in lower leg/ankle
Upper body/chest padding	• Baseball/softball (catcher) • Cricket • Fencing • Gridiron • Hockey (goalie)	• Broken/fractured ribs • Contusion
Gloves	• Boxing • Cricket • Hockey (goalie)	• Broken/fractured/dislocated fingers • Contusion
Wrist/forearm guard	• Inline skating • Snowboarding	Broken/fractured wrist
Footwear	• Athletics (spikes) • Basketball • Baseball • Boxing • Cricket • Football codes (AFL, soccer, rugby) • Golf	• Shin splints • Strains/sprains • Stress fractures

on Resources

Interactivities Protective equipment/likely injury (int-6633)
Protective equipment: which sport? (int-6634)

While protective equipment is designed to prevent injury, there are instances where this may not occur. In November 2014, Australian cricketer Philip Hughes was struck by a cricket ball on the back of his neck, just below his helmet, during a Sheffield Shield match. The blow to his neck led to a haemorrhage, and, tragically, he died two days later in hospital. The Australian cricket community was shocked that such a tragedy could happen on the field and, subsequently, many questions were asked about the safety of equipment used and emergency medical care on field.

FIGURE 2.16 The Masuri helmet, featuring the StemGuard attachment, which provides greater protection to the back of the head and neck.

Hughes was wearing a Masuri-branded helmet when the accident occurred. At that time there was no helmet that could have protected Hughes from the ball hitting an artery in his neck. Masuri has since released a helmet with greater protection in an effort to prevent another tragic death. It features a clip-on 'StemGuard' made of plastic and foam to help protect the back of the neck (see figure 2.16).

2.4.2 Equipment

Another development in protective equipment addresses the increasing participation rates of females in contact sport. Continued advancement of local and national competitions, particularly in AFL, rugby and soccer, has led to improvements in protective equipment designed specifically to reduce the risk of breast injury. Impact protection vests are also worn by females participating in high-impact sports such as martial arts. These lightweight vests create a barrier between the individual and any impacts from equipment, the ground or other participants, reducing the risk of injury to the breast and ribcage area.

FIGURE 2.17 Zena sport have created a flexible protective vest that protects the chest and ribcage area in contact sports.

EXAM TIP

When asked to describe how protective equipment can reduce the risk of injury, ensure you refer to the body part that will be protected and the type of injury that can be prevented.

For example, cricketers wear gloves to protect their hands and fingers. This can reduce the risk of dislocating or breaking fingers when catching a fast-moving ball.

on Resources

Weblinks Tackling breast injury in sport
Zena Sport

2.4.3 Footwear

Sports require different types of footwear depending on the demands of the sport and the surface being played on. Specialised footwear can include running shoes, spikes and football boots. A good running shoe will help prevent injuries such as shin splints, overpronation and underpronation of the foot, and Achilles tendon problems. For example, running shoes should have the following characteristics:

- a good grip on the playing surface
- stability that allows quick changes of direction
- cushioning for shock absorption, such as gel pads or air bladders
- flexibility to allow the foot to flex
- comfort for the wearer
- correct fit.

Shoes should be laced properly before activity to allow a firm fit around the foot. A podiatrist may prescribe orthotics for athletes with congenital defects such as flat feet, high arches, unequal leg length, and overpronation or underpronation. Orthotics inserted into the shoe will prevent ongoing injury.

2.4.4 Taping

Preventative **taping** (or strapping) and bandaging of joints before playing or training can reduce the chance of injury and the severity of a ligament sprain (see figure 2.18). Taping is used to restrict some potentially harmful movements while allowing the desired movement of a joint or muscle during activity.

FIGURE 2.18 Preventative taping can reduce the chance of injury.

taping the use of strapping tape to limit the range of movement in a joint as part of an athlete's prevention or rehabilitation strategy

Taping can be used as a preventative measure, especially in high-risk activities, such as ankles in netball, or in rehabilitation after an injury has occurred, to protect the injured site during the healing phase and prevent further injury. It can also be used to enhance **proprioceptive** feedback from the affected site, especially when there has been previous injury.

proprioception the ability of the muscles, tendons and joints to receive and process stimuli about their position

There are many types of tapes and bandages on the market. Rigid strapping tape is used if the athlete wants to restrict movement and provide mechanical support and proprioception. Soft elastic bandages are used for initial injury, especially to compress soft tissue and reduce swelling of the affected area. Basic taping techniques include anchors, stirrups, figure of six and figure of eight.

While taping offers many benefits, potential harms can include irritation of the skin and reduced circulation if too tight. Tape does also lose elasticity over time, and therefore can become less effective than when initially applied. Taping can be applied by athletes but is often applied by medical professionals.

on Resources

Weblink Taping techniques

Kinesiology taping

An alternative form of tape is kinesiology tape. This tape is thinner and more elastic than traditional rigid strapping tape. It is a less restrictive type of taping that allows muscle support while not compromising range of joint motion. The tape is not completely wrapped around the injured joint or muscle, but applied over or on the periphery of these areas (see figure 2.19). Benefits of this type of taping are thought to include pain relief, greater range of motion and the ability to wear it for longer than rigid strapping tape.

The tape is applied in different techniques to rigid strapping with three general shapes:

- an 'I' shape where the tape is applied linearly
- a 'Y' shape for larger muscles, such as the deltoid across the shoulder
- an 'X' shape for large and long muscles such as down the hamstring on the biceps femoris.

FIGURE 2.19 Kinesiology taping allows an athlete a greater range of movement while still offering support to an injured muscle or joint.

2.4.5 Braces

Sports braces play a similar role to taping in the prevention of sports injuries, with the added advantage of the athlete being able to put on the brace themselves (see figure 2.20). While they can be expensive, a good quality brace will last longer and may be cheaper in the long term if the athlete needs to repeatedly tape an area.

FIGURE 2.20 A knee brace provides extra support during physical activity.

As well as being used for the prevention of sporting injuries, taping, bandages and braces can also be used for the musculoskeletal conditions outlined in subtopic 2.2, especially for arthritic joints.

on Resources

Video eLesson How to tape (eles-2580)

doc-41912

PRACTICAL ACTIVITY Taping an ankle

Goal

To learn how to tape an ankle

Equipment

- rolls of thick (38 mm) and thin (12 mm) strapping or masking tape
- under tape (to protect skin and hair)

Instructions

Access **How to tape** in the Video eLessons section of the Resources panel. Work in pairs to follow the instructions as one person's ankle is strapped. Then swap roles to strap the other person's ankle. Once the ankle is taped, perform some movements such as jogging, jumping and changing direction to feel how taping can act as a protection from sustaining an injury.

For comparison, look at the range of motion of the non-taped ankle compared to the taped ankle by moving each foot side to side, up and down and in a circular motion.

Primary data/Reflection

Briefly describe how to tape an ankle, including the main techniques used. Reflect on the level of ease or difficulty when taping the ankle.

Comment on how the tape felt when performing movements and the impact it had on your ability to successfully complete different movements.

Question

1. Outline why an individual might use taping as a preventative measure.

2.4 Activity

2.4 Quick quiz on

2.4 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
3	1	2, 4

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Discuss** the important considerations for the use of protective equipment in sport.
2. **Explain** why correct footwear is important for the prevention of injury.
3. **Outline** the purpose of taping and braces.

APPLY your understanding

4. Answer the following.
   a. Choose a sport and **list** all the protective equipment that is available for playing that sport.
   b. **Outline** why each piece of equipment has been introduced.
   c. **Explain** the potential injury prevented by each piece of equipment.
   d. **Outline** how each piece of equipment protects the athlete.
   e. Nominate whether the equipment is compulsory or optional.

2.4 Exam questions

Question 1 (3 marks)

Outline the three reasons why taping is most commonly used.

Question 2 (2 marks)

Describe a preventative measure that could be used in netball to reduce the risk of a soft-tissue injury.

Question 3 (4 marks)

Source: *ACHPER 2021, Exam Unit 1, Section B, Q.5*; © ACHPER

Mountain biking is a sport of riding bicycles offroad, often over rough terrain. Unlike road bikers, mountain bikers pursue obstacles and see the world as a natural and challenging playground full of winding trails.

Mountain bike riders are commonly seen wearing protective equipment such as full-face helmets, as pictured.

a. **Explain** the purpose of the full-face helmet as protective equipment for mountain bike riders.
b. **Describe** another form of protective equipment which may be worn by mountain bike riders.

More exam questions are available in your learnON title.

2.5 Key skills

Key skills

- explore a variety of causes of musculoskeletal injuries
- implement and describe the correct application of physical aids and physiological strategies in a variety of sporting activities to maintain optimal functioning of the musculoskeletal system

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

2.5.1 Tell me

To address these key skills, it is important to remember the following:

- injuries can be classified as acute, chronic and overuse
- injuries can be caused by an external force (direct contact) or an internal force (indirect contact) and can affect the hard or soft tissue of the body
- physiological strategies to prevent injury include physical preparation of the athlete, warm up and cool down and rehabilitation
- physical aids such as protective equipment, taping and bracing can support the optimal functioning of the musculoskeletal system.

2.5.2 Show me

Practice question (10 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

Sports injuries are often classified based on the way they have occurred and whether they are acute or chronic injuries.

a. **Explain** the *difference* between acute and chronic injuries. (2 marks)

b. Acute injuries can be further *classified* into direct and indirect due to the mechanism in which they occur. Provide a **description** and a relevant sporting *example* for each of these. (4 marks)

c. Overuse injuries usually occur due to a continual performance of the same type of movement and there are a large variety of factors which lead to these types of injuries.
List two different *factors* which may lead to an overuse injury. (2 marks)

d. **Discuss** a preventative measure that could be used to *reduce the risk* of an injury. (2 marks)

Decode the question

Strategies to decode the question

- **Identify the action words:**
  Explain — to make the meaning of something clear and understandable
  Describe — provide a detailed account of
  List — provide a series of items
  Discuss — go into detail about the characteristics of a key concept
- **Key terminology** — *difference*, *classified*, *example*, *factors*, *reduce the risk*
- **Key concepts** — acute and chronic injuries, direct and indirect injuries, injury, overuse injuries, preventative measures
- **Marking scheme —** 10 marks — always check the marking scheme for the depth of response required, linking to key information highlighted in the question.

Sample response and marking scheme

a. Acute injuries occur *suddenly* and usually without warning, whereas chronic injuries are usually linked to overuse of a certain area of the body *over time*.
Award 1 mark each for explaining the difference between acute and chronic injuries.

b. A direct injury occurs as a result of an *external force*. An example would be a *direct hit from an implement*, such as being struck on the leg by a hockey stick.
An indirect Injury is a result of an *internal force*, usually caused by a *rapid change in direction or intensity*, where the force needed is larger than the load the muscles or ligaments can withstand. An example is when a netballer lands awkwardly on their ankle and tears a ligament.
Award 1 mark for a description of a direct injury.
Award 1 mark for an example of a direct sporting injury.
Award 1 mark for a description of an indirect injury and **1 mark** for an example.

c. Overuse injuries can occur due to the following:
- *inadequate or unsuitable footwear*
- *inadequate recovery time in between training sessions*
- *unsuitable training surface*
- *increase in the intensity of training*

Award 1 mark each for a correct factor that could have led to an overuse injury.

d. Taping a shoulder to *reduce the range of motion* while still allowing desired movement of the joint could *reduce the likelihood* of an injury while taking an overhead mark in football.
Award 1 mark for identification of a protective measure.
Award 1 mark for how this could reduce the risk of an injury occurring.

2.5.3 Let me do it

Question 1 (5 marks)

Rollerblading uses a number of pieces of protective equipment across a range of body parts to assist in the prevention of injury.

a. Wrist guards are worn to reduce the likelihood of what type of injury occurring? **(1 mark)**

b. **Identify** another piece of protective equipment from the image above and suggest what type of injury it may prevent. **(2 marks)**

c. As well as using physical aids, a variety of physiological strategies can be used to prevent injury. **Describe** one of these strategies and indicate how it can contribute to the prevention of injury. **(2 marks)**

2.6 Review

Hey students! Now that it's time to revise this topic, go online to:

Review your results

Watch teacher-led videos

Practise exam questions

Find all this and MORE in jacPLUS

2.6.1 Summary

Injuries and illnesses of the musculoskeletal system

- Sports injuries can be classified as acute, chronic or overuse. Injuries can be sustained through direct contact, such as an external force, or indirect contact, such as an internal force.
- Injuries occur to soft tissue such as skin, ligaments, tendons and muscles; and to hard tissue such as bones. Common types of injuries include cuts, abrasions, contusions, tears, strains, sprains, fractures and dislocations.
- Measures can be taken to minimise the risk of injuries occurring in sport and to make the return to training as efficient as possible.
- Insufficient recovery time between physical activity or excessive training volume can contribute to the likelihood of an individual suffering from overtraining. Structuring sessions to include adequate rest and recovery, and including gradual increases in training loads is vital to prevent injury.
- Musculoskeletal illnesses affect the bones, muscles, joints and ligaments of the body and often limit the capacity and mobility of an individual.
- The most common illnesses in Australia affecting the musculoskeletal system include arthritis and osteoporosis.
- Arthritis is characterised by inflammation around the joints, causing pain and stiffness. The most common forms are juvenile arthritis, osteoarthritis and rheumatoid arthritis.
- Osteoporosis is characterised by the thinning and weakening of bone and is more common in women and people over 55 years of age.

Physiological strategies to prevent musculoskeletal injuries

- Common preventative measures for musculoskeletal conditions include participation in regular physical activity, maintenance of healthy body weight, limiting sedentary behaviour and eating a nutritious diet.
- Sports injury prevention includes the following strategies: pre-participation screening; physical preparation of athletes; an appropriate warm up and cool down; rehabilitation; use of protective equipment; correct footwear; taping and the use of braces.
- The structure of training programs and the types of recovery techniques have a significant role to play in the prevention of sports injuries.
- Rehabilitation is an important part of recovery once an injury is sustained. It is the process of returning to optimal functioning as well as reducing the chance of re-injury.

Physical aids to support the musculoskeletal system

- Protective equipment is most effective if it is worn during training and games; it fits correctly; it is specific and appropriate for the sport, size and age of the athlete; and is regularly checked and maintained.
- Correct footwear for the sport/activity and sizing will help prevent injuries such as shin splints.
- Taping and braces are used to support and restrict the movement of a joint or muscle and reduce the chance of re-injury.

Resources

Interactivity Acute and chronic injuries and illnesses of the musculoskeletal system quiz (int-6635)

2.6.2 Key terms

acute injury an injury that occurs quickly and for which pain and loss of function is immediate
arthritis a condition characterised by inflammation of a joint, causing pain and stiffness
chronic injury an injury that recurs due to weakness or insufficient rehabilitation
cool down low-intensity activity completed at the end of a training session or competition that allows the body to recover faster by increasing the breakdown of metabolic waste products, such as lactic acid, and preventing venous pooling, gradually returning the body to its resting physiological state
direct injury an injury caused by external force
indirect injury an injury caused by internal force
musculoskeletal injury any damage that occurs to the structures of the muscular or skeletal systems of the body
osteoporosis a condition in which the bones become weak and thin, and therefore brittle
overtraining when an individual trains in a way that does not allow their body to recover sufficiently; symptoms can include a decrease in physical performance, increased fatigue, persistent muscle soreness, mood disturbances and a feeling of being 'burnt-out'
overuse injury an injury caused by excessive and repeated use of the same muscle, bone or joint
proprioception the ability of the muscles, tendons and joints to receive and process stimuli about their position
rehabilitation the process of returning to optimal functioning as well as reducing the chance of re-injury
sports injury prevention strategies that include any processes completed by a coach, athlete or sports administrator to minimise the risk of injury
taping the use of strapping tape to limit the range of movement in a joint as part of an athlete's prevention or rehabilitation strategy
warm up activities and exercise undertaken at the beginning of a training session with the aim of preparing the body both physiologically and psychologically for the training session that follows

2.6 Exam questions

2.6 Section A — Multiple choice questions

Question 1 (1 mark)

A muscle strain is an example of:

A. an acute injury.
B. a chronic injury.
C. an overuse injury.
D. a direct injury.

Question 2 (1 mark)

Excessive movement of a joint is most likely to result in which type of injury?

A. Contusion
B. Laceration
C. Dislocation
D. Fracture

Question 3 (1 mark)

Which of the following is an example of an overuse injury?

A. Broken wrist
B. Shin splints
C. Concussion
D. Muscle sprain

Question 4 (1 mark)

The most common form of arthritis is:

A. juvenile arthritis.
B. osteoporosis.
C. rheumatoid arthritis.
D. osteoarthritis.

Question 5 (1 mark)

One of the main risk factors for developing osteoporosis is:

A. a diet high in fats.
B. poor calcium intake.
C. youth.
D. brittle bones.

Question 6 (1 mark)

A common preventative measure against developing illnesses affecting the musculoskeletal system is:

A. regular participation in physical activity.
B. consuming a diet high in calcium.
C. maintaining poor posture.
D. protecting your back when lifting heavy objects.

Question 7 (1 mark)

An important consideration for the physiological preparation of an athlete to prevent injury is:

A. a thorough warm up.
B. wearing protective equipment.
C. taping a joint.
D. checking the field for dangers.

Question 8 (1 mark)

The role of pre-participation screening is to:

A. check your strengths and weaknesses.
B. determine medical history that could have an impact on physical activity.
C. improve your questionnaire skills.
D. see how fit you are.

Question 9 (1 mark)

A helmet is a preventative measure to reduce the risk of what type of injury to the head?

A. Contusion
B. Dislocation
C. Concussion
D. Sprain

Question 10 (1 mark)

Taping can assist in the prevention of injuries to a joint via:

A. enhancing blood flow to the joint.
B. restricting movement around a joint.
C. increasing movement around a joint.
D. improving fitness.

2.6 Section B — Short answer questions

Question 1 (1 mark)

Source: Adapted from *ACHPER 2023 Exam Unit 1, Section B, Q1d;* © ACHPER

During a high intensity interval training session (HIIT), Jessie was completing his workout doing high knees on the spot. Whilst doing so, Jessie landed on the outside of his foot, feeling a sharp pain and unable to weight bear on his right foot.

Identify the type of injury this is.

Question 2 (4 marks)

Source: *ACHPER 2022 Exam Unit 1, Section B, Q7.d,e;* © ACHPER

a. **Discuss** physiologically how a muscle strain occurs and explain how this may impact a tennis player's movement during a match. **(2 marks)**

b. **Explain** an appropriate physical aid which could be implemented to prevent a muscle strain. **(2 marks)**

Question 3 (4 marks)

Source: *ACHPER 2023 Exam Unit 1, Section B, Q4;* © ACHPER

Ice hockey is played on ice by two teams which consist of six players. Ice hockey is a fast paced and physically demanding game with the objective of shooting the rubber puck past a goalie and into a net, often at speeds of over 150 km/h.

Identify two examples of protective equipment worn by a goalie and explain how each of these pieces of equipment will minimise the risk of injury.

Question 4 (2 marks)

Source: *ACHPER 2023 Exam Unit 1, Section B, Q1b;* © ACHPER

Describe the type of stretching which should be performed in a warm up for a cricket training session.

Continue to build your exam skills

Access the Unit 1 Area of Study 1 Review at the end of Topic 3. This includes:

- Practice extended response
- Practice examination
- Practice school-assessed coursework.

3 Performance enhancement of the musculoskeletal system

3.1 Overview

Hey students! Bring these pages to life online

Watch videos

Engage with interactivities

Answer questions and check results

Find all this and MORE in jacPLUS

LEARNING SEQUENCE

3.1 Overview
3.2 Permitted methods that enhance performance of the musculoskeletal system: training
3.3 Permitted substances that enhance the performance of the musculoskeletal system: nutritional supplements
3.4 Prohibited substances and methods that enhance performance of the musculoskeletal system: hormones
3.5 Key skills
3.6 Review

3.1.1 Introduction

Many athletes use permitted and prohibited performance-enhancing substances and methods to give them an advantage over the competition. However, as well as providing benefits to the athlete, these substances and methods may also potentially harm them.

Performance enhancement includes any method, device or substance that has the potential to physiologically improve performance. These enhancements can be permitted, such as training methods or nutritional supplements, or they can be prohibited, such as synthetically manufactured hormones. Individuals who use these substances and methods need to be aware of potential doping risks along with harms to their health.

FIGURE 3.1 What permitted and prohibited substances and methods can be used to enhance the performance of the musculoskeletal system to improve the muscular strength, power and speed of an athlete?

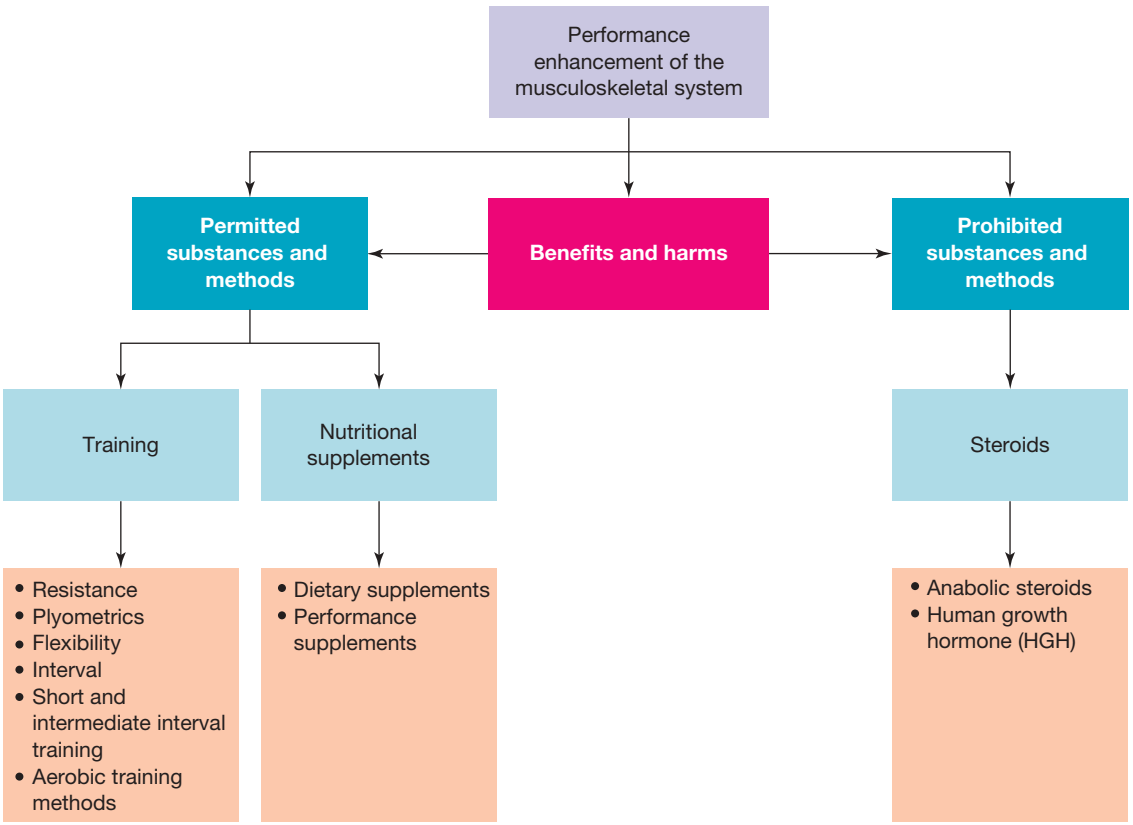
In this topic, you will explore substances and methods (both permitted and prohibited) that can assist with training, performance and recovery. You will discover their potential benefits and harms, and how they can enhance the performance of the musculoskeletal system.

3.1.2 Key knowledge and Key skills

Key knowledge	Key skill	Subtopic
• potential benefits and harms of permitted and prohibited substances and methods that enhance performance of the musculoskeletal system, such as training, nutritional supplements, creatine supplementation and hormones (including steroids and growth hormones)	• investigate, evaluate and critically analyse the effects of a range of performance-enhancing substances and methods on the musculoskeletal system from a physiological perspective	**3.2** **3.3** **3.4**

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

3.1.3 Topic preview



3.2 Permitted methods that enhance performance of the musculoskeletal system: training

Key knowledge	Key skill
• potential benefits and harms of permitted and prohibited substances and methods that enhance performance of the musculoskeletal system, such as training, nutritional supplements, creatine supplementation and hormones (including steroids and growth hormones)	• investigate, evaluate and critically analyse the effects of a range of performance-enhancing substances and methods on the musculoskeletal system from a physiological perspective

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

Today, athletes employ a number of practices to enhance their performance and assist with training and recovery. **Performance-enhancing** methods and substances are used by many athletes and are thought to improve performance by:

- influencing the physiological capacity of a particular body system (e.g. use of creatine supplementation to increase creatine stores in the muscle for replenishment of ATP)
- removing physiological constraints that affect performance (e.g. use of diuretics to reduce body weight so the athlete is lighter or makes a weight category)
- increasing the speed of recovery (e.g. use of compression garments to increase blood flow and removal of wastes).

3.2.1 Training methods

As previously discussed, the musculoskeletal system plays an important role in body movement, as well as creating energy for movement. Muscles attach to bones to create movement, and the reactions that take place within the muscles determine how hard, fast or long we can work. The musculoskeletal system contributes to both **aerobic** and **anaerobic** energy production.

performance-enhancing includes methods, devices or substances that improve athletic performance
aerobic energy produced with the presence of oxygen
anaerobic energy produced without the presence of oxygen

A variety of training methods and aids can be used by athletes and coaches to enhance the performance of the musculoskeletal system (see figure 3.2). By determining the relevant fitness components, energy systems and muscles used in each sport, athletes and coaches can decide on the best method to improve an athlete's performance.

FIGURE 3.2 A variety of methods can be used to train the musculoskeletal system, both **(a)** anaerobic and **(b)** aerobic training.

Training methods that can specifically enhance the performance of the musculoskeletal system include:

- *anaerobic training methods* such as resistance training, plyometric training and short, and intermediate interval training to develop muscular power, muscular strength, anaerobic capacity and speed
- *aerobic training methods* such as continuous training, fartlek or long-interval training to develop muscular endurance and aerobic power.

Through specific training, a number of **chronic muscular adaptations** occur that enhance an athlete's performance. These are outlined in table 3.2.

3.2.2 Anaerobic training methods: benefits and harms

Resistance training

Resistance training involves exercising a muscle or group of muscles against a resistance. It is the most common training method used to develop muscular strength, power or endurance.

The main physiological effects of using resistance training to enhance the performance of the musculoskeletal system include:

- increased muscle size, mass and fuel stores
- increased bone density and strength.

These changes benefit the performance of the individual because they lead to an increased capacity to produce the greater strength and/or power required to run faster, throw or kick further, or jump higher in their chosen sport.

While resistance training is a very good way to develop the musculoskeletal system, athletes need to consider the potential harms from engaging in this type of training. Harms can include:

- overtraining — not allowing enough recovery between sessions for the muscles to repair and grow
- injury — lifting too heavy a weight or using incorrect technique, placing stress on muscles, bones and joints.

As discussed in topic 1, muscle contractions are classified according to the movement they cause:

- *concentric and eccentric*, where muscle length changes as force is developed
- *isometric*, where muscle tension is developed, but muscle length does not change.

Resistance-training methods are based on each of these classifications and can involve the use of free weights, machine weights and body weight (see figure 3.3).

chronic muscular adaptations the long-term responses of body systems developed in response to a training program

resistance training training that aims to build muscular strength, muscular power or muscular endurance by exercising muscles or a group of muscles against a resistance

FIGURE 3.3 Resistance training methods involve different types of muscle contractions: **(a)** concentric and eccentric free weight training **(b)** isometric training.

Mechanical aids to resistance training

In addition to the traditional use of dumbbells, barbells and weighted machines, resistance training can also incorporate a variety of mechanical aids. These aids can include tyres, parachutes, elastic cords and weighted vests (see figure 3.4). These aids aim to provide added resistance while completing sport-specific movement, such as running, to develop strength and power specific to the muscles used in the activity.

FIGURE 3.4 Mechanical aids such as parachutes, tyres and resistance cords can be used to assist resistance training.

Plyometric training

The aim of **plyometric training** is to increase muscular power by first stretching a muscle (eccentric contraction) and then contracting it (concentric contraction) in the shortest time possible.

This training method takes advantage of the *stretch-shortening cycle* or the stretch reflex. This is when the body attempts to resist the sudden change in muscle length by calling on the stretched muscle to contract, and thus prevent the suddenly stretched muscle from tearing. Essentially, plyometrics trains this reflex to develop a more powerful contraction of the muscle. The benefit of this type of training is it allows the athlete to produce more explosive power when running, jumping, kicking or throwing, depending on the muscles focused on.

Because plyometric exercises can create so much muscular power, potential harms relate to the safety and appropriateness of the exercises being performed. Specific guidelines should be followed.

- These exercises can place considerable stress on the body and joints, and are not recommended for individuals with poor fitness levels.
- Individuals should start with low-impact activities before progressing to those which place greater stress on the body.
- If not completed correctly and without adequate fitness or recovery, plyometric training has the potential to cause injury through tearing of the muscles.

Examples of plyometric exercises are shown in figure 3.5.

Low-impact drills, such as:

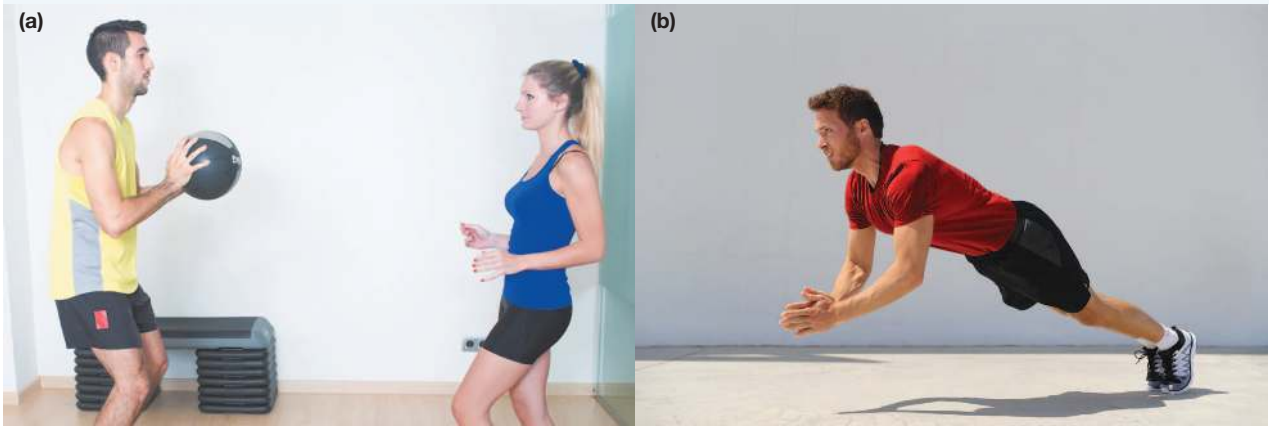
- skipping with and without a rope
- doing low hops, step and jumps
- throwing a light (2.5 kg) medicine ball (see figure 3.5a),

High-impact drills, such as:

- bounding with alternate legs
- clap push-ups (see figure 3.5b)
- jumping on, over and from benches that are 35 cm high
- throwing a heavy medicine ball (above 4 kg).

plyometric training training that aims to increase muscular power by first stretching a muscle then contracting it in the shortest time possible

FIGURE 3.5 Plyometric training exercises: **(a)** low-impact medicine ball throw and **(b)** high-impact clap push-up



Interval training: short and intermediate interval training

Interval training involves set periods of work followed by set periods of rest or recovery repeated several times in an exercise session. This type of training allows for repeated high-intensity work periods that improve speed, muscular power, anaerobic capacity and agility. Interval training can be used to develop all three energy systems, depending on the manipulation of the work and rest periods, and the intensity the repetitions are performed at. The types of interval training specific to the anaerobic enhancement of the musculoskeletal system are outlined in table 3.1.

interval training training that consists of intervals of work followed by intervals of rest or recovery

TABLE 3.1 Summary of interval training types

Interval type	Energy system	Work intensity	Work-to-rest ratio	Suitable sports
Short	ATP-CP	95%+ MHR	1:5+	100-metre sprints Intermittent team sports
Intermediate	Anaerobic glycolysis	85-90% MHR	1:3	200-metre sprint Intermittent team sports

TABLE 3.2 Chronic muscular adaptations of anaerobic and aerobic training

	Chronic adaptation	Benefit to performance	Potential harms
Anaerobic training	• Muscular hypertrophy • Increased number and size of myofibrils • Increased stores of adenosine triphosphate (ATP), CP and glycogen • Increased glycolytic capacity • Increased speed and force of contractions • Increased tolerance to accumulation of metabolic by-products	**Increased muscular strength, muscular power, anaerobic capacity and/or speed via:** • Greater strength and force created by the muscle • Greater capacity to produce energy quickly • Faster speed of muscle contraction • Greater ability to continue to work at higher intensities • Increased capacity to tolerate by-products and delay the onset of fatigue	**Risk of injury due to:** • Lack of adequate fitness • Incorrect application of training principles • Not enough recovery • Too heavy resistance • Incorrect technique • Overtraining

(continued)

TABLE 3.2 Chronic muscular adaptations of anaerobic and aerobic training *(continued)*

	Chronic adaptation	Benefit to performance	Potential harms
Aerobic training	• Increased size and number of mitochondria • Increased myoglobin • Increased stores of glycogen and triglycerides • Increased capacity to oxidise glucose and fats • Increased a-VO_2 difference • Decreased use of the anaerobic glycolysis system	**Increased muscular endurance and/or aerobic power via:** • Greater capacity to produce energy due to more sites for aerobic energy production • Greater capacity to work for longer due to greater fuel availability • Ability to work aerobically at higher intensities for longer • Delayed lactate inflection point (LIP) and therefore decreased reliance on anaerobic energy systems	**Risk of injury due to:** • Lack of adequate fitness • Incorrect application of training principles • Not enough recovery time • Incorrect technique • Overtraining

The benefit of short and intermediate interval training for the athlete is through the adaptations that occur at the muscular level, allowing them to run faster through improved speed, muscular power and anaerobic capacity. This type of training is useful for team sports where the work-to-rest ratio can resemble that of a game situation, with intense bursts of speed followed by periods of recovery.

Potential harms of these types of interval training include increased risk of injury due to inadequate fitness levels and incorrect application of training principles, including not allowing enough recovery for the body to adapt between sessions.

3.2.3 Aerobic training methods: benefits and harms

As identified in table 3.2, aerobic training produces a variety of chronic muscular adaptions to enhance performance (see figure 3.6). These adaptations allow for greater energy production, especially when working at higher aerobic intensities. However, the critical factor in improved performance relates to the efficient delivery of oxygen to the working muscles via the cardiorespiratory system. This aspect will be discussed in depth in topic 6. Training methods most suited to aerobic energy production are briefly outlined in table 3.3.

FIGURE 3.6 Continuous training increases the number and size of mitochondria in the muscle to produce energy for aerobic activities.

TABLE 3.3 Summary of continuous training methods

Training type	Description	Example
Continuous	Continuous activity that lasts a minimum of 20 minutes at the required sub-maximal (70–85% HR max) intensity	Runners, swimmers or cyclists exercising continuously for 30 minutes at 80% HR max
Fartlek	Continuous activity that involves surges of higher intensity throughout the session, such as an increase in pace or running up a hill	Stride hard for 30 seconds + jog for 90 seconds recovery; stride hard for 30 seconds + jog for 75 seconds recovery; stride hard for 30 seconds + jog for 60 seconds recovery. Repeat 4 times.

Long interval training	Intervals lasting between 1–5 minutes. Work periods of sub-maximal intensity closer to 85% HR max. Rest periods passive or active at lower intensity. Work-to-rest ratio 1:1 1:0 or 2:1	Middle distance runner — run 4 minutes 85% HR max, rest 4 minutes

3.2.4 Flexibility training: benefits and harms

Flexibility refers to the range of movement around a joint. As a key structure of the musculoskeletal system, the muscles, ligaments and tendons that make up a specific joint require good mobility to allow for effective movement. Flexibility is specific to a joint and can vary around the body.

Flexibility training is about improving the range of movement at joints that are important for maximum performance in a particular sport or physical activity.

Stretching is the most common form of exercise to increase an individual's flexibility. To make gains, an individual should stretch regularly. This could be daily, as part of single session, or incorporated into the warm up and cool down of a training session.

Recognised methods of stretching include static, dynamic and proprioceptive neuromuscular facilitation (PNF).

- *Static stretching* involves gradually stretching the muscle across a joint to the full range of motion and holding for 15–30 seconds (e.g. a standing quadricep stretch). Generally, this type of stretching occurs during a cool down at the end of a training session or game.
- *Dynamic stretching* involves controlled movements through the joint's full range of motion (e.g. arm swings). This type of stretching is included as part of a warm up to mimic the movements that will occur in the activity about to be undertaken.
- *Proprioceptive neuromuscular facilitation (PNF) stretching* involves using an isometric contraction of the muscles before stretching them through the full range of motion.

The benefits of flexibility training include increased mobility at a joint, along with improved posture and body awareness. Potential harms can include the risk of injury through incorrect technique or lack of warm up prior to stretching.

flexibility training training that moves a joint through its range of movement; it can be static or dynamic.

FIGURE 3.7 Flexibility can be increased via **(a)** a static stretch or **(b)** a dynamic stretch, where the body moves through its range of motion such as leg swings.

EXAM TIP

When describing the training methods that can enhance the musculoskeletal system, ensure that you include examples and link them to a physiological benefit.

For example, flexibility training includes dynamic stretching, such as arm swings. This helps to warm up the muscles, ligaments and tendons of the shoulder joint. This increases the range of motion of the joint, allowing an athlete to successfully perform a skill, such as a full reach in a tennis serve.

doc-41913

PRACTICAL ACTIVITY Training to improve performance: plyometrics

Goal

To understand how training can enhance the performance of the musculoskeletal system

Instructions

Participate in the following plyometrics training session. Make sure you have completed a thorough warm up prior to completing these exercises. For each exercise, perform at a low level with ten repetitions. Include a recovery of 3 minutes between each exercise.

- Squat jumps
- Alternate leg bounds
- Power skipping
- Lateral (side) jumps

Primary data/Reflection

Write a brief paragraph about your participation in the training session. Consider the following: Were you able to maintain the same intensity for each repetition? Which muscle groups were being used?

Questions

1. Discuss the way in which plyometrics can improve the performance of the musculoskeletal system.
2. Outline the potential harms of this type of training and link them to suggested safety considerations.

3.2 Activity

3.2 Quick quiz on

3.2 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 3	4	5, 6, 7, 8

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Define** the term *performance enhancement*.
2. **Describe** each of the permitted training methods that can be used to enhance musculoskeletal performance.
3. **Outline** the actual and perceived benefits and potential harms from participating in a resistance training session.
4. **Discuss** the ways aerobic training can enhance the performance of the musculoskeletal system.
5. **Explain** why an athlete might use a mechanical aid in addition to normal training. Provide specific examples.

APPLY your understanding

6. **Discuss** how flexibility training can enhance the musculoskeletal system.
7. Muscular hypertrophy is a chronic adaptation from participating in a resistance training program. Using an example, **explain** how this adaptation can improve performance of the musculoskeletal system for an individual.
8. **Explain** how plyometric training uses the stretch reflex to increase muscular power.

3.2 Exam questions

Question 1 (1 mark)

Source: *ACPHER 2018 Exam Unit 1, Section A, Q.7;* © ACHPER

Identify the type of legal performance-enhancing method that causes microscopic tears to muscle cells, which then repair to help the muscles regenerate and grow stronger.

A. Core training
B. Flexibility training
C. Resistance training
D. Continuous training

Question 2 (3 marks)

Outline the three types of stretching that can be used to enhance the performance of the musculoskeletal system.

Question 3 (3 marks)

Athletic field events such as shot-put, discus and javelin require significant upper body strength and power to be able to throw maximal distance. **Outline** one training method that could enhance their ability to do this and include a benefit and harm from this type of training.

More exam questions are available in your learnON title.

3.3 Permitted substances that enhance the performance of the musculoskeletal system: nutritional supplements

Key knowledge	Key skill
• potential benefits and harms of permitted and prohibited substances and methods that enhance performance of the musculoskeletal system, such as training, nutritional supplements, creatine supplementation and hormones (including steroids and growth hormones)	• investigate, evaluate and critically analyse the effects of a range of performance-enhancing substances and methods on the musculoskeletal system from a physiological perspective

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

3.3.1 Nutritional supplements

Nutritional supplements have been developed for athletes in an effort to assist them to gain an edge over their competitors. Unfortunately, a number of these supplements have no real scientific credibility and the long-term effects of using them have not yet been fully researched. In addition, any supplement may carry a drug or doping risk. It is the athlete's own responsibility to avoid breaking the anti-doping rules. On the other hand, nutritional supplements can play some part in assisting the athlete to reach their peak performance.

nutritional supplements food or preparations ingested in excess of those consumed in a normal diet to supplement or increase the amount of nutrients available

Nutritional supplements can be divided into three broad groups:

1. *Specialised sports foods*. These address an athlete's specific nutritional needs and include sports drinks, sports bars or gels, and liquid-meal supplements (see figure 3.8). Athletes find that these products can be a useful addition to their specialised nutrition program because they are easy to incorporate into any training regime.
2. *Performance supplements*. These benefit performance and/or recovery from exercise. Research has found few of the benefits claimed by so-called nutritional performance supplements are actually supported by scientific evidence. As such, these supplements should be used with caution. There is some support, in certain circumstances, for the use of creatine, protein, caffeine and sodium bicarbonate being of benefit to the athlete.
3. *Dietary supplements*. The athlete should not require supplements provided they follow a diet that addresses their daily energy requirements. Supplements are only required if a specific nutritional deficiency is identified. For example, calcium and iron supplements are sometimes advised for female endurance athletes.

FIGURE 3.8 Dietary supplements may be beneficial if specific nutrients are lacking in the diet.

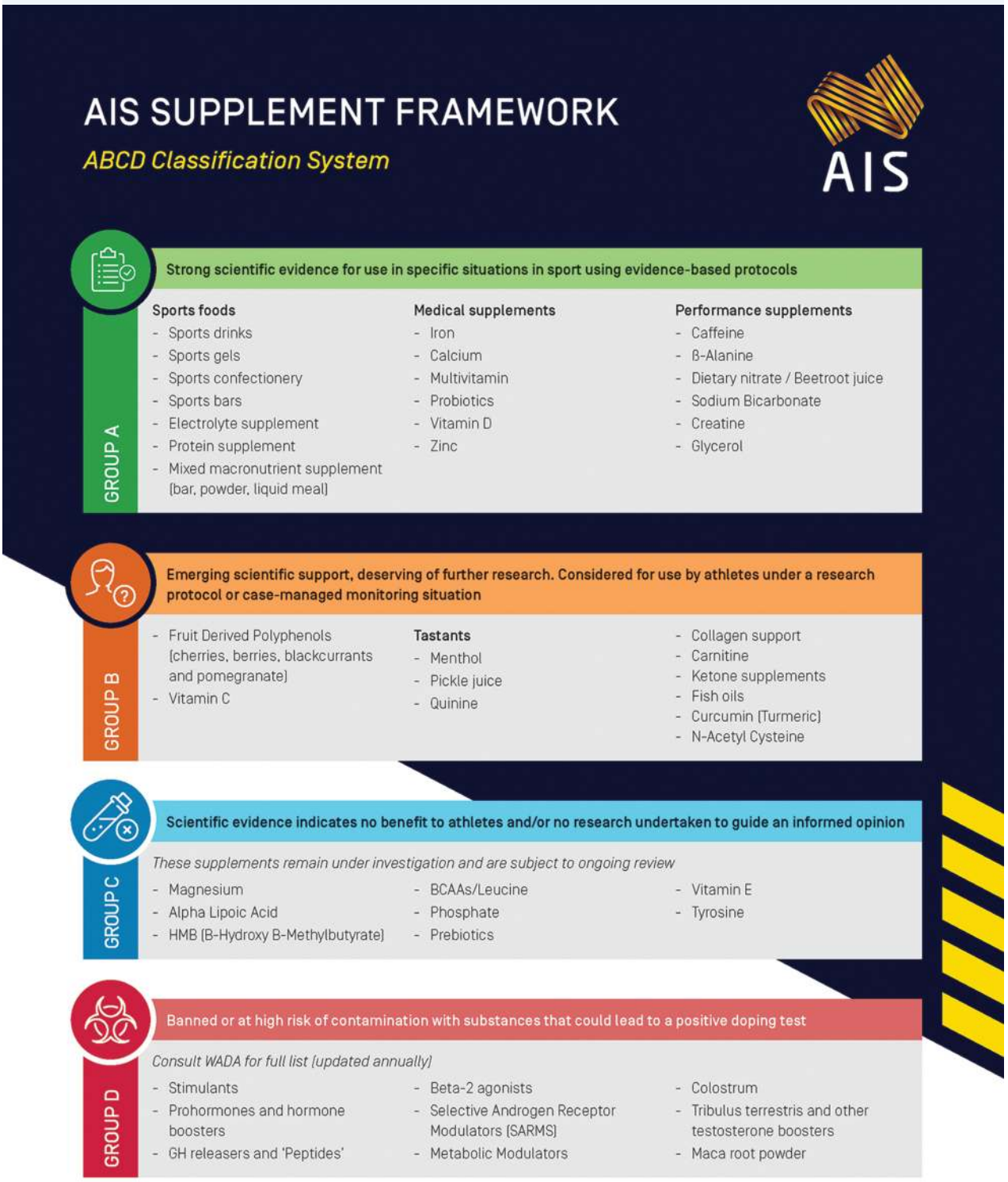
The Australian Institute of Sport (AIS) provides information about the appropriate use of nutritional supplements and anti-doping regulations as they apply to these supplements.

The AIS uses the ABCD classification system to identify sports supplements that athletes can use, and categorises them according to the amount of scientific evidence available to support their use. Figure 3.9 gives a summary of these categories or groupings. Currently, only group A supplements have scientific backing and are supported by the AIS for use by its athletes.

CONCEPT CONNECTOR

On a whiteboard, brainstorm dietary supplements that could enhance the musculoskeletal system. Using different colours, indicate which ones are sports foods, dietary supplements and/or performance supplements. For each type of nutritional supplement, suggest team sports or individual events that may use these to enhance performance. Clearly link to aspects of the game/event that the supplements may enhance.

FIGURE 3.9 AIS supplement framework



on Resources

Digital document Supplement research (doc-41914)

Weblink AIS nutrition

3.3.2 Specialised sports foods

Nutritional supplements play an important role in fuel supply, delaying fatigue and assisting recovery. They can be consumed prior to, during or after a training bout or competition to aid the athlete. Specialised sports foods, methods and supplements that can enhance the performance of the musculoskeletal system are outlined below.

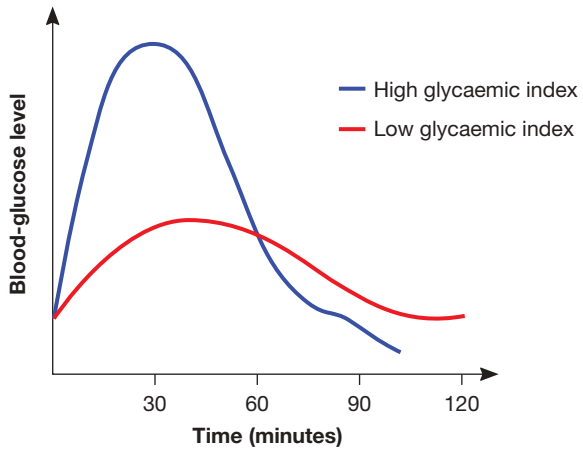
3.3.3 Carbohydrates

Carbohydrates are the major fuel required for activities of high intensity (anaerobic) as well as activities that are submaximal (aerobic) and that have a prolonged duration. The body can store only a certain amount in the liver and muscles; therefore, it is important for an athlete to make sure they consume enough carbohydrates to maintain their energy production. The following discusses methods and specialised sports food that athletes may use to meet their fuel needs and enhance the performance of their musculoskeletal systems.

Application of the glycaemic index

The glycaemic index (GI) is a ranking of carbohydrates on a scale from 0 to 100 according to the extent to which they raise blood-glucose levels after eating. Foods that have a *high glycaemic index* (70 and above) are those that are rapidly digested and absorbed, and result in a rapid increase in blood glucose levels. Foods with a *low glycaemic index* (55 or less) are slowly digested and absorbed, and produce gradual rises in blood glucose and insulin levels (see figure 3.10).

FIGURE 3.10 Rate of release of glucose for foods with a high and low glycaemic index



Knowledge of the glycaemic index allows athletes, coaches and sports dietitians to determine what carbohydrate foods athletes should eat and when they should eat them. This is particularly important for submaximal endurance athletes, where glucose is the main fuel for replenishment of ATP.

glycaemic index is a ranking of carbohydrates on a scale from 0 to 100 according to the extent to which they raise blood glucose levels after eating

Low-GI carbohydrate foods should be eaten before an event to maximise blood glucose stores and provide a sustained release during activity, whereas high-GI carbohydrate foods are recommended during activity to replace and top up stores, as well as after activity to replace depleted stores quickly. Manipulated correctly, application of the glycaemic index benefits the athlete by optimising carbohydrate availability for energy production and thereby optimally enhancing their performance and recovery. It is worth noting that not all athletes respond positively and may experience gastrointestinal upset or bloating in response to the consumption of carbohydrates. Figure 3.11 shows the glycaemic index of many common carbohydrates.

FIGURE 3.11 The glycemic index of many common carbohydrates

Carbohydrate loading

Carbohydrate loading is a method typically used by endurance athletes competing in events lasting longer than 90 minutes (e.g. marathons, triathlons, cross-country skiing) to maximise carbohydrate (glycogen) stores in the muscle and liver. Additional carbohydrates are consumed prior to the event to increase stores by 50–100 per cent above normal resting levels.

Consumption of 7–12 grams of carbohydrate per kilogram of body mass, along with tapering for 36–72 hours prior to the event, is the most successful strategy for increasing the muscle glycogen stores in endurance athletes. During the event, athletes should consume small amounts of carbohydrates (30–60 g per hour) to delay the depletion of stores.

carbohydrate loading the manipulation of training and nutrition prior to endurance events to maximise muscle glycogen (carbohydrate) stores

The benefit to the athlete from carbohydrate loading is that they are able to exercise at an optimal pace for longer because of the increased availability of glycogen stores. However, this strategy does not work for all athletes, and potential harms include bloating, weight gain and gastrointestinal discomfort. A sample carbohydrate-loading meal plan suitable for a 70 kg athlete is outlined in table 3.4.

TABLE 3.4 Sample carbohydrate-loading meal plan

Breakfast	3 cups of low-fibre breakfast cereal with 1½ cups of reduced fat milk 1 medium banana 250 mL orange juice
Snack	Toasted muffin with honey 500 mL sports drink
Lunch	2 sandwiches (4 slices of bread) with filling as desired 200 g tub of low-fat fruit yoghurt 375 mL can of soft drink
Snack	Banana smoothie made with low-fat milk, banana and honey cereal bar
Dinner	1 cup of pasta sauce with 2 cups of cooked pasta 3 slices of garlic bread 2 glasses of cordial
Late snack	Toasted muffin and jam 500 mL sports drink
This sample plan provides approximately 14 800 kJ, 630 g carbohydrate, 125 g protein and 60 g fat.	

Source: Written by the AIS Department of Sports Nutrition, last updated June 2009. @ Australian Sports Commission

Sports gels

Sports gels are a compact source of carbohydrate designed to provide a large boost of fuel in one serving (see figure 3.12). They are easily consumed and digested quickly, allowing a more concentrated intake of carbohydrate (60–70 per cent), which is beneficial both during and after activity to replenish depleted stores in the muscle. Individuals participating in sustained high-intensity exercise for longer than 45 minutes and endurance exercise for more than one hour may use these to replenish their fuel stores.

Sports gels can vary in flavour, consistency, type and amount of carbohydrates. Other ingredients such as electrolytes and caffeine may also be present in the sports gel. Due to their highly concentrated form, sports gels should be consumed with water or similar fluids to reduce the risk of gastrointestinal upset. Athletes should experiment with gels during training sessions to assess tolerance prior to competition.

FIGURE 3.12 Specialised sports foods that address specific nutritional needs of the athlete

Sports bars

Like sports gels, **sports bars** provide a compact and practical source of carbohydrates to boost fuel levels pre-, during and post-activity and replenish fuel stores at the muscle site. As well as containing a high concentration of carbohydrates, sports bars often contain protein and micronutrients. They are similar to muesli or cereal bars, having a chewy consistency, and can be coated with chocolate or include nuts and grains. A concern with sports bars is overuse and the replacement of nutritious whole foods with the convenience of a bar. Again, athletes are advised to experiment with bars during training sessions to assess tolerance prior to competition.

sports gel fortified food in a gel form that contains a blend of carbohydrates and protein to provide a large boost of fuel in one serving

sports bar fortified food in a bar form that contains a blend of carbohydrates and protein to provide a large boost of fuel in one serving

Liquid-meal supplements

Liquid-meal supplements are supplements typically containing a carbohydrate-rich, protein-moderate, low-fat powder (or liquid) that can be mixed with water or milk. They often include additional sources of vitamins, minerals and essential amino acids. Liquid meal supplements can be purchased as ready-to-drink or in powder mix. They can vary in flavour, fat and fibre content and in the amount of protein, carbohydrates, vitamins and minerals present.

This compact form of energy is especially useful for athletes who are aiming to increase lean body mass, coping with demanding training programs or undergoing growth spurts. Liquid meal supplements are also useful as a post-exercise recovery snack to replace fuel and promote repair of muscle cells. This is especially important if an athlete does not have access to food during the first 30 minutes after exercise. A concern with liquid meal supplements is overuse and the replacement of nutritious whole food with the convenience of a drink, as well as overconsumption of kilojoules and unwanted weight gain.

3.3.4 Hydration

Adequate hydration is very important for an athlete to maintain and even enhance their performance. Depending on the type of fluid an athlete consumes, they have the potential to rehydrate as well as refuel. Hydration can assist the musculoskeletal system to function at optimal levels and reduce the potential for fatigue via dehydration and depletion of energy stores. Dehydration, via the loss of water and electrolytes, interferes with the ability of the muscles to contract, thus decreasing performance. Depletion of energy stores, specifically glycogen, limits the capacity of the muscles to produce energy for contraction and the intensity at which the athlete can perform will decrease.

FIGURE 3.13 Athletes drink sports drinks for electrolyte replenishment and hydration.

Sports drinks

Sports drinks (carbohydrate-electrolyte drinks) provide both fluid and carbohydrate to allow an athlete to rehydrate and refuel at the same time. These drinks are ideal to consume before, during or after training and competition, and help delay the fatigue that can be caused by dehydration and depletion of energy stores.

Sports drinks typically contain 6–8 per cent carbohydrate and 10–25 mmol/L electrolyte (sodium and potassium). They rapidly deliver both fluids and fuels when consumed. The taste of sports drinks encourages athletes to increase their fluid intake. Electrolyte replacement, particularly sodium, helps to maintain the athlete's desire to drink, and can help to reduce further fluid loss through urination.

liquid-meal supplements supplements typically containing a carbohydrate-rich, protein-moderate, low-fat powder formula that can be mixed with water or milk

Concerns about the use of sports drinks relate to overconsumption and the additional carbohydrates having an impact on energy balance and displacement of other nutrients. Sports drinks can also cause gastrointestinal discomfort for some athletes, and they can contribute to dental erosion. Therefore, minimal contact time with teeth is recommended.

There are different types of sports drinks to meet the different needs of athletes. These are outlined in figure 3.14.

FIGURE 3.14 Types of sports drinks

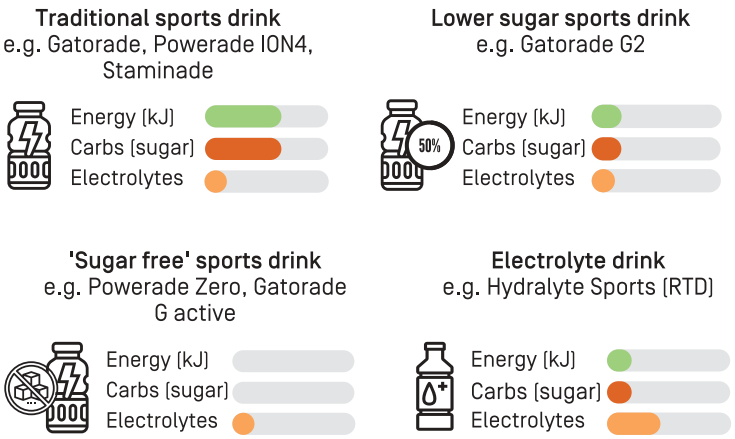


TABLE 3.5 Specialised sports foods

Nutritional supplement	Form	Perceived benefit	Potential harm or disadvantages
Sports gels	Gel 30–40 g sachets or tubes	• High concentration of CHO to top up/refuel stores for energy production • Reduce/delay the effects of fatigue due to fuel depletion	• Expensive • Concentrated CHO can cause gastrointestinal upset
Sports bars	Bar 50–60 g	• High concentration of CHO to top up/refuel stores for energy production • Reduce/delay the effects of fatigue due to fuel depletion	• As per sports gels overconsumption can impact on energy balance
Liquid meal supplements	Powder (mix with water or milk) Liquid	• Post-exercise recovery snack to replenish fuel and promote repair of muscle cells	• Overconsumption can impact on energy balance • Unwanted weight gain • May displace other whole foods
Sports drinks	Powder Liquid	• Rehydration • Replenishment of fuel (glucose) stores	• Overconsumption can impact on energy balance • Gastrointestinal upset • Dental erosion

3.3.5 Performance supplements

Creatine

A naturally occurring compound found in skeletal muscle, **creatine** is created through daily intake of foods such as fish, poultry and red meat. It is also manufactured in the kidneys through the intake of some amino acids. Creatine monohydrate is the commonly supplemented form of creatine (see figure 3.15).

FIGURE 3.15 Creatine is a nutritional sports supplement.

The use of creatine phosphate in the regeneration of adenosine triphosphate (ATP) for short-duration, high-intensity exercise is well known. Initial research cited a 25 per cent increase in stored creatine when taking a creatine supplement in comparison with not taking a supplement. However, subsequent research findings have varied considerably. What is agreed on is that creatine supplementation will enhance performance involving repeated sprints or bouts of high-intensity, short-duration activity separated by short recovery intervals of less than 1 minute. It is also recommended for developed, elite athletes who use resistance training to increase lean body mass, or for team athletes who participate in intermittent sports such as netball, football or racquet sports.

There are two recognised creatine supplementation regimens used by the AIS:

1. *Rapid loading protocol* — 20 grams daily (4 × 5-gram doses) for a total of five days. This protocol is linked to weight gain, usually in the form of fluid retention.
2. *Slow loading protocol* — smaller doses (3 grams) ingested each day.

To enhance creatine uptake, creatine should also be taken with a large amount of carbohydrates (50–100 grams). Once loaded, a maintenance dose of 3 grams daily is recommended. Extended loading protocols are not required.

Although no recognised findings have been reported on the possible side effects of long-term use of creatine, there are anecdotal reports of weight gain due to fluid retention, cramps and harmful effects on the liver and kidney when creatine has been consumed in excess of recommended doses. If protocols such as those presented above are followed, creatine should not cause these side effects in healthy people.

Protein supplements

Protein is a popular nutritional supplement that many athletes use due to its function in the growth and repair of muscle tissue and cells. Protein can be found naturally in foods such as red meat, poultry, nuts, eggs and legumes, as well as a formulated supplement in the form of a drink, bar or powder.

Protein supplements can assist the performance of the musculoskeletal system through increased muscle protein synthesis and therefore an increased muscle cross-sectional area. This increase leads to a greater storage of fuels and a greater ability to produce strength and power. Training intensity and frequency can increase due to the increased repair of the muscle cells.

Timing of protein consumption is important and the most benefit is gained by consuming protein immediately after exercise. At this time, muscle uptake and retention of amino acids is enhanced and appears to continue to be enhanced for up to 24 hours.

Endurance athletes in heavy training, athletes wanting to gain muscle mass and strength, and athletes in the initial stages of training all have a higher need for protein than other athletes. However, the increase in protein intake can be achieved through manipulating an athlete's diet.

creatine a naturally occurring compound found in skeletal muscles that assists in the regeneration of ATP in the muscle cells

protein supplements nutritional supplements used by many athletes to aid in the growth and repair of muscle tissue and cells

Protein powders

The most common forms of supplementation are protein powders made into shakes and protein bars (see figure 3.16). The amount of protein in powders is generally higher than can be achieved in consuming foods containing protein. The powders are classified according to the amount of protein and other nutrients they contain.

FIGURE 3.16 Protein powders are a quick and convenient supplement that can be used to assist muscle growth and repair.

Whey protein is the most common supplement form as it is rapidly digested and rich in branched chain amino acids. It comes in three forms:

- whey protein isolate: highest amount of protein with all lactose and fat removed
- whey protein concentrate: high amount of protein with small amounts of lactose and fat present
- whey protein hydrolysate: a combination of the above forms.

Research suggests that supplements offer no advantage over consuming protein-rich foods as part of a balanced diet. Protein consumption well above recommended intakes (>2 grams per kilogram BM) does not stimulate further muscle building or recovery, and is not recommended by sports dietitians.

In fact, excess protein consumption may displace other important nutrients from the diet. Some health risks might also be associated with excessive protein intake because of the extra demand placed on the kidneys to excrete any unused amino acids. Furthermore, excessive protein intake can compromise bone density and may also lead to weight gain if food choices are also high in fat.

However, athletes may require a supplement when consumption of food is difficult post-exercise. Products such as liquid meal supplements offer convenience and a practical solution to consuming adequate protein.

Caffeine supplementation

Caffeine was removed from the World Anti-Doping Agency (WADA) prohibited list on 1 January 2004. Since then, caffeine has been used by some athletes to enhance their performance. In terms of the effects of caffeine on the body, it has previously been believed that caffeine:

- mobilises fat from adipose tissue and muscle cells, resulting in glycogen sparing in endurance athletes
- alters the nervous system, creating a change in perception of effort and fatigue
- stimulates both the release and the action of adrenaline
- causes a **diuretic** effect, leading to dehydration.

Recent research now brings into question the ability of caffeine to enable glycogen sparing, as well as its diuretic effect on the athlete. There is sound evidence that caffeine is likely to enhance performance in the following:

- endurance sports (>60 min)
- brief sustained high intensity sports (1–60 min)
- team and intermittent sports (work rate, skills and concentration)
- single efforts involving strength or power.

How much caffeine?

The amount of caffeine in various food and drink varies widely (see figure 3.17). Caffeine doses of 1–3 milligrams per kilogram BM or 70–200 milligrams have proven to be beneficial in prolonged exercise lasting longer than 60 minutes. Caffeine can be consumed prior to or throughout the exercise. Furthermore, studies show that ingestion of more than 3 milligrams per kilogram BM of caffeine does not further increase performance, but may increase the risk of side effects, including increased heart rate, impairment of technique and over-arousal. Athletes need to be conscious of the fact that there is great individual variability in the response to caffeine intake.

caffeine a drug that acts on the central nervous system (CNS) to stimulate the release of adrenaline and alters perception of effort and fatigue

diuretic causes increased production and excretion of urine from the body

FIGURE 3.17 Typical content of caffeine in selected food and drink

Instant coffee

Serve: 250 mL
Caffeine content (mg): 60 (12–169)*

Red Bull

Serve: 250 mL
Caffeine content (mg): 80

Tea

Serve: 250 mL
Caffeine content (mg): 27 (9–51)*

Coca-Cola

Serve: 375 mL
Caffeine content (mg): 36

Chocolate (milk)

Serve: 60 g
Caffeine content (mg): 5–15

Kombucha

Serve: 250 mL
Caffeine content (mg): 5–27

No Doz

Serve: 1 tablet
Caffeine content (mg): 100

Mother energy drink

Serve: 500 mL
Caffeine content (mg): 160

*The caffeine content of tea and coffee varies widely depending on the brand, the way that the individual makes their cup of tea or coffee, and the size of their mug or cup.

CASE STUDY

Caffeine: a legal performance-enhancing drug

By Kate Schlag

If you were to rifle through almost any of my teammate's bags — or even mine, for that matter — there's a good chance you'd find performance-enhancing drugs. I promise we're not cheating, though: every other team uses (and, often, relies on) the same drug — caffeine.

Believe it or not, there's little scientific question that caffeine is an effective performance-enhancing drug. The first study to investigate the relationship between caffeine and exercise performance, published in 1978, reported that caffeine reduced cyclists' rating of perceived exertion by increasing fat oxidation; theoretically, those fatty acids were mobilised to be used by muscles early on, sparing glycogen for later use when your muscles are really exhausted.

Since then, several other theories have been proposed to explain caffeine's ergogenic capacity: caffeine stimulates the central nervous system, thereby enhancing mental alertness and reaction times (key in a sport that relies on mental acuity to make both offensive and defensive plays). It also increases calcium release and inhibits calcium re-uptake, two actions that play a role in muscle contraction. These effects result in increased muscle contraction force, allowing you to play longer and harder.

Initially, these studies focused on high amounts of caffeine (10–13 mg/kg body weight — for a 77 kg man, that's about 5–8 cups of coffee) in endurance events, but more recent studies have focused on low to moderate doses (≤3 mg/kg body weight, or 1–2 cups of coffee for a 77 kg man) in sustained high-intensity sports (like swimming and rowing) and stop-and-go sports. Researchers confirm that these lower doses can and do enhance performance. Here's what else you should know about caffeine and athletic performance.

All caffeine isn't created equal

There are over 60 sources of naturally occurring caffeine in nature, from coffee and cocoa beans to tea leaves and kola nuts. Because these plants and the foods and drinks they're turned into contain many other micronutrients, antioxidants and compounds in addition to caffeine, their effects on the body can vary widely. Tea, for example, contains higher amounts of theobromine and theophylline, which also stimulate the central nervous system. But it also contains L-theanine, an amino acid that increases the generation of alpha waves, which are associated with a more relaxed — but still alert — state of consciousness. The added sugar in a can of Coke — about 10 teaspoons — leads to a huge sugar spike immediately but often leaves you feeling even more lethargic (and in need of another caffeine boost) hours later.

The takeaway: If you're used to caffeinating with one type of caffeine before games and suddenly switch to another, be aware that it might not affect you in the same way. As with other tenets of sports nutrition, experiment with different forms of caffeine during practices and workouts and find out which type works best for you.

More isn't necessarily better

If two cups of caffeine can improve your performance, what can four cups do? It might make you incrementally faster, but it's likely that it will also make you jittery, shaky and anxious, which might not translate into success on the ultimate field. Too much caffeine might also hinder your decision-making: one study found that while 200 mg of caffeine improved the accuracy and speed of problem-solving, doubling the dose to 400 mg impaired problem-solving abilities. After 600 mg of caffeine, cognitive performance is said to decline rapidly. Experts seem to agree that the optimal range for exercise performance is 3–6 mg per kg of body weight. For that 77 kg man, that's between 1.5 and 3 cups of coffee.

It's also important to note that habitual coffee or tea drinkers can build a tolerance to caffeine, which means that if you regularly consume caffeine throughout the day, you may not feel the effects of one dose of caffeine on game day. If you're a regular consumer, try cutting out caffeine three or four days before a tournament and then reintroducing it on Saturday morning.

The takeaway: The difference between 'alert and focused' and 'jittery and anxious' might be small; again, find your optimal range during practices and workouts. If you're really looking to improve performance from caffeine, you may want to consider saving it for when you really need it — which means decreasing your weekly caffeine intake.

It doesn't affect everyone the same way

Some people can drink coffee all day without feeling any negative side effects; others have to take their last sip of a caffeinated beverage before 3 pm or they risk staying up all night. In general, women metabolise caffeine twice as fast as men, as do smokers compared to non-smokers (a faster caffeine metabolism means that you'll process caffeine faster, abating its effects more quickly).

Genetics play a pretty big role as well: an enzyme called CYP1A2 is responsible for metabolising caffeine, and multiple studies have shown a high inter-individual variation in its expression. Your nervous system could also account for some variation, as caffeine's effects partly depend on the percentage of receptors that bind to caffeine ...

... Caffeine can cross the blood–brain barrier as soon as 15 minutes following ingestion, increasing alertness and wakefulness almost immediately (in fact, just smelling roasted beans or the aroma of a steaming pot can increase brain activity). Peak caffeine levels usually occur around 45–60 minutes, when lipid oxidation is also increased. From there, you — an average, non-smoking adult — will probably feel the effects for another three to four hours, although this can be highly variable as well.

The takeaway: By now, you should know whether you're more sensitive or more tolerant to caffeine. If you don't, look to your parents, as caffeine sensitivity is hereditary. Aim to get your caffeine 45–60 minutes before the first pull, although you can play around with this timeline at practice.

Some side effects might hinder performance

While caffeine improves the immediate physical aspects of performance, it may have longer-term impacts that, ultimately, could lead to a net *decrease* in performance. The consumption of caffeine might interfere with sleep duration and quality, which has further implications when you consider that many important tournaments last three, or even four, days. Ingesting caffeine before a night game might improve performance, but it also might hinder your sleep, making you more tired and groggy for your morning game. In addition, no studies have looked at how taking caffeine multiple times a day affects performance — for example, once before quarters, semis and finals. If you're sensitive to the effects of caffeine, this begs the question: should you ingest caffeine before each and every game, or save the jolt for, hopefully, your appearance in finals?

With respect to other potential side effects, some studies have shown that caffeine intake may affect hydration status and carbohydrate metabolism. However, these studies have found either inconsistent or statistically insignificant results on performance ...

Source: www.ultiworld.com, 26 March 2015.

Sodium bicarbonate

Sodium bicarbonate increases the body's ability to dispose of excess hydrogen ions that are produced during anaerobic glycolysis. Hydrogen ions are thought to have a significant fatiguing effect on the body when working anaerobically. Bicarbonate loading acts as a buffer within the muscle, reducing the fatiguing effect of hydrogen on the functioning of the muscle. It is relevant to high-intensity events lasting between 1 and 7 minutes.

Bicarbonate can be consumed as a capsule or effervescent powder. The AIS recommends the following two protocols for ingestion of bicarbonate:

1. *Acute bicarbonate loading* — 200–400 milligrams per kilogram BM dose ingested 2–2.5 hours prior to the session.
2. *Chronic bicarbonate loading* — 500 milligrams per kilogram BM dose ingested per day over five days and split into five doses over the day.

Studies have shown that acute bicarbonate loading has a moderate effect in enhancing the performance of anaerobic exercise or events, and chronic bicarbonate loading can increase buffering capacity, with effects lasting for at least 24 hours following the last dose. It should be noted that very few studies have been completed in a sports setting.

The main side effect associated with sodium bicarbonate loading is gastrointestinal upset. Athletes should not combine this supplement with other nutritional supplements such as caffeine and creatine.

sodium bicarbonate a source of sodium that neutralises acids; it is ingested orally as a capsule or effervescent powder.

TABLE 3.6 Performance supplements that enhance the musculoskeletal system

Performance supplement	Performance benefits	Potential harms
Creatine	Increased stores of creatine in muscle allow for: • Increase in force and power produced in muscle contractions • Train harder at higher intensities • Delays CP depletion and fatigue • Decreases reliance on anaerobic glycolysis, reduces lactate accumulation, delaying fatigue	• Weight gain due to fluid retention • Possible side effects: gastrointestinal upset, muscle cramps • Excessive use may cause liver and kidney damage
Protein	• Used for muscle growth and repair • Increases muscle cross-sectional area — increase power and strength • Increases PC storage • Allows increased training intensity and frequency • Promotes glycogen resynthesis for increased fuel availability	• May displace other foods • Expensive • Extra consumption may displace other important nutrients from the diet • Health risks associated with excessive protein intake because of the extra demand placed on the kidneys to excrete any unused amino acids • Can compromise bone density • May lead to weight gain if food choices are also high in fat
Caffeine	• Change in perception of effort and fatigue • Stimulates release and action of adrenaline	• Overuse can lead to dependence Excessive consumption can lead to: • Increased heart rate • Impairment of technique • Over-arousal • Anxiety • Insomnia
Sodium bicarbonate	• Buffers hydrogen out of muscle at a faster rate, allowing for more to be produced • Delays fatigue	• Gastrointestinal upset

on Resources

Digital document Performance supplements that enhance the musculoskeletal system (doc-41915)

Weblink Professor Louise Burke talks about nutrition and supplements in sport

3.3.6 Dietary supplements

Vitamin and mineral supplements

Vitamins and **minerals** are an important part of an athlete's diet. Vitamins assist chemical reactions in the body (and thus help to release energy from food), while minerals play an important role in muscle contraction, nerve transmission, fluid balance and enzyme activity.

vitamins essential components of a balanced diet; they allow normal body growth and maintenance by assisting chemical reactions in the body.

minerals inorganic substances in the body required for adequate functioning of the body; they are important components of bone, muscle, skin and blood.

Eating a balanced diet ensures an adequate vitamin and mineral intake; however, supplementation may be required to prevent or treat a dietary deficiency in some athletes. This may be caused from dieting, not consuming a certain food or food groups, or recovering from injury or illness. If there is no deficiency, use of supplements has been shown to have no effect on performance enhancement

and excess consumption tends to be excreted by the body. Supplementation can take the form of a multivitamin/mineral that contains a variety of vitamins and minerals, for example Centrum, or a single-nutrient supplement such as calcium or iron.

Calcium

Calcium is important for muscle contraction, nerve transmission, enzyme activity and blood clotting. It is also an essential component of bones and teeth. Calcium requirements increase during childhood, adolescence, pregnancy and breastfeeding. Inadequate calcium intake may lead to low bone-mineral density and the risk of stress fractures. Calcium is important for athletes, and those at risk include athletes with an insufficient intake of dairy foods in their diet, those with a poor calcium balance due to malabsorption from the small bowel and females with impaired menstrual function. Supplementation is recommended for athletes who may require more or who are at risk of not consuming enough calcium in their diet. It is only recommended under medical supervision.

calcium a mineral found mainly in the hard part of bones and is essential for healthy bones. It is also important for muscle contraction, nerve transmission, enzyme activity and blood clotting.

EXAM TIP

When discussing how a nutritional supplement can enhance the performance of an athlete, make sure you indicate whether it should be consumed before, during or after an event.

For example, protein supplements are best consumed immediately after an event to enhance muscle growth and repair.

doc-41916

PRACTICAL ACTIVITY Nutrition and hydration

Goal

To understand how nutritional supplements can enhance performance in a multi-event competition

Instructions

Participate in a mini-athletics carnival of five events. These could include 100 m sprint, 800 m race, long jump, shot-put and relay. Make sure there is adequate rest between each event.

Primary data/Reflection

Critique your performance in each event. Consider your hydration and nutrition levels and the amount of rest you had between events.

Questions

1. Suggest two nutritional supplements that could be used during an athletics carnival to enhance performance.
2. Outline how they could enhance performance for a multi-event competition.

3.3 Activity

3.3 Quick quiz on | **3.3 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 4, 5	3, 6, 7	8, 9

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Define** what constitutes a nutritional supplement.
2. **Outline** how carbohydrate-based sports food can assist the performance of the musculoskeletal system.
3. **Discuss** how knowledge of the glycaemic index of foods can help an athlete optimise their performance.
4. **Outline** why performance supplements should be used with caution.
5. **Define** protein supplementation. Is it recommended for athletes?

APPLY your understanding

6. Nutritional supplements can be divided into three broad groups. **List** and **outline** each of the groups, including examples.
7. **Compare** and contrast sports gels, sports bars and liquid meal supplements.
8. **Explain** the importance of hydration for an athlete and **justify** why an athlete would consume a sports drink in comparison to water.
9. For each of the following sports, choose one nutritional supplement and **explain** how it might be beneficial for that sport.
   - Long distance cycling
   - Weightlifting
   - Team sports such as soccer

3.3 Exam questions

Question 1 (2 marks)

Consumption of carbohydrates is important for energy production. **Identify** one specialised sport food containing carbohydrates and explain how it can enhance the performance of the musculoskeletal system during exercise.

Question 2 (1 mark)

Source: *ACHPER 2023, Trial Exam Unit 1, Section A, Q.13;* © ACHPER

Caffeine is used by athletes to enhance performance as it can:

A. decrease perception of fatigue.
B. increase fuel stores.
C. decrease levels of dehydration.
D. decrease muscle soreness.

Question 3 (2 marks)

Creatine is a performance supplement used by a variety of athletes. Outline one benefit and one harm of using creatine to enhance performance

More exam questions are available in your learnON title.

3.4 Prohibited substances and methods that enhance performance of the musculoskeletal system: hormones

Key knowledge	Key skill
• potential benefits and harms of permitted and prohibited substances and methods that enhance performance of the musculoskeletal system, such as training, nutritional supplements, creatine supplementation and hormones (including steroids and growth hormones)	• investigate, evaluate and critically analyse the effects of a range of performance-enhancing substances and methods on the musculoskeletal system from a physiological perspective

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

Taking or using (prohibited) performance-enhancing substances or methods is commonly referred to as '**doping**'. This issue has been and will continue to be the dominant moral and ethical issue in sport. Sports such as baseball, athletics and cycling have made headlines for the use of prohibited performance-enhancing substances. The Russian Federation was banned from competing in all major sporting events from 2019 for four years because of widespread violations of the anti-doping code.

Indeed, the International Olympic Committee (IOC) has singled out doping as the greatest challenge to the integrity and future of world sport.

The World Anti-Doping Agency (WADA) was established in 1999 in response to the concerns of the IOC. WADA is an international, independent agency that is composed of and funded by governments and sporting movements throughout the world. The mission of WADA is to 'promote, coordinate and monitor the fight against doping in sport in all its forms'.

The introduction of **anti-doping codes** in sport has been an integral part of the fight to eradicate the use of drugs and other prohibited performance-enhancing methods in sport. These practices are prohibited because they:

- artificially enhance the performance of an athlete
- are potentially harmful to the health of an athlete
- are contrary to the spirit of sport.

doping the use by, or distribution to, an athlete of certain substances or methods that could have the effect of artificially improving the athlete's physical and/or mental condition and enhancing their performance

anti-doping codes codes established to eradicate the use of drugs and other illegal performance-enhancing methods in sport

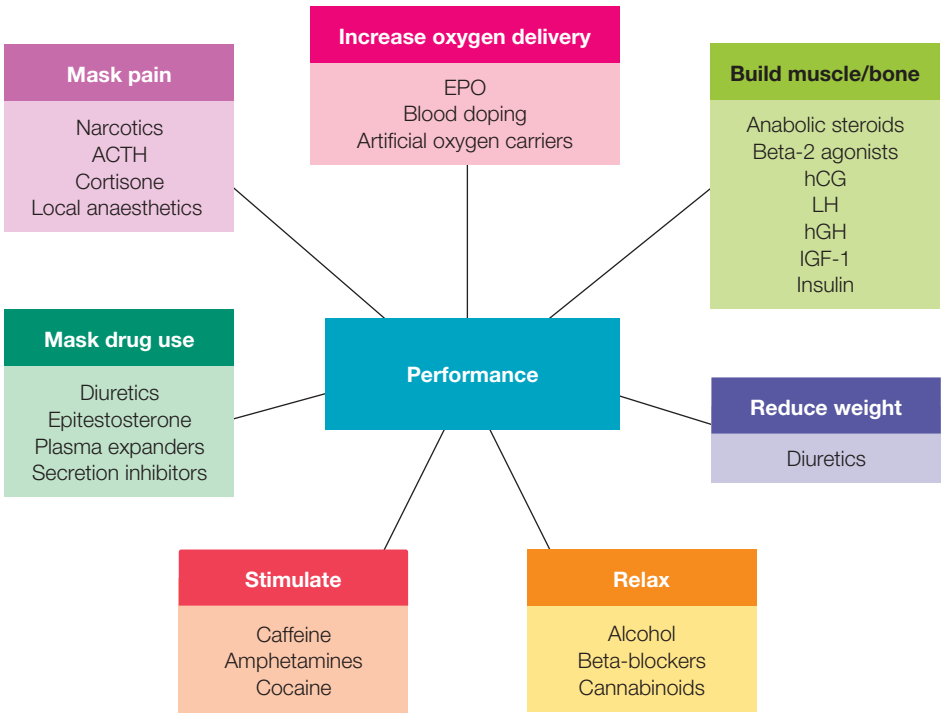
Performance-enhancing substances and methods

Performance-enhancing substances and methods have been employed by athletes and coaches for a variety of reasons:

- to increase strength and muscle mass (anabolic agents, steroids)
- to counteract undesirable side effects (hormones, anti-oestrogenic substances)
- to mask the presence of banned substances (diuretics)
- to increase alertness and/or aggressiveness (caffeine, amphetamines)
- to enhance oxygen transfer (blood doping)
- to alter samples provided for testing (urine substitution)
- to speed up the rehydration process (intravenous infusions)
- to reduce pain (narcotics).

FIGURE 3.18 Cycling has a long history of riders using prohibited performance-enhancing substances to gain an edge over their competitors.

FIGURE 3.19 Performance-enhancing drugs can have a variety of effects on performance.



Performance-enhancing drugs are currently prohibited or illegal in most sports. Furthermore, some performance-enhancing practices currently used in sport produce exactly the same results, but are not prohibited nor illegal. For example, the illegal drug anabolic steroid increases lean muscle mass, thus enhancing the strength and power an athlete can generate. However, the same effect can be obtained legally by participating in a resistance training program, as discussed earlier in this topic.

WADA produces a list of prohibited substances and methods annually. Many drugs are prohibited at all times, whereas others are prohibited only in competition. Some substances are banned only in certain sports. Athletes caught using these drugs have been stripped of their medals and records and banned from their sports, sometimes for years and, on occasion, for life.

The performance-enhancing drugs and methods most relevant to the development of the musculoskeletal system include those based on naturally occurring hormones in the human body, specifically anabolic steroids, growth hormones and related substances (see table 3.7). These substances are prohibited at all times.

on Resources

Weblink WADA prohibited drug list

Digital document Performance-enhancing substances (doc-41917)

Anabolic steroids

Steroids are synthetically produced drugs that mimic the effect of the hormone testosterone. Testosterone has both an anabolic effect and an androgenic effect on the human body. The anabolic effect promotes bone density, muscle growth and rapid recovery from injury, while the androgenic effects are the development and maintenance of male secondary sexual characteristics, such as growth of the male reproductive system and development of muscle mass, a deeper voice and facial hair.

steroids synthetically produced drugs that mimic the effect of the hormone testosterone

Athletes may use steroids for their anabolic effects; that is, the building of bone and muscle to increase the amount of strength and power they can produce (see figure 3.20). With greater strength and power, athletes are able to produce more force to run quicker, jump higher and throw further. The other reason for athletes using steroids is an increased rate of recovery, which allows them to train more often and for longer periods of time. The use of anabolic steroids allows an athlete to increase muscle growth and strength quicker than through legal methods such as resistance training.

Potential harms related to the use of steroids can be different for males and females, due to the increased level of testosterone in the body. Males are at risk of possible infertility, increased libido, testicular atrophy, baldness and development of breast tissue. Females are at risk of menstrual problems, increased body and facial hair, an enlarged clitoris and deepening of the voice. Both genders are at equal risk of tendon injury, fluid retention, liver damage, tremors, mood swings and depression, hypertension, acne (face and back) and cancer.

A legal alternative to anabolic steroids to promote muscle growth is resistance, plyometric and short-interval training, and the use of protein supplementation to assist the growth and repair of muscle.

FIGURE 3.20 American baseballer Mark McGwire admitted to using both anabolic steroids and human growth hormone during his career.

FIGURE 3.21 Resistance training is a permitted way for an athlete to build strength.

Human growth hormone

Human growth hormone (HGH) is a peptide hormone that is naturally produced by the pituitary gland. This hormone determines the height, bone and muscle growth of an individual.

Some athletes may take synthetic **growth hormone** in the belief that it will increase muscle strength, and hence athletic performance, through its capacity to build muscle. However, research indicates that the effects of HGH are

growth hormone a synthetically produced drug that mimics the effect of the hormone human growth hormone (HGH)

inconclusive at best. Any performance benefits are most likely the result of taking a combination of steroids and HGH. Other growth factors, such as Hexarelin, stimulate the release of growth hormone and have been linked to quicker recovery and healing times from injury. Similar to steroids, use of human growth hormone and related factors allows an athlete to increase muscle growth and strength quicker than through legal methods such as resistance training.

Potential harms of human growth hormone use include fluid retention, acromegaly, thickened skin, hypertension, hairiness, cardiac disease, osteoarthritis, and joint and bone pain.

Like steroids, a legal alternative to using human growth hormone to promote muscle growth and strength development is resistance, plyometric and short-interval training, as well as the use of protein supplementation to assist the growth and repair of the muscles.

EXAM TIP

Permitted and prohibited substances and methods generally have the same benefit, which is to enhance performance. However, the potential harms for the prohibited substance are often more severe and a greater health risk. When responding to comparison questions, make sure you can clearly identify the similarities and differences between these substances and methods.

For example, both resistance training and anabolic steroids induce muscle hypertrophy to increase strength and power (similarity). However, anabolic steroids are more likely to cause physiological harms, such as increased mood swings and depression, in comparison to resistance training, where injury is more likely to occur due to incorrect technique.

TABLE 3.7 Prohibited methods used to enhance the performance of the musculoskeletal system

WADA classification	Examples	Performance benefits	Potential harms (side-effects)	Permitted alternative
S1 Anabolic agents	• Anabolic steroids • Nandrolone • Stanozolol • Tetrahydroges-trinone (THG)	• Increased lean muscle mass and strength • Reduced fatigue • Increased rate of recovery • Increased aggression	In males: • Possible infertility • Increased libido • Testicular atrophy • Baldness • Development of breast tissue	• Resistance training • Plyometric training • Short interval training • Protein supplementation
			In females: • Menstrual problems • Increased body and facial hair • Enlarged clitoris • Deepening of the voice	
			Both: • Tendon injury • Fluid retention • Liver damage • Tremors • Mood swings and depression • Hypertension • Acne (face and back) • Cancer	

S2 Growth factors	• Growth hormone releasing hormone (GHRH) • Insulin-like growth factor-1 (IGF-1) • Hexarelin	• Enhanced muscle and bone development • Increased muscle size and strength • Reduced recovery time • Increased healing time from injury	• Acromegaly • Thickened skin • Hypertension • Hairiness • Cardiac disease • Fluid retention • Osteoarthritis • Joint and bone pains	• Resistance training • Plyometric training • Short interval training • Protein supplementation

doc-41918

PRACTICAL ACTIVITY Prohibited substances in sport

Goal

To identify the perceived benefits and potential harms of the use of prohibited substances for performance enhancement in sport

Instructions

As a class, participate in a game of baseball/softball.

Primary data/Reflection

Analyse the skills required in a game of baseball or softball and suggest reasons why an individual may choose to use a prohibited substance, such as anabolic steroids, to enhance their performance. Make a clear link between the skills and how use of a prohibited substance would benefit the individual.

Questions

1. The aim of the batter is to hit a home run. Outline how a prohibited substance may assist the athlete to do this.
2. Identify three potential harms of using the prohibited substance discussed in question 1.

3.4 Activity

3.4 Quick quiz on

3.4 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 5	4	3

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Define** the term *doping*.
2. **List** some of the reasons why some athletes may use performance-enhancing drugs in sport.
3. What is WADA? **Explain** its role in anti-doping initiatives.

APPLY your understanding

4. **Discuss** why some drugs are banned all the time, but others are prohibited only in certain sports and at certain times.
5. **Outline** how hormone-based drugs such as steroids and human growth hormone can physiologically enhance athletes' performance.

3.4 Exam questions

Question 1 (1 mark)

Anabolic steroids are used by athletes who want to:

A. increase muscle bulk, strength and power.
B. reduce muscle cell breakdown.
C. increase size and number of mitochondria.
D. reduce vasoconstriction of blood flow to the skin

Question 2 (2 marks)

Compare the similarities and differences between the use of growth hormone and resistance training to enhance performance.

Question 3 (3 marks)

Source: *ACHPER 2021, Trial Exam Unit 1, Section B, Q.11a*; © ACHPER

Tasha has been competing for many years at an international level in high jump. Over the past 3 years, her performance has plateaued, and she has had a number of serious injuries which have inhibited her training load.

a. **Identify** and **discuss** an illegal method or substance Tasha may consider using to enhance her performance in high jump

More exam questions are available in your learnON title.

3.5 Key skills

Key skill

- investigate, evaluate and critically analyse the effects of a range of performance-enhancing substances and methods on the musculoskeletal system from a physiological perspective

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

3.5.1 Tell me

To address this key skill, it is important to remember the following:

- understand the potential benefits and perceived harms of a range of permitted and prohibited substances and methods that can be used by an athlete to enhance the functioning of the musculoskeletal system
- physiological refers to changes that occur within the body, specifically to the skeletal or muscular system
- performance enhancement relates to improvements in the functioning of the musculoskeletal system
- provide a clear link between the musculoskeletal physiological adaptation and how it can enhance performance.

3.5.2 Show me

Practice question (5 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

a. **Name** a prohibited substance a *weightlifter* may choose to use and **identify** one *perceived benefit* and one *potential harm* of using this substance. (4 marks)

b. **Suggest** a permitted method that a *weightlifter* could use to induce the same *benefits* as the prohibited substance identified in **part a.** to enhance their performance. (1 mark)

Decode the question

Strategies to decode the question

- **Identify the action words:**
  Name — identify or state
  Identify — determine the key characteristics or features
  Suggest — put forward a possible answer for consideration
- **Key terminology** — *weightlifter perceived benefit, potential harm*
- **Key concepts** — prohibited substance, permitted method, performance enhancement
- **Marking scheme** — 5 marks — Always check the marking scheme for depth of response required, linking to key information highlighted in the question.

Sample response and marking scheme

a. A weightlifter may choose to use anabolic steroids to induce *hypertrophy*, enabling them to lift heavier weights due to a larger surface area of the muscle. Furthermore, the regular use of anabolic steroids could lead to a *greater chance of injury,* which could result in the athlete missing out on competitions. Another potential harm is *loss of appetite* and associated factors such as *fatigue and weakness*.
Other possible answers for perceived benefits:

- decrease in recovery time
- reduction in body fat

Other possible answers for *potential harms:*

- acne
- hair loss
- weight gain
- problems sleeping
- high blood pressure

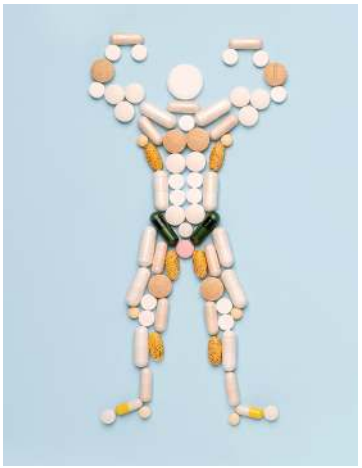
Award 1 mark for identifying a prohibited substance.
Award 1 mark for identifying one perceived benefit.
Award 1 mark for identifying one potential harm.
Award 1 mark for linking the perceived benefit and potential harm to a weightlifter.

b. Resistance training will increase their *muscle size (hypertrophy)* and enhance their ability to lift heavier weights.
Award 1 mark for identifying a permitted method

3.5.3 Let me do it

Question 1 (6 marks)

Identify one training method, one nutritional supplement and one prohibited method that an athlete might use to build muscle strength and power. **Discuss** similarities and difference between the potential benefits and harms of each of these.



3.6 Review

Hey students! Now that it's time to revise this topic, go online to:

Review your results

Watch teacher-led videos

Practise exam questions

Find all this and MORE in jacPLUS

3.6.1 Summary

Performance enhancement

- Performance enhancement includes any methods, devices or substances that have the potential to improve athletic performance. They can be permitted or prohibited.
- Performance-enhancing substances and methods improve performance by influencing the physiological capacity of a particular body system, removing physiological constraints that impact on performance or increasing the speed of recovery.

Permitted substances and methods

- Permitted substances and methods to enhance the performance of the musculoskeletal system include training methods such as resistance training, plyometric training, and short- and intermediate-interval training.
- Training methods and mechanical devices can improve an athlete's performance by increasing the strength, flexibility, power and speed generated by the muscles to run faster, jump higher and throw further.
- Nutritional supplements can also benefit the athlete. There are many nutritional supplements on the market, although many of them have no scientific backing to support their performance-enhancement claims. While specialised sports foods or drinks are very popular and can be a useful addition to a specialised program, nutritional performance supplements should be used with caution. Only a few so-called nutritional performance supplements actually offer benefits supported by scientific evidence.
- The AIS provides an information program for its athletes, which categorises sports supplements. Currently, only those supplements found in group A have scientific backing and are supported by the AIS for use by its athletes. Examples of these supplements include sports drinks, electrolyte replacement supplements, sports bars or gels, liquid-meal supplements, orally ingested vitamin or mineral supplements, protein supplements, caffeine, creatine and bicarbonate.

Prohibited substances and methods

- Doping is the use of certain substances or methods that could artificially improve an athlete's physical and/or mental condition, thus enhancing their performance. Performance-enhancing drugs are currently banned or considered illegal in most sports.
- Performance-enhancing drugs may be taken by athletes to increase their strength and muscle mass, counteract undesirable side effects, mask the presence of other banned substances, increase alertness or aggressiveness, or reduce pain.
- The World Anti-Doping Authority (WADA) produces a list of banned substances and methods annually that athletes and sporting organisations must abide by. Drugs can be prohibited at all times, only in competition or only in certain sports, depending on their classification and effects on the body.
- Performance-enhancing drugs most relevant to the development of the musculoskeletal system include those based on naturally occurring hormones in the human body, including anabolic steroids, growth hormones and related substances.

3.6.2 Key terms

aerobic energy produced with the presence of oxygen
anaerobic energy produced without the presence of oxygen
anti-doping codes codes established to eradicate the use of drugs and other illegal performance-enhancing methods in sport
caffeine a drug that acts on the central nervous system (CNS) to stimulate the release of adrenaline and alters perception of effort and fatigue
calcium a mineral found mainly in the hard part of bones and is essential for healthy bones. It is also important for muscle contraction, nerve transmission, enzyme activity and blood clotting.
carbohydrate loading the manipulation of training and nutrition prior to endurance events to maximise muscle glycogen (carbohydrate) stores
chronic muscular adaptations the long-term responses of body systems developed in response to a training program
creatine a naturally occurring compound found in skeletal muscles that assists in the regeneration of ATP in the muscle cells
diuretic causes increased production and excretion of urine from the body
doping the use by, or distribution to, an athlete of certain substances or methods that could have the effect of artificially improving the athlete's physical and/or mental condition and enhancing their performance
flexibility training training that moves a joint through its range of movement; it can be static or dynamic.
glycaemic index is a ranking of carbohydrates on a scale from 0 to 100 according to the extent to which they raise blood glucose levels after eating
growth hormone a synthetically produced drug that mimics the effect of the hormone human growth hormone (HGH)
interval training training that consists of intervals of work followed by intervals of rest or recovery
liquid-meal supplements supplements typically containing a carbohydrate-rich, protein-moderate, low-fat powder formula that can be mixed with water or milk
minerals inorganic substances in the body required for adequate functioning of the body; they are important components of bone, muscle, skin and blood.
nutritional supplements food or preparations ingested in excess of those consumed in a normal diet to supplement or increase the amount of nutrients available
performance-enhancing includes methods, devices or substances that improve athletic performance
plyometric training training that aims to increase muscular power by first stretching a muscle then contracting it in the shortest time possible
protein supplements nutritional supplements used by many athletes to aid in the growth and repair of muscle tissue and cells
resistance training training that aims to build muscular strength, muscular power or muscular endurance by exercising muscles or a group of muscles against a resistance
sodium bicarbonate a source of sodium that neutralises acids; it is ingested orally as a capsule or effervescent powder.
sports bar fortified food in a bar form that contains a blend of carbohydrates and protein to provide a large boost of fuel in one serving
sports gel fortified food in a gel form that contains a blend of carbohydrates and protein to provide a large boost of fuel in one serving
steroids synthetically produced drugs that mimic the effect of the hormone testosterone
vitamins essential components of a balanced diet; they allow normal body growth and maintenance by assisting chemical reactions in the body.

3.6 Exam questions

3.6 Section A — Multiple choice questions

Question 1 (1 mark)

The most relevant anaerobic training methods to enhance performance of the musculoskeletal system are:

A. resistance training, fartlek training, flexibility training.
B. plyometric training, continuous training, circuit training.
C. resistance training, plyometric training, short-interval training.
D. plyometric training, flexibility training, long-interval training.

Question 2 (1 mark)

Plyometrics aims to increase muscular power by which of the following methods of contraction?

A. A rapid isokinetic contraction followed by a rapid concentric contraction
B. A rapid eccentric contraction followed by a rapid concentric contraction
C. A rapid eccentric contraction followed by a rapid concentric contraction
D. Holding an isometric contraction

Question 3 (1 mark)

Source: *ACHPER 2023, Trial Exam Unit 1, Section A, Q.12;* © ACHPER

Creatine supplementation is most likely to improve the performance of:

A. marathon runners.
B. a netballer.
C. 100 m sprinter.
D. a tennis player.

Question 4 (1 mark)

Sports gels are commonly used by athletes to increase fuel supply of which nutrient?

A. Protein
B. Carbohydrates
C. Fats
D. Vitamins and minerals

Question 5 (1 mark)

Sports drinks can limit the fatigue of an athlete during an event, as they can:

A. hydrate an athlete.
B. hydrate and refuel an athlete.
C. refuel an athlete.
D. stop hunger.

Question 6 (1 mark)

Source: *ACHPER 2020, Trial Exam Unit 1, Section A, Q.13;* © ACHPER

Which of the following is a reported benefit of consuming human growth hormone, for performance enhancement?

A. increase in the amount of subcutaneous (meaning underneath the skin) fat
B. increase in lean body mass
C. buildup of connective tissue within muscles
D. decrease in lean body mass

Question 7 (1 mark)

Prohibited performance-enhancing drugs most relevant to the musculoskeletal system include:

A. steroids and stimulants.
B. steroids and blood doping.
C. steroids and growth hormone.
D. steroids and beta blockers.

Question 8 (1 mark)

Source: *ACHPER 2019, Trial Exam Unit 1, Section A, Q.10;* © ACHPER

In which of the following sports would the use of performance enhancing anabolic steroids be used to increase muscular size and strength improve performance?

A. weightlifting
B. 1500 m swimming
C. marathon running
D. high jump

Question 9 (1 mark)

Power athletes may use human growth hormone (HGH) in an attempt to increase their muscle bulk. A potential harm of taking this drug could be:

A. increased blood viscosity.
B. hypertension.
C. decreased libido.
D. increased heart rate.

Question 10 (1 mark)

A legal alternative to using steroids that could induce the same physiological changes to enhance performance would be:

A. creatine supplementation.
B. human growth hormone injections.
C. resistance training.
D. continuous training.

3.6 Section B — Short answer questions

Question 1 (6 marks)

Source: Adapted from *ACHPER 2022, Trial Exam Unit 1, Section B, Q.12*; © ACHPER

Creatine supplementation is a legal substance sometimes used in resistance training and associated competitions such as weightlifting.

a. **Identify** two potential side-effects of creatine supplementation an individual may experience. **(2 marks)**
b. **Evaluate** the effectiveness of creatine supplementation to enhance the performance of the musculoskeletal system. **(4 marks)**

Question 2 (7 marks)

Eliud Kipchoge is a Kenyan long distance runner who has run five of the fastest ten marathons in history. His quickest time was 2 hours, 1 minute and 9 seconds, set at the 2022 Berlin Marathon.

a. Elite endurance athletes such as Eliud Kipchoge will carbohydrate (CHO) load before the event. **Outline** the dietary and training strategies that should be used in conjunction with CHO loading. **(2 marks)**
b. **i.** Other than the associated benefits of increasing muscle and liver glycogen stores, **describe** on advantage of CHO loading and how it assists performance. **(3 marks)**
ii. **Outline** two disadvantages that may be associated with CHO loading. **(2 marks)**

Question 3 (2 marks)

The Australian Open Tennis tournament occurs in summer, when temperatures can often reach 35–40 degrees Celsius.

List and **explain** one hydration technique, other than drinking water, that tennis players could use to enhance performance.

Question 4 (1 mark)

Source: *ACPHER 2013, Trial Exam Unit 1, Section B, Q.12*; © ACHPER

In January 2013 Lance Armstrong, winner of seven Tour De France titles, admitted that he had used numerous performance-enhancing drugs and/or practices to help him secure these wins.

List one perceived benefit and one side-effect that Armstrong would have experienced by consuming the substance anabolic steroid.

Benefit:

Side-effect:

Question 5 (1 mark)

Source: *ACHPER 2015, Trial Exam Unit 1, Section B, Q.10*; © ACHPER

Michael Clarke is an Australian cricketer who hit a score of 128 off 163 balls in two days of play during a five-day test match against India. In the same summer season Peter Handscomb hit a score of 103 off 64 balls in a Twenty20 game that was completed in three hours.

Michael Clarke was advised to consume caffeine during the five-day test match.

List and **explain** one hydration technique, other than drinking water, that Michael Clarke could utilise during a five-day test match to enhance performance.

Question 6 (1 mark)

Source: *ACHPER 2008, Trial Exam Unit 1, Section B, Q.19*; © ACHPER

During 2005, the media ran a number of stories relating to the use of caffeine supplements as a performance-enhancing practice for elite athletes.

a. **Outline** two supposed performance benefits associated with the use of caffeine.

b. **Outline** two potential side-effects associated with the use of caffeine as a performance-enhancing substance.

Continue to build your exam skills

Access the Unit 1 Area of Study 1 Review at the end of Topic 3. This includes:

- Practice extended response
- Practice examination
- Practice school-assessed coursework.

AREA OF STUDY 1 How does the musculoskeletal system work to produce movement?

OUTCOME 1

On completion of this unit, the student should participate in and analyse information from a variety of practical activities to explain how the muscular and skeletal systems function and interact to produce movement, and evaluate the use of performance enhancement substances and methods.

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission

REVIEW CONTENT SEQUENCE

U1 AOS1 Extended response — Build your exam skills
U1 AOS1 Practice examination online only
U1 AOS1 Practice school-assessed coursework online only

U1 AOS1 Extended response — Build your exam skills

A guide to the extended response:

- An essential skill in VCE Physical Education is being able to answer an extended response question. The Unit 3 and 4 VCAA exam will feature a question prompting you to react to a stimulus, which could be a case study of a specific sport, or images or data gathered during physical activity. This question typically carries 8 marks.
- An extended response question requires an answer that weaves together and interconnects various key knowledge points into a comprehensive response.
- The requirements for these questions might direct you to include certain key knowledge in your answer, either through dot points or within a sentence. Addressing all these key knowledge areas is necessary to achieve a high score.
- The question will clearly outline the key knowledge to address, serving as a 'checklist' to guide you. You should demonstrate your understanding of each key knowledge by connecting it to the information in the question's stem. It's important to identify the significant elements in the stimulus that will support your answer. Some questions may ask you to illustrate the interrelationship between concepts.
- A response that earns a high score will integrate the key knowledge, showing how the concepts are interconnected, rather than treating each one in isolation.

Extended response questions are marked holistically, and marks are awarded based on:

- how the response has been structured
- how well the key knowledge has been understood
- the connection between the stimulus material and the response.

Tell me

For Unit 1 Area of Study 1, it is important to remember the following:

- correct anatomical terminology for the structures and functions of the muscular and skeletal systems
- the variety of movements used in physical activity, sport and/or exercise and the interaction between bones, muscles, joints and joint actions
- different types of muscle contractions and the role of agonists, antagonists and stabilisers in movement
- the relationship between motor unit recruitment, activation and force production in movement

- the causes of causes of musculoskeletal injuries
- how physical aids and physiological strategies are applied in a variety of sporting activities to maintain optimal functioning of the musculoskeletal system
- the effects of a range of performance-enhancing substances and methods on the musculoskeletal system from a physiological perspective.

Show me

Practice question (8 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

Cricket has evolved from the traditional Test match played over five days to limited over games, such as the fast-paced Twenty20 (T20) format where each team bats for a single innings of 20 overs. Whilst the basics of the game, two teams of eleven players – one batting, the other fielding – has remained the same, the pace and tactics of the game have changed.

Test cricket is a game of endurance, requiring skill and concentration. It has a slower pace and the batter has time to select shots they want to play. They are more likely to block and play straight bat shots as depicted in figure a.

T20 on the other hand, involves big hitting and fast running between the wickets to score as many runs as possible in the limited overs. The batter is more likely to play powerful hook or cross bat shots as depicted in figure b.

FIGURE (a) Batters are more likely to block and play straight bat shots in a Test match whereas in **(b)** T20, the batter is more likely to play powerful shots.

Based on your understanding of the musculoskeletal system and *factors* that can influence successful performance, **discuss** the *similarities and differences* between the *batting performance* of a Test player and a T20 player.

Your response should include reference to:

- interactions of the bones and muscles to create movement
- joint actions
- motor unit recruitment
- training to enhance the musculoskeletal system.

Decode the question

Strategies to decode the question

- **Identify the action word:**
  Discuss — go into detail about the characteristics of a key concept
- **Key terminology** — *factors*, *similarities and differences*, *batting performance*
- **Key concepts** — musculoskeletal system, interactions of the bones and muscles to create movement, joint actions, motor unit recruitment, training to enhance the musculoskeletal system
- **Marking scheme** — 8 marks — always check marking scheme for the depth of response required, linking to key information highlighted in the question

Sample response

Both the Test cricketer and the T20 cricketer require use of the upper body to play their selected shots. The skeletal system, specifically the bones, provides an attachment point for the muscular system to create movement. The muscles, when activated, pull on the bones across a joint to create the desired movement. Specific muscles used in either batting shot include the pectoralis major, deltoid, latissimus dorsi, biceps and triceps which attach to various bones of the upper body including the humerus, ulna, radius, clavicle, and scapula.

A difference between each shot relates to the joint actions required. The block or straight drive of the Test cricketer requires shoulder and elbow flexion where the joint angle decreases to move in a straight line. *In comparison*, the hook shot requires rotation of the upper body and shoulder adduction to swing their arms high across their body to complete the shot.

When comparing the shots taken in both forms of cricket, the block only requires a small amount of force to stop the ball, therefore less impulses are sent to the muscles resulting in fewer and smaller motor units being recruited. *In comparison*, in T20 when completing a hook or cross bat shot more force is required. This means many impulses are sent to the muscles with many more and larger motor units being recruited and activated. This allows for more fast twitch fibres to be recruited to complete the powerful shots and sprinting between the wickets.

Both Test and T20 cricketers could use resistance training enhance the performance of the musculoskeletal system however they may focus on different areas to support the requirements of their game. *The T20 cricketer is more likely* to focus on muscular power and speed to increase muscle size for big hits and fast running between the wickets in comparison to the Test cricketer who is more likely to focus on endurance. Due to the long 5-day format of Test cricket, aerobic training and skill development is more suited than power.

Marking guide

High range response	• Ideas are well organised and coherent • Engages with the stimulus material of both the question and images to answer the question correctly • Compares the similarities and differences between both forms of cricket and batting shot • Strong examples of how the bones and muscles work together, using correct terminology and comprehensively discussing the major bones and muscles required for each batting style • Correct identification and comprehensive discussion of joint actions relevant to each batting style • Thorough discussion of motor unit recruitment for both batting shots depicted in the figures • Comprehensive discussion of training type suited to each form of cricket to enhance the musculoskeletal system

Mid range response	• Ideas are organised and usually coherent • Engages with some stimulus material, including the question and/or images, to provide a satisfactory answer • Discusses the similarities and/or differences between the two forms of cricket and batting shots — although this may be one sided. • Provides some examples of how bones and muscles coordinate, attempting to use appropriate terminology and discussing the primary bones and muscles involved in each batting style • Identifies and discusses the joint actions relevant to each batting style • Offers some discussion of motor unit recruitment for the batting shots shown in the images • Some discussion of the type of training appropriate for each form of cricket to improve the musculoskeletal system
Low range response	• Ideas may be present but lack organisation or coherence • The stimulus material may be used but may not be fully understand and not applied to answer the question correctly • Comparison of the two forms of cricket and batting shots lacks depth or detail • Examples of bones and muscles working together are included but with limited use of correct terminology or incomplete discussion • Some joint actions are included but the discussion may be partially incorrect • Discussions of motor unit recruitment may not be connected to batting shots in the images • Mentions training types for cricket but the discussion on how they enhance the musculoskeletal system is limited

Let me do it

Extended response question learn on

Question 1 (8 marks)

Baseball is a popular sport played worldwide. A game usually consists of nine innings, and the team with the greatest number of runs at the end of the game wins. Skills required include throwing (pitching and fielding), catching, batting and base running.

Baseball has many injuries linked to the physical requirements of the sport. Being hit with a fast ball, sliding into bases or repetitive use of the same body past, such as with pitching, can all lead to injury. Players need to take several preventative measures to reduce the likelihood of injuries occurring.

Unfortunately, baseball has had a number of scandals relating to prohibited drug use. The strength and power required to hit 'home runs' has fuelled the use of prohibited substances to gain an advantage over the opposition. Whilst this may provide initial benefit to an athlete, there are also many harms associated with these substances.

Explain how a baseball player can take appropriate measures to enhance optimal performance of the musculoskeletal system.

Your response should include references to:

- interaction of bones, muscle and joints as a lever system
- warm up
- protective equipment
- potential benefits and harms of prohibited substances.

Hey students! Now that you have completed the Extended Response, access the following in learnON

Practice examination

Practice SAC

Receive immediate feedback

Find all this and MORE in jacPLUS

Hey teachers! Now access learnON to assign the quarantined school-assessed coursework

Assign the quarantined school-assessed coursework

Track your students' results

Identify strengths and weaknesses

Find all this and MORE in jacPLUS

UNIT 1

AREA OF STUDY 2

What role does the cardiorespiratory system play in movement?

OUTCOME 2

On completion of this unit, the student should be able to participate in and analyse information from a variety of practical activities to explain how the cardiovascular and respiratory systems function and interact, and evaluate the use of performance enhancement substances and methods.

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

TOPIC SEQUENCE

4 Structure and functions of the cardiovascular system 136

5 Structure and functions of the respiratory system 167

6 Enhancing the performance of the cardiorespiratory system 198

UNIT 1 AREA OF STUDY 2 REVIEW

Extended response — Build your exam skills 234

Practice examination ..... online only

Practice school-assessed coursework ..... online only

4 Structure and functions of the cardiovascular system

4.1 Overview

Hey students! Bring these pages to life online

Watch videos

Engage with interactivities

Answer questions and check results

Find all this and MORE in jacPLUS

LEARNING SEQUENCE

4.1 Overview
4.2 Exploring the cardiovascular system's structure and function — heart, blood and blood vessels
4.3 Role of the cardiovascular system in thermoregulation
4.4 Responses of the cardiovascular system to physical activity
4.5 Key skills
4.6 Review

4.1.1 Introduction

How do you measure your fitness? While there are many fitness components to consider, such as muscular strength, when people consider fitness they generally use cardiovascular system assessments as the primary indicator of physical fitness. This is because our cardiovascular system plays such a vital role in all human movements.

In this topic we will investigate how the cardiovascular system responds to exercise at various intensities and temperatures. To help you understand how all this occurs, the anatomy of the heart will be thoroughly explored, along with the functions of specific cardiovascular structures (e.g. blood vessels).

This topic provides a foundation for understanding how the cardiovascular and respiratory systems work together, particularly during rest and physical activity, which will be expanded on later in this area of study.

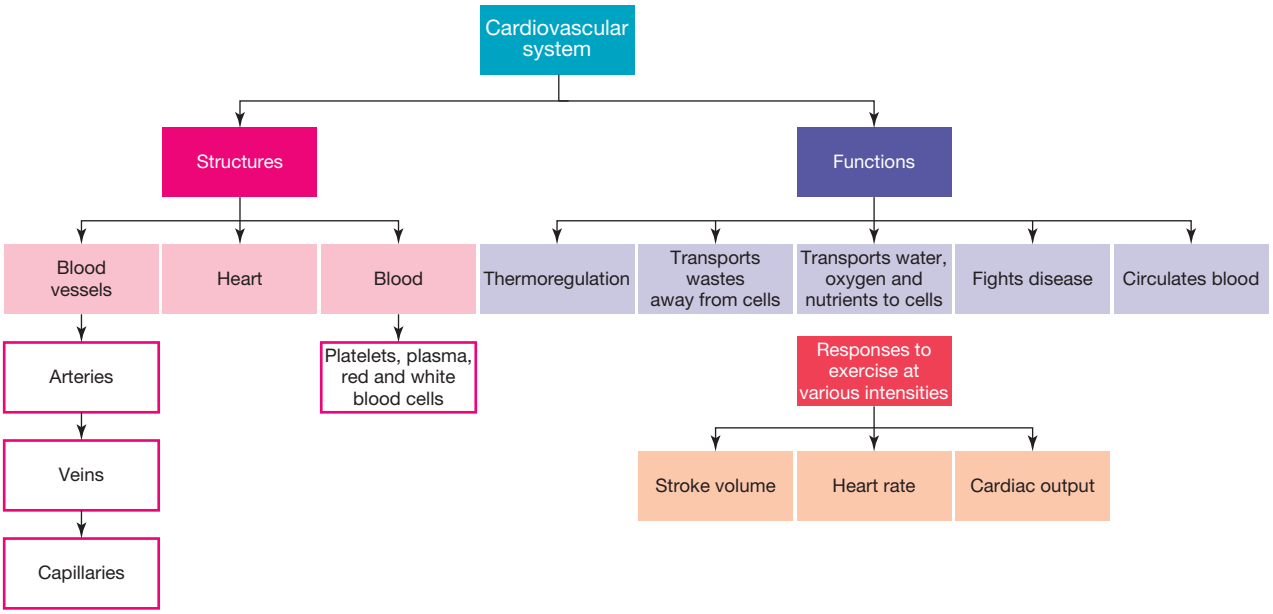
FIGURE 4.1 How do the structures of the cardiovascular system work together to meet the demands of the body during rest and exercise?

4.1.2 Key knowledge and Key skills

Key knowledge	Key skills	Subtopic
• the structure and function of the cardiovascular system, including the heart, blood, blood vessels and blood flow around the body at rest and during various intensities of physical activity, sport and/or exercise	• apply and use anatomical terminology to identify the structures and function of the cardiovascular and respiratory systems	**4.2**
• the role of the cardiovascular system in thermoregulation, including vasodilation and vasoconstriction of the blood vessels to regulate blood distribution at rest and during physical activity, sport and/or exercise	• examine the role and process of thermoregulation through participation in physical activity, sport and/or exercise	**4.3**
• the relationship between stroke volume, heart rate and cardiac output at rest, submaximal and maximal exercise intensities	• use primary data to measure and analyse the changes to the cardiovascular and respiratory systems at rest compared with various exercise intensities	**4.4**

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

4.1.3 Topic preview



4.2 Exploring the cardiovascular system's structure and function — heart, blood and blood vessels

Key knowledge	Key skill
• the structure and function of the cardiovascular system, including the heart, blood, blood vessels and blood flow around the body at rest and during various intensities of physical activity, sport and/or exercise	• apply and use anatomical terminology to identify the structures and function of the cardiovascular and respiratory systems

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

4.2.1 What is the cardiovascular system?

The **cardiovascular system** consists of the heart, blood and blood vessels. These structures all work together to ensure blood is circulated throughout the body, delivering nutrients to cells and removing waste products.

cardiovascular system the heart and blood vessels circulate blood throughout the body, delivering water, oxygen and nutrients to cells, and removing waste products such as carbon dioxide

The structure of the cardiovascular system

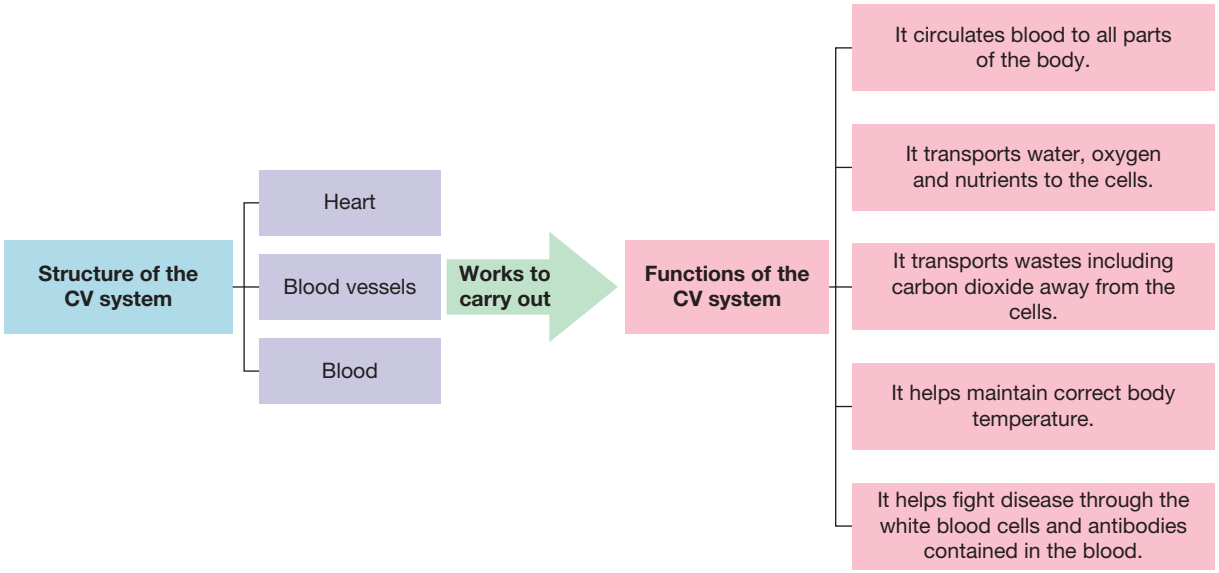
The heart acts as the cardiovascular system's powerhouse, pumping blood with precision. Surrounding it is a network of blood vessels, which include arteries, veins and capillaries.

FIGURE 4.2 The cardiovascular system

The relationship between the cardiovascular system's structure and function

The cardiovascular system is designed to accomplish specific functions efficiently (see figure 4.3). In this topic we will explore in detail how its specific structures are designed to transport metabolic substances to and away from cells, and keep our body at healthy temperatures.

FIGURE 4.3 The structure and function of the cardiovascular system are closely intertwined.



4.2.2 Structure of the heart

The heart is a pump designed to circulate blood throughout the cardiovascular system (see figure 4.2).

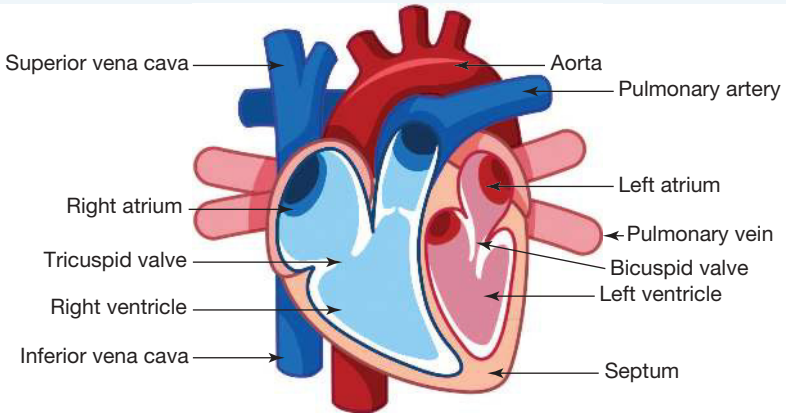
The heart has four chambers — two **atria** and two **ventricles**.

- The atria are the upper chambers that receive blood.
- The ventricles are the lower chambers that pump blood.

In figure 4.4, the tricuspid and bicuspid valves are open to fill the heart with blood. These one-way valves prevent blood flowing back into the atrium. The septum divides the heart into two pumps:

- The left pump is the left atrium and left ventricle.
- The right pump is the right atrium and right ventricle.

FIGURE 4.4 The structure of the heart



The blood in the two pumps does not mix because the left pump has **oxygenated** blood for the body, while the right pump has **deoxygenated** blood that travels to the lungs for the removal of carbon dioxide.

Valves are located between the atria and the ventricles, and at the entrance to the arteries from the heart. The mitral valve (also known as the bicuspid valve) is on the left side of the heart and the tricuspid valve is on the right side. These valves allow blood to travel in one direction, stopping blood in the ventricles from flowing back into the atria. The red areas in figure 4.5 show where there is oxygen-rich blood, while the blue areas show where there is oxygen-poor blood.

atria the two upper chambers of the heart. They receive blood from the veins and pump it into the lower chambers (ventricles).

ventricles the two lower chambers of the heart. They receive blood from the atria and pump it to the lungs (right ventricle) and to the body (left ventricle).

oxygenated oxygen-rich (blood)

deoxygenated oxygen-poor (carbon dioxide-rich) (blood)

4.2.3 Location of the heart

The heart's chambers fill effectively because of the assistance from gravity. The upper chambers (atria) are positioned superior to the lower chambers (ventricles), which use gravity to help blood get from the top to the bottom of the heart, efficiently pumping out the blood to the body.

FIGURE 4.5 The valves of the heart

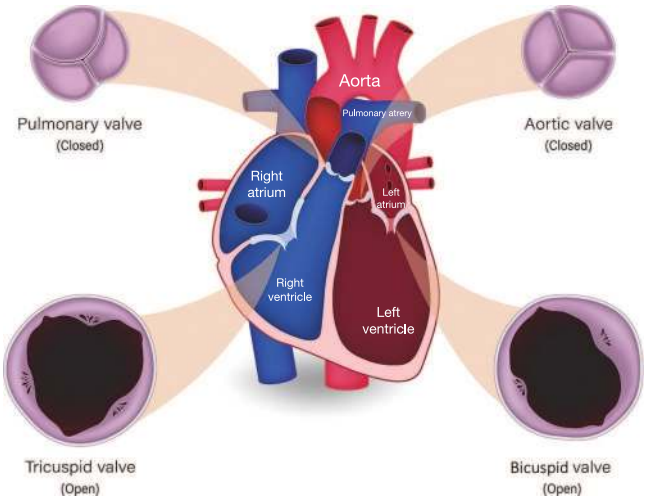
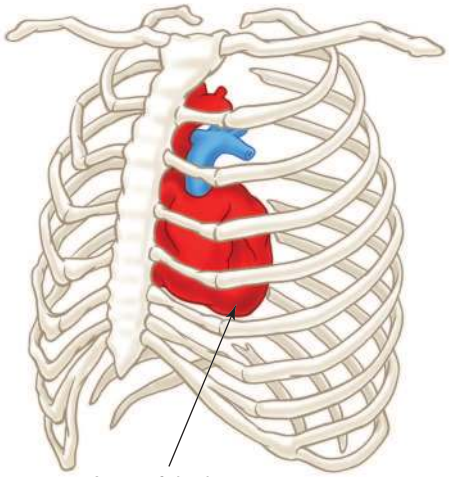


FIGURE 4.6 The heart is well protected by the rib cage.



The apex of the heart (left ventricle) is tilted slightly left, downwards and forwards, for optimal blood flow through the heart's chambers. It also makes it easier for the heart to expand and contract more effectively.

EXAM TIP

Exam questions often require you to show the difference between the functions of the left side of the heart and the right side.

For example, make sure you write 'left ventricle' to show that it is responsible for pumping blood into the aorta.

on Resources

Interactivity Structure of the heart (int-9314)

4.2.4 Functions of the heart

The heart is an involuntary muscle; that is, we do not have conscious control over its functioning. It works by the continual contraction and relaxation of the atria and ventricles. When the heart contracts, it forces blood out of the heart via the ventricles and into the arteries. This is called **systole**. When the heart relaxes, it fills with blood from the veins. This is called **diastole**. The **cardiac cycle** (see figure 4.7) is made up of the atria contracting (systole) while the ventricles relax (diastole), and the ventricles contracting (systole) while the atria relax (diastole).

This cyclic process allows us to complete our daily tasks. It means that we have a constant supply of oxygenated blood to our muscles, organs and other tissues, which

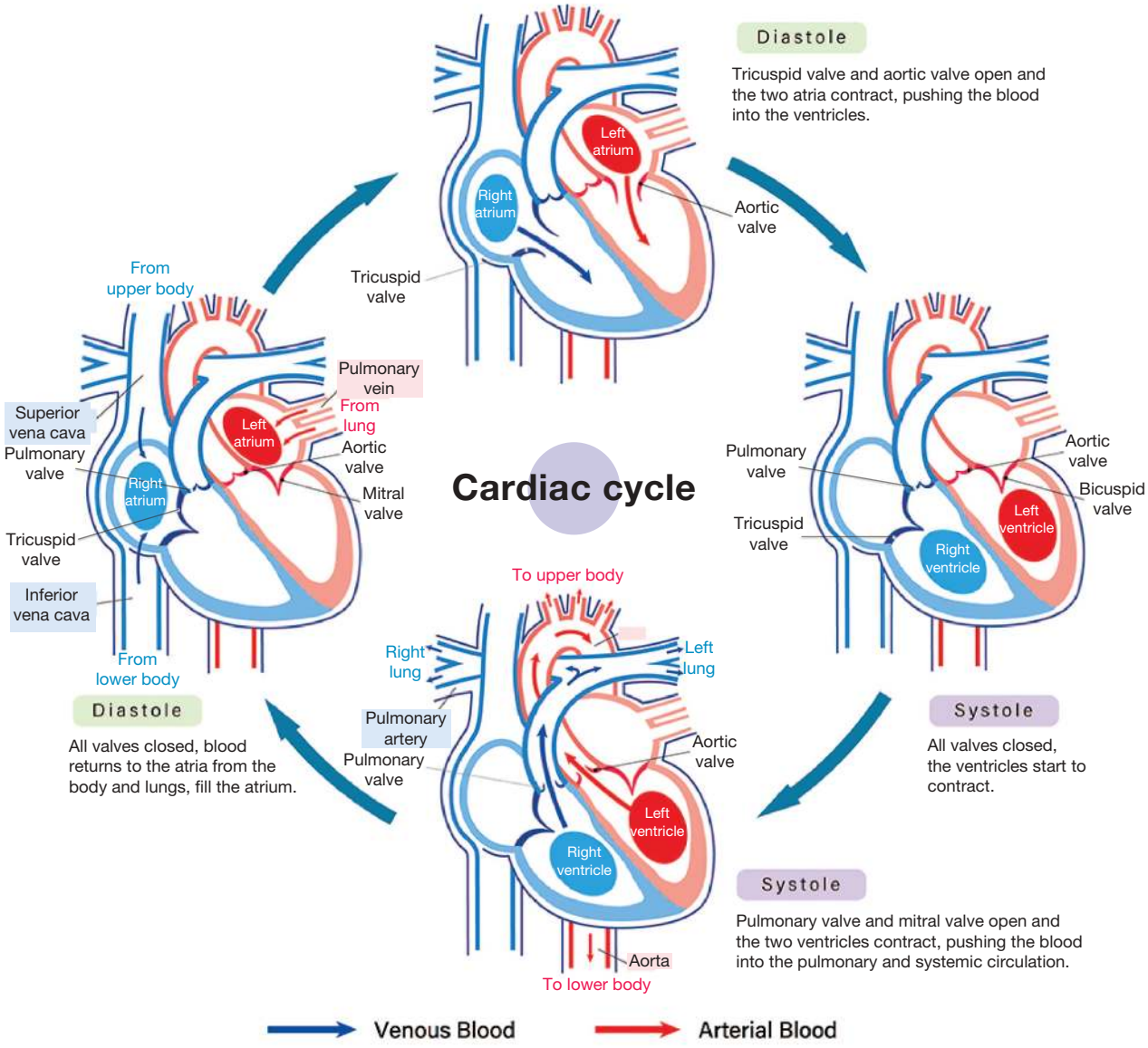
systole a contraction of the heart muscle, specifically the ventricles

diastole a relaxation of the heart muscle

cardiac cycle the movement of blood through the heart in one heartbeat. It consists of alternate systole and diastole of the atria and the ventricles.

enables them to function optimally. The heart also carries out other important functions, such as the transport of water and the removal of waste products, such as carbon dioxide. Later in this topic, we will discuss the heart's responses to physical activity, which include the heart beating faster to meet the heightened oxygen demands of the working muscles.

FIGURE 4.7 The cardiac cycle



Resources

Video eLesson How your heart works (eles-2581)

Interactivity The cardiac cycle (int-9315)

4.2.5 Blood

Blood is a vital part of the cardiovascular system and facilitates the execution of many of its essential functions. Blood is the only body tissue that is a liquid. Blood cells make up 45 per cent of the blood volume, while plasma makes up

blood the fluid circulated by the heart around the body. It consists of plasma, red and white blood cells, and platelets.

the other 55 per cent. Blood transports materials required for energy production, including oxygen and glucose, and by-products of energy production, such as carbon dioxide and lactate, around the body. Blood also plays an important role in the **thermoregulation** of the body. Each individual has approximately 4–5 litres of blood in their body, and it takes around one minute to circulate around the body at rest. Exercise improves the quality and quantity of the body's blood supply.

The three types of blood cell are summarised in figure 4.8 and table 4.1.

Plasma

Plasma is a clear yellowish fluid, of which over 90 per cent is water. It carries the blood cells, continually passing through the capillary walls and into the cells. Plasma provides the cells with proteins, salts, glucose, fats, antibodies and some oxygen. It also removes waste products. In emergencies, plasma is the first substance fed into the injured body to replace any lost fluids. Any blood transfusions are normally given later.

FIGURE 4.8 The components of blood

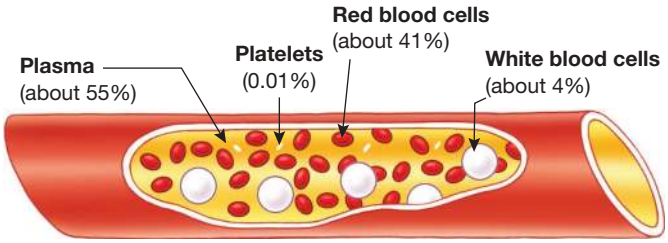


TABLE 4.1 Summary of the role and function of blood components

Blood component	Function
Red blood cell	Transports oxygen around the body
White blood cell	Protects against disease
Platelet	Causes blood to clot
Plasma	Carries blood cells around the body

4.2.6 Blood vessels

In addition to the heart, the cardiovascular system has three types of **blood vessels** that control the direction and volume of the blood flow around the body:

- arteries (see figure 4.9)
- veins (see figure 4.10)
- capillaries (see figure 4.11)

thermoregulation the maintenance of core body temperature within a narrow range

blood vessels a transport network of arteries, capillaries and veins that carries nutrients and waste around the body

FIGURE 4.9 An artery has a thick, elastic, muscular wall.

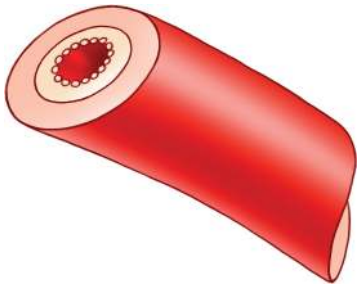


FIGURE 4.10 A vein has a thinner, less elastic wall than an artery wall.

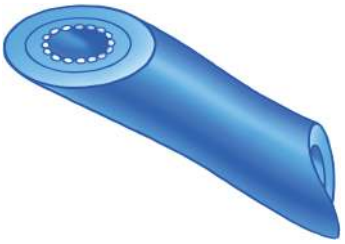


FIGURE 4.11 A capillary has a very thin wall that allows oxygen, carbon dioxide and nutrients to pass into the cells.

This network is also referred to as the vascular system. Table 4.2 summarises the structures and functions of the blood vessels.

TABLE 4.2 Summary of structures and functions of blood vessels

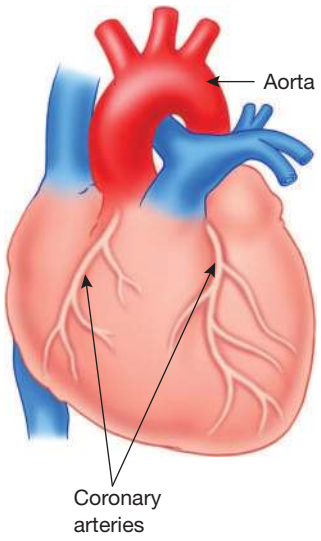
Blood vessel	Structure	Function
Artery	Large, thick, elastic wall	Carries blood away from the heart
Capillary	Small, thin wall Only one cell thick	Site of exchange for nutrients and wastes between cells and cardiovascular system
Vein	Thin, large diameter One-way valves	Carries blood back to heart

4.2.7 Blood circulation

Circulation of blood throughout the body is divided into two closed circuits as seen in figure 4.12:

- **systemic circulation**, when oxygenated (oxygen-rich) blood is transported from the heart via the left ventricle and aorta and circulated into the arteries around the body (except for the lungs), and deoxygenated (oxygen-poor) blood returns to the heart via the vena cava into the right atrium
- **pulmonary circulation**, when deoxygenated blood is transported away from the heart and circulated to the lungs via the right ventricle and pulmonary artery, and oxygenated blood returns to the heart via the pulmonary vein into the left atrium.

FIGURE 4.12 The two coronary arteries supply oxygen and nutrients to the cardiac muscle.



Resources

Video eLesson Circulation of blood throughout the body (eles-0452)

4.2.8 Arteries

Arteries always carry oxygen-rich blood from the heart to the body. The aorta is the largest artery in the body (see figures 4.4 and 4.12). The left ventricle pushes the blood into the aorta and on to the rest of the body. The volume of blood pumped into the arteries with each beat is quite large. The artery walls are elastic so they can expand with each heartbeat to accommodate this volume.

When you take your heart rate, you are recording the number of beats of the heart by feeling the pressure of the blood being pushed into the arterial system. The two most common points for recording a heart rate are the carotid (neck) and radial (wrist) pulse. You should always take your heart rate at only one point on the body, using a fingertip and not a thumb. A quick method of calculating your heart rate is to take it for 10 seconds, then multiply that number by six to find the beats per minute.

Figure 4.13 shows the location of two major pulse sites on the body. Checking and determining the strength of the pulse can help determine the next best steps for first aid treatment. A weak or absent pulse will often indicate a need for immediate medical attention. The pulse in the carotid artery and radial artery is often easy to feel because it is near the surface of the skin.

systemic circulation the arteries and veins that feed blood from the heart to the whole body and back to the heart again for reoxygenation

pulmonary circulation the arteries and veins that feed blood from the heart to and from the lungs where blood is oxygenated

arteries large, thick-walled blood vessels that carry blood away from the heart

FIGURE 4.13 Checking for a pulse provides vital information about the heart's functioning.

As the network of blood vessels extends deeper into the body, arteries progressively narrow and become **arterioles**.

Like other muscles, the heart needs a supply of oxygen and nutrients, which are delivered by the cardiovascular system. There are two **coronary arteries** (see figure 4.12), both of which branch from the aorta and spread across the heart muscle to feed all the chamber walls with nutrients. One of the most common causes of heart attack is the blockage of one or both of the coronary arteries with fatty deposits, which are often the result of an unhealthy lifestyle. This reduces the blood supply to the heart muscle, causing severe pain in the chest and possibly death of part of the heart muscle or the individual.

arterioles small blood vessels that branch off from arteries and extend to capillaries

coronary arteries the arteries that supply oxygen and nutrients to the cardiac muscle (heart)

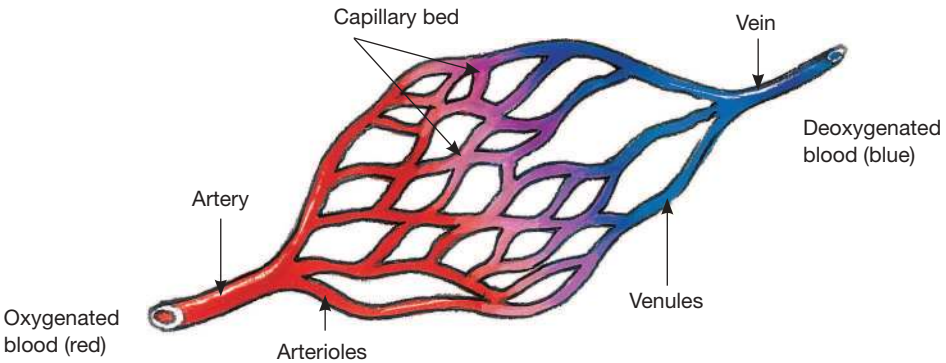
capillaries tiny blood vessels in the cardiovascular system between the ends of the arterioles and the venules. They are the site for the exchange of gases between the cells and the cardiovascular system.

precapillary sphincters one-way valves that control blood flow within capillaries

4.2.9 Capillaries

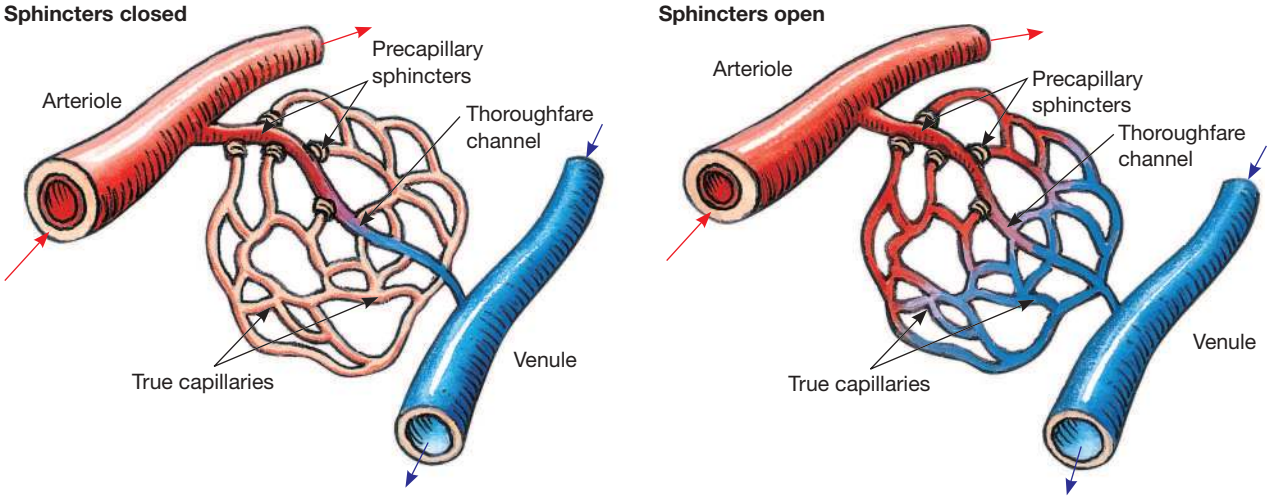
Capillaries are the smallest blood vessels, and they form the next stage of the blood vessel network after the arterioles (see figure 4.14). The exchange of nutrients and waste between the blood and the body cells occurs in the capillaries. Heat from the cells is also absorbed by the blood in the capillaries. This exchange of materials and heat is easy because the thin walls of the capillaries are only one cell thick.

FIGURE 4.14 The capillaries are the smallest division in the blood circulation network. Gases and nutrients are exchanged in the capillaries.



When you begin to exercise, the capillaries undergo vasodilation, widening in diameter to allow the blood flow required during exercise. Other capillaries feeding the working muscles also come into use by 'gateways' or **precapillary sphincters** opening up and allowing more blood to the muscles. The cardiovascular system uses these sphincters to channel blood to various body sites depending on prevailing conditions (see figure 4.15).

FIGURE 4.15 When whole body sections require increased blood flow (such as muscles during exercise), precapillary sphincters open to allow a greater volume of blood.



A long-term exercise program may increase the number of capillaries supplying blood to muscles (including the heart). This allows an increased supply of oxygen and other nutrients to the muscles, and a more rapid removal of wastes (e.g. carbon dioxide and lactate). The capillaries eventually carry these wastes to the venules, which then carry them into the veins.

veins blood vessels that carry deoxygenated blood and waste products from the body's cells back to the heart

venous pooling a collection of blood in the leg veins when high-intensity activity stops too suddenly

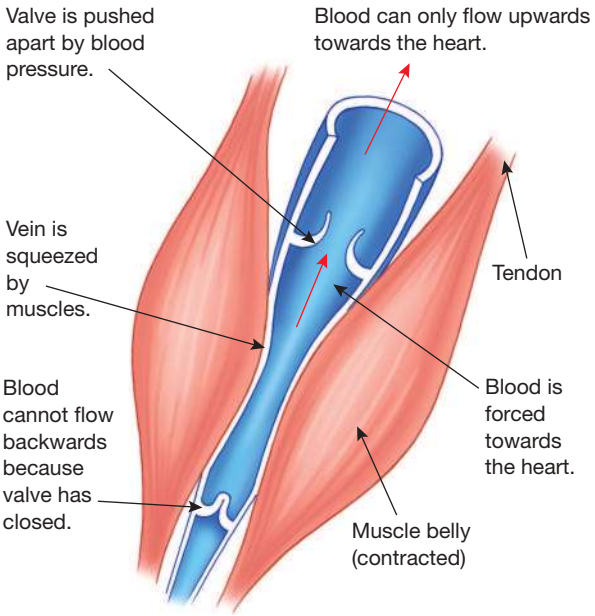
4.2.10 Veins

When blood reaches the veins, it is no longer surging or pulsing under the influence of the heartbeat. Instead, the flow is steady and consistent. The walls of the veins are quite thin and not as elastic as the walls of the arteries.

Veins carry blood with lower oxygen content and a high carbon dioxide content because the muscles and cells have extracted oxygen to produce energy. The return of blood to the heart in the veins depends on the contraction of skeletal muscles. Veins running alongside muscles are squashed or squeezed when the muscles contract. One-way valves force blood in the veins upwards towards the heart against the force of gravity (see figure 4.16).

Venous pooling after exercise is a problem if you do not gradually cool down. Given the increased blood flow during exercise (from around 5 litres per minute to possibly over 30 litres per minute), a gradual return to rest conditions is paramount. During a cool down, the muscle pump system continues to move the gradually diminishing excess blood flow around the body until it has reached resting level. Without this process, the combination of high blood flow and gravity creates an increase (or 'pooling') of blood in the legs.

FIGURE 4.16 The contracting muscles squeeze the vein, forcing the blood against gravity towards the heart.



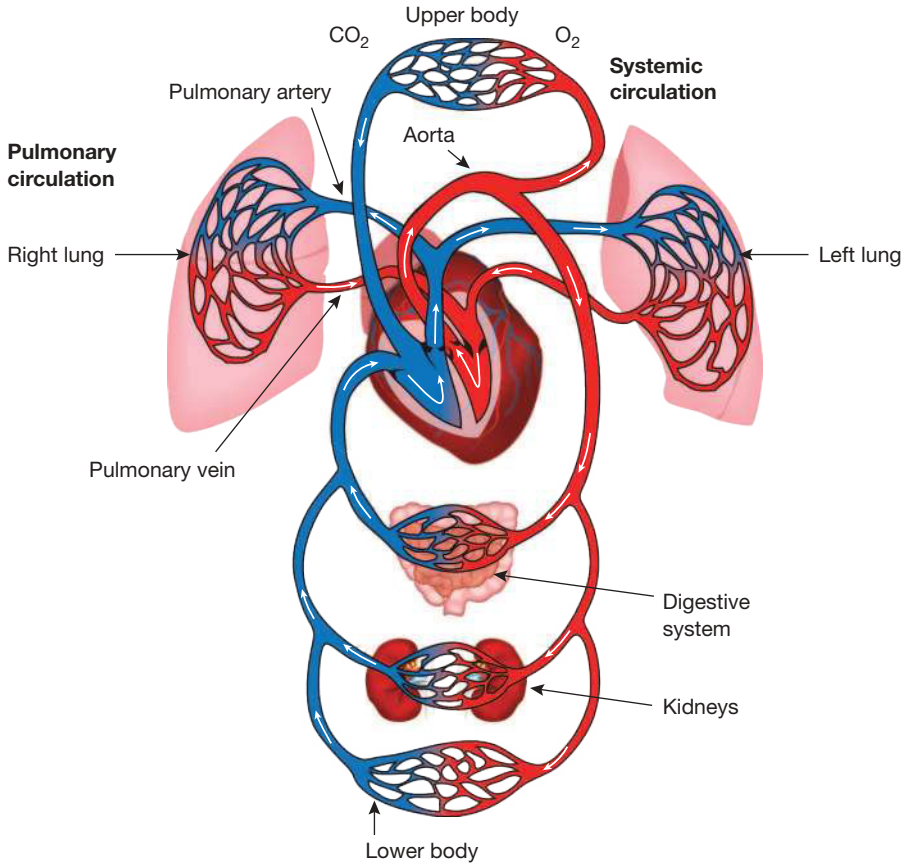
on Resources

Digital document Diagram of the heart (doc-1103)

Interactivities Blood vessel structure and functions (int-6641)
Blood flow in the heart (int-6640)

4.2.11 Putting it all together: how blood circulates throughout the body

FIGURE 4.17 The circulation of the blood: systemic and pulmonary



At the start of the topic, we emphasised that the structures of the heart allow it to perform its vital functions. We have discussed how blood flows through the heart and collects oxygen via the lungs. Transportation of blood, gases and nutrients occurs through the cardiovascular system's heart and network of blood vessels. Below is a 10-step sequence that shows how the cardiovascular system transports blood to our body's cells:

1. Blood undergoes *pulmonary circulation*, travelling from the heart to the lungs for oxygenation via the pulmonary artery and then returning as oxygen-rich blood through the pulmonary vein.
2. *Systemic circulation* is initiated when the contraction of the left ventricle pushes oxygenated blood into the aorta.
3. The *aorta* branches into smaller arteries and takes blood to different parts of the body.
4. These smaller *arteries* branch into even smaller arterioles that take oxygen-rich blood to the extremities.
5. *Arterioles* provide the gateway between larger arteries and capillaries.
6. *Precapillary sphincters* constrict and relax to allow blood flow to the capillaries.
7. *Capillaries* exchange oxygen, nutrients and other by-products with the body's cells.

8. *Venules* collect blood form the capillaries. Venules combine to make veins.
9. *Veins* collect oxygen-poor blood and oxygen-rich blood (depending on which capillaries they are from) from the body's tissues.
10. *Superior* and *inferior vena cava* (veins) bring oxygen-poor blood back to the right atrium of the heart to restart circulation.

4.2 Activity

4.2 Quick quiz on

4.2 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 3, 4, 5	6, 7, 8	9, 10

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Explain** what is meant by the cardiovascular system.
2. **List** the five functions of the cardiovascular system.
3. a. **Outline** the cardiac cycle.
   b. **Outline** the difference between systole and diastole.
4. **Compare** the differences between the three types of blood vessels — arteries, veins and capillaries.
5. **Define** the term *heart rate*.
6. **Discuss** the factors that can affect heart rate.

APPLY your understanding

7. **Explain** the importance of capillaries in physical activity.
8. **Explain** the importance of arteries during sports that have periods of high intensity.
9. **Explain** how the body addresses the issues caused by venous pooling.
10. Detail the path that blood flows through the heart, **outlining** all structures. Begin at the vena cava.

4.2 Exam questions

Question 1 (1 mark)
Which of the following is a chamber of the heart?

A. Left aorta
B. Right bicuspid
C. Left atrium
D. Right vena cava

Question 2 (2 marks)
Define the term *stroke volume* and identify its unit of measurement.

Question 3 (2 marks)
Outline the function of the valves within the heart.

More exam questions are available in your learnON title.

4.3 Role of the cardiovascular system in thermoregulation

Key knowledge	Key skill
• the role of the cardiovascular system in thermoregulation, including vasodilation and vasoconstriction of the blood vessels to regulate blood distribution at rest and during physical activity, sport and/or exercise	• examine the role and process of thermoregulation through participation in physical activity, sport and/or exercise

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

4.3.1 What is thermoregulation?

Thermoregulation relates to the maintenance of body temperature and the heat exchange that occurs between the body and the environment. Core temperature has a narrow range (36.5–37.5 °C) and any alterations can have an impact on the functioning of the individual.

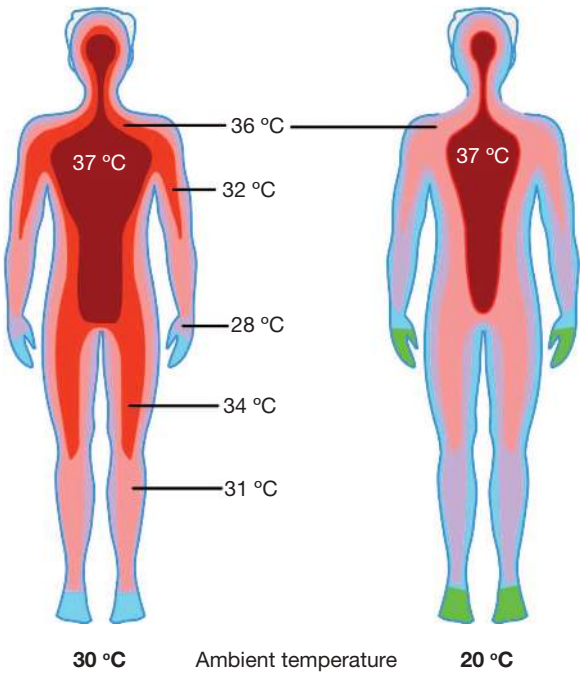
4.3.2 Role of thermoregulation through participation in physical activity, sport and/or exercise

When an individual is engaging in physical activity, sport and/or exercise, the role of the cardiovascular system is to maintain the body's core temperature within a narrow range. During exercise, the body will increase its core temperature (see figure 4.18).

Factors that influence the body's core temperature during exercise include:

- muscle use and energy production
- increased blood flow around the body
- changes in environmental conditions such as heat and humidity.

FIGURE 4.18 An increase in body temperature can be seen in these figures. Note the difference in the core and extremities.



4.3.3 Process of thermoregulation through participation in physical activity, sport and/or exercise

The body has a number of mechanisms to address changes in body temperature such as heat loss, heat gain or the need for heat balance. The cardiovascular system plays an important role in thermoregulation and maintaining **homeostasis** of the body; that is, maintaining a constant internal environment for the optimal functioning of the body and its systems.

Optimal functioning of the body occurs when body temperature is approximately 37 °C. Body temperature is monitored by the brain, specifically the hypothalamus, and the mechanisms to control it include:

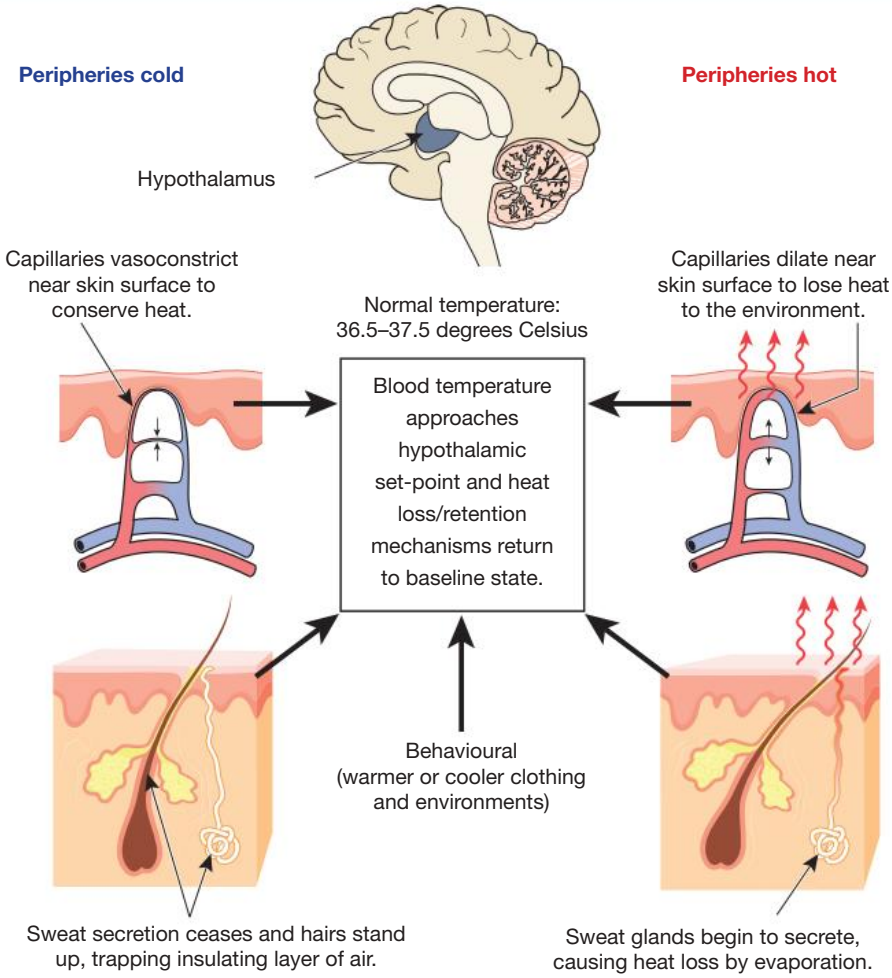
- sweating
- shivering
- controlling blood flow to the skin and around the body.

homeostasis a constant internal environment for optimal functioning of the body and its systems

FIGURE 4.19 Sweating and shivering are two distinct responses the body uses to control its temperature.

It is in this last mechanism that the cardiovascular system plays the greatest role (see figure 4.20).

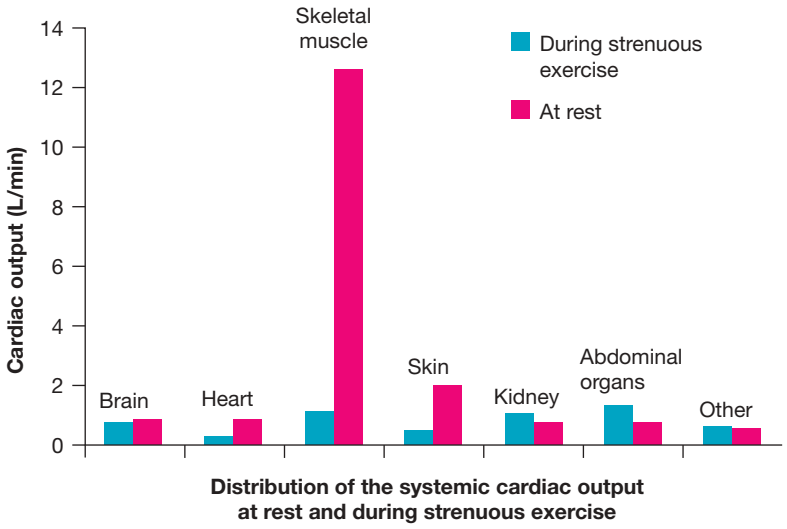
FIGURE 4.20 Thermoregulation mechanisms to control body temperature



When the body is too hot and it needs to lose heat, the cardiovascular system will automatically direct more blood flow through the vessels to the skin surface in an attempt to cool the body via increased sweating and heat loss to the external environment. The blood vessels expand or dilate to allow this increased blood flow, and this process is known as **vasodilation**.

vasodilation a process whereby blood vessels increase their diameter, causing an increase in blood flow

FIGURE 4.21 During strenuous exercise, blood flow is directed to the skin and working muscles.



When the body is too cold and it needs to retain heat, the cardiovascular system will restrict blood flow to the skin and redirect it to the internal organs, decreasing heat loss. The blood vessels reduce in size or contract, and this process is known as **vasoconstriction**.

vasoconstriction a process whereby blood vessels narrow or constrict, causing a decrease in blood flow

Thermoregulation is essential to maintain optimal body temperature.

During exercise, both vasodilation and vasoconstriction can reduce blood flow to working muscles, either through redirection of blood to the skin for heat loss or to the internal organs to maintain heat. This can ultimately affect the athlete's energy production. This often results in the athlete being unable to perform at their desired level, or at all, in order to maintain the homeostasis of the body.

FIGURE 4.22 The process of sweat production during exercise

The body generates heat during exercise, which can contribute to the body's core temperature becoming too high.

↓

The hypothalamus starts the cooling response by triggering mechanisms for heat removal from the body.

↓

The blood vessels leading to the skin (arteries and arterioles) undergo vasodilation.

↓

There is an increase in blood flow from the body's core to the surface of the skin.

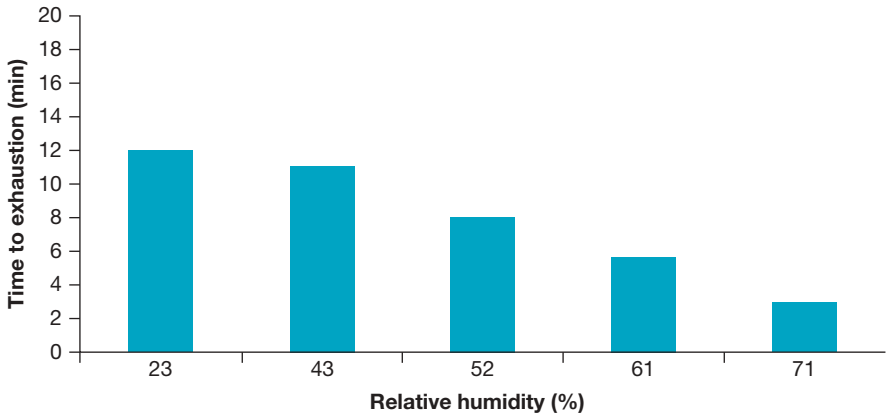
↓

The blood reaches the skin's surface, where it undergoes heat transfer to the environment.

↓

We sweat and continue to exercise.

FIGURE 4.23 Relative humidity increases thermoregulatory stress and decreases aerobic performance.



4.3.4 Hyperthermia and exercise in the heat

During exercise, energy expended during muscular contraction results in heat production, which in turn brings about an increase in both muscle and core body temperatures. Although an increased temperature of the skeletal muscles enhances the ability of the muscles to contract, performance becomes markedly impaired when the body's core temperature rises significantly. A rise in core temperature greater than 37.5–38.3 °C is referred to as **hyperthermia**.

When the body's core temperature begins to rise, the body's thermoregulation mechanisms, such as sweat production, operate to ensure that any increase remains within a safe range. This is essential since core temperature rises of more than about 3 °C can result in the impairment of bodily and mental functions, and the development of heat stroke, which can be fatal.

Exercising in the heat imposes additional stress on the body's thermoregulation mechanisms, and the cardiovascular system must work harder to maintain homeostasis to stop core temperature rising towards critical levels (figure 4.24).

FIGURE 4.24 Cooling the body while exercising in the heat is important to limit the effects of hyperthermia.

The cardiovascular system assists in the removal of body heat via redirection of blood flow and increased sweating rates. There is an increase in blood flow to the skin (vasodilation) in an attempt to increase the rate of the body cooling through the evaporation of sweat from the surface of the skin.

The redirection of blood flow and increased sweating can lead to impaired performance, as less blood flows to the working muscles than would normally in cooler conditions. Fluid loss through sweating causes a decrease in blood plasma volumes, so it is important that the athlete drinks plenty of water to help counteract this.

Thermoregulation during humid conditions

Humidity refers to the water concentration in the atmosphere. It is a measure of water vapour, which is water in gas form, in the air. Relative humidity is the maximum amount of water vapour that can exist in the air at its current temperature.

hyperthermia a rise in the body's core temperature above 37.5–38.3 °C

If the relative humidity is high, this means that the amount of water vapour in the air is higher than usual. In these conditions, the body cannot effectively evaporate sweat because the air surrounding the body cannot hold any more water. When you are exercising or playing sport in humid conditions (especially when it's hot), you may get a feeling of 'stickiness' on your skin, which is quite uncomfortable.

4.3.5 Hypothermia and exercise in the cold

Hypothermia is a thermal risk associated with exercising in cold environmental conditions. It occurs when the body's core temperature falls below 35 °C. The body will respond to heat loss via shivering and the redirection of blood flow in order to generate heat and maintain core temperature.

The cardiovascular system attempts to reduce this heat loss by redirecting blood flow away from the extremities and towards the major organs in order to sustain their function. The vasoconstriction of the blood vessels close to the skin assists in reducing the heat lost to the external environment.

Once again, performance in physical activity will be impaired as blood flow to working muscles will also be reduced in an attempt to maintain homeostasis (figure 4.25).

FIGURE 4.25 Hypothermia is a risk for all who venture into cold environments, and it can result in fatigue-like symptoms developing.

hypothermia a reduced core body temperature below 35 °C

EXAM TIP

When questions refer to 'physiological changes', ensure you are specific about the changes you are referring to in your answer.

For example, referring to the vasodilation of arteries is very different from referring to the widening of blood vessels, because blood vessels and arteries have different functions.

4.3 Activity

4.3 Quick quiz on | **4.3 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 3	2	4, 5, 6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Outline** what is meant by *thermoregulation*.
2. **Discuss** the role of vasodilation and vasoconstriction in thermoregulation.
3. **Outline** the differences between hyperthermia and hypothermia.

APPLY your understanding

4. Participating in physical activity on a hot day can stress the body. **Discuss** the role of the cardiovascular system in the removal of heat from the body.
5. **Discuss** how the cardiovascular system physiologically helps maintain core body temperature at healthy levels in cold environments.
6. **Explain** why aerobic performance may decrease during humid conditions.

4.3 Exam questions

Question 1 (3 marks)

Identify three mechanisms controlled by the brain to ensure optimal functioning and temperature.

Question 2 (1 mark)

Identify the term for the process by which blood vessels increase their diameter, causing an increase in blood flow.

Question 3 (3 marks)

When core temperature falls below 35 °C, the body will respond by reducing this heat loss through a number of mechanisms.

Identify the term associated with this and **outline** two ways the body tries to reduce the heat loss when this occurs.

More exam questions are available in your learnON title.

4.4 Responses of the cardiovascular system to physical activity

Key knowledge	Key skill
• the relationship between stroke volume, heart rate and cardiac output at rest, submaximal and maximal exercise intensities	• use primary data to measure and analyse the changes to the cardiovascular and respiratory systems at rest compared with various exercise intensities

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

4.4.1 The cardiovascular system and physical activity

When you begin to exercise, a number of changes occur within the cardiovascular system to meet the requirements of the body. These immediate, short-term responses are commonly called **acute responses** to exercise. They revolve around the greater demand for and more efficient delivery of oxygen and fuels to the working muscles to create energy and remove waste products.

Increased heart rate (HR)

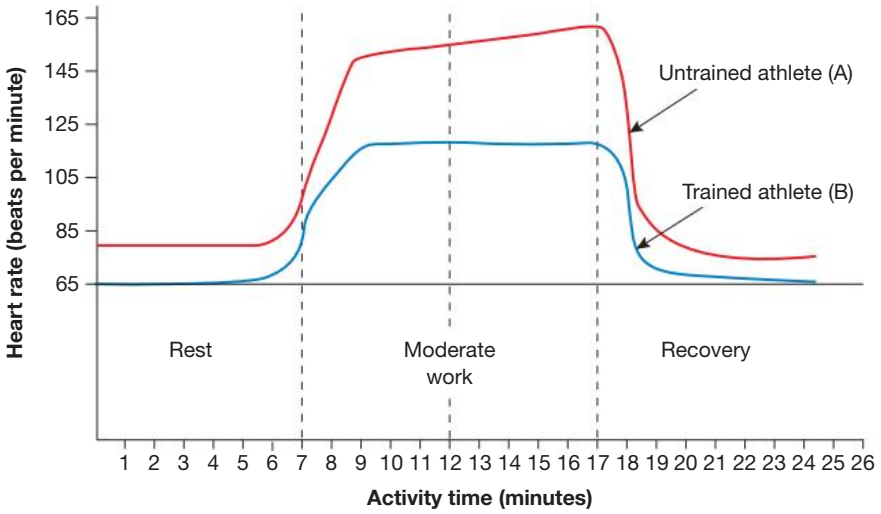
- Heart rate refers to the number of times your heart beats per minute.
- During exercise, HR quickly increases above resting levels to assist with the greater requirements of the muscles for oxygen to create energy and the associated removal of wastes.
- Generally, HR increases linearly with exercise intensity (see figure 4.26). That is, as exercise intensity increases, so too does HR.

acute responses the body's immediate, short-term responses that last only for the duration of the activity and for a short time afterwards (recovery)

- Average resting HR is approximately 72 bpm, reaching up to and beyond 200 bpm during maximal exercise.
- HR will return to resting levels once physical activity is ceased.
- An approximate calculation of your maximum HR is 220 minus your age. For example, maximum HR for an 18-year-old is:

$$220 - \text{age} = \text{maximum HR}$$
$$220 - 18 = 202 \text{ advisable maximum HR.}$$

FIGURE 4.26 Heart rate responses before, during and after exercise for a trained athlete and an untrained athlete



CONCEPT CONNECTOR

Fill up a small squeeze bottle and a larger squeeze bottle (e.g. two different sized tomato sauce bottles) with water as fast as possible.

Consider how the water filling the smaller container could represent how heart rate and stroke volume affect cardiac output.

Using this activity as an example, explain why stroke volume plateaus at a certain point.

Increased stroke volume (SV)

- **Stroke volume** refers to the amount of blood ejected from the left ventricle into the aorta with every heartbeat. During exercise, stroke volume increases to allow more oxygen to be delivered to the working muscles to create energy.
- As shown in figure 4.27, stroke volume = amount of blood in the left ventricle before contraction (end-diastolic volume) — the amount of blood in the left ventricle after contraction (end-systolic volume). The amount of blood in the left ventricle before contraction has an influence on the amount of blood ejected from the left ventricle (stroke volume).
- Like heart rate, stroke volume increases with exercise intensity, but only to a certain point. When the heart beats rapidly, there is a shorter filling time for the ventricles because it doesn't have enough time to fill up with blood during the diastole/relaxation phase before each beat. This means the stroke volume will plateau at approximately 40–60 per cent of an individual's maximal exercise capacity and remain unchanged until exhaustion (see figure 4.28).

stroke volume (SV) the amount of blood ejected from the left ventricle with each heartbeat (contraction) of the heart. It is measured in millilitres per beat (mL/beat).

FIGURE 4.27 (a) Stroke volume during rest, compared to **(b)** stroke volume during maximal exercise

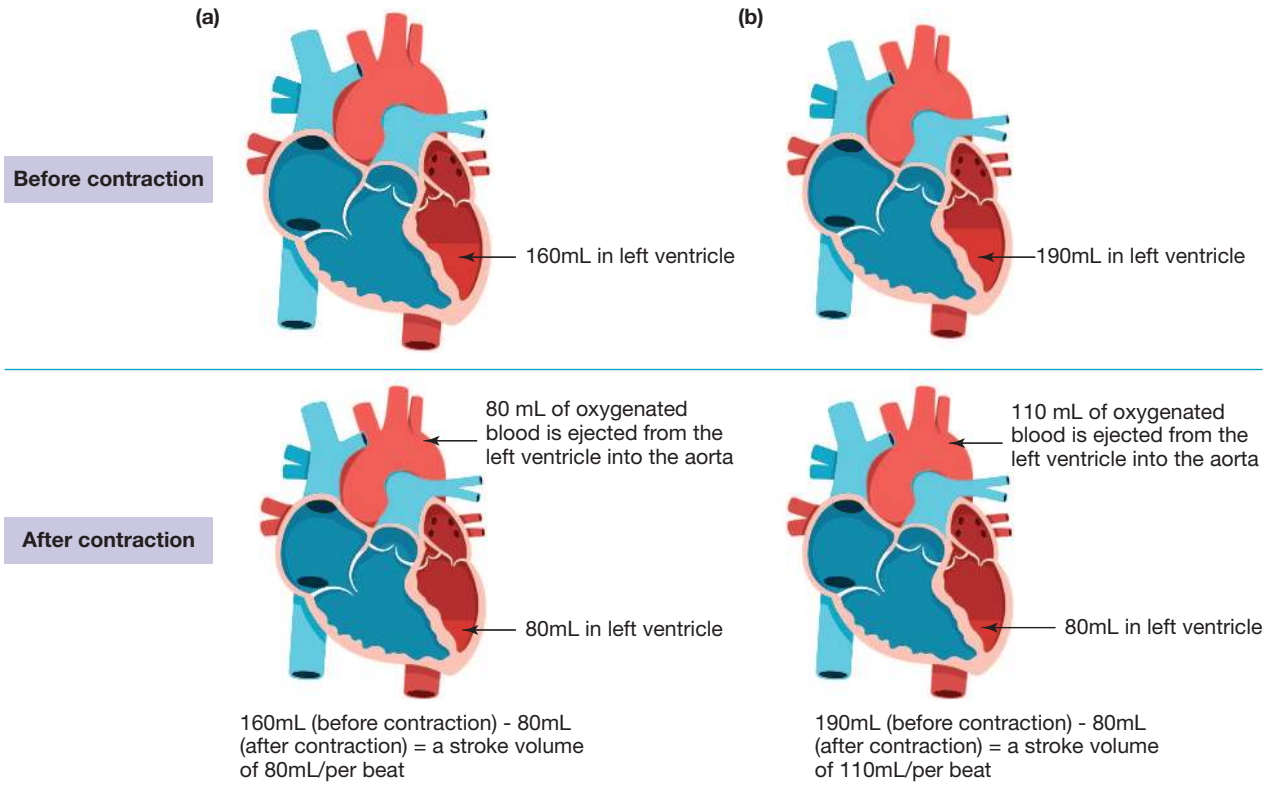
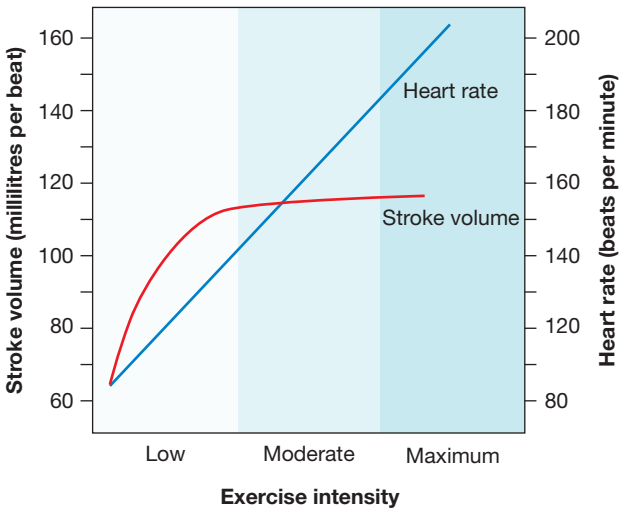


FIGURE 4.28 Heart rate and stroke volume responses to exercise

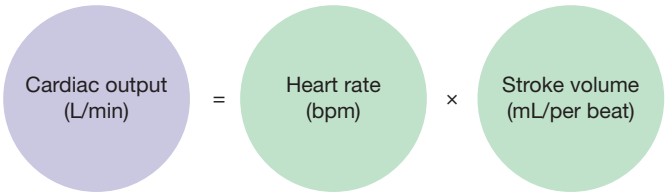


- The amount of blood in the left ventricle before contraction increases during maximal exercise due to the increase in oxygen-rich blood supplied by the pulmonary veins from the lungs. Venous return increases during maximal exercise as the demand for oxygen increases.
- Stroke volume for the average adult female and male at rest may be about 60 mL/beat and 80 mL/beat, respectively. These values can increase to 110–130 mL/beat during maximal exercise. For a trained athlete, these values will be higher.

Increased cardiac output (Q̇)

The amount of blood pumped from the heart into the arterial system over 1 minute (**cardiac output**, Q̇) increases due to the increase in both heart rate and stroke volume to deliver more blood and oxygen to the working muscles (Q̇ = HR X SV). This is shown in figure 4.29).

FIGURE 4.29 The cardiac output equation



Like heart rate and stroke volume, cardiac output increases proportionally with exercise intensity.

At rest, cardiac output for the average adult male is approximately 5–6 litres per minute (L/min) It may rise to about 20 L/min for an untrained male during maximal exercise. Figures for females are slightly lower for a number of physiological reasons, about 15 L/min for an untrained female during exercise.

Integrated cardiac response to exercise

As previously discussed, cardiac output is directly affected by the responses of heart rate and stroke volume to the increased demand for oxygen and fuel to working muscles for energy production.

$$\dot{Q} = HR \times SV$$

The contribution of all three varies as an individual transitions from rest to exercise of increasing intensities.

At rest, the average heart rate is 70 beats per minute and stroke volume is approximately 70 millilitres per beat. This gives a cardiac output ($\dot{Q} = HR \times SV$) of roughly 5 litres per minute.

$$70\,\text{bpm} \times 70\,\text{mL/beat} = 4.9\,\text{L/min}$$

As the individual transitions from rest to exercise, both heart rate and stroke volume will increase to increase the cardiac output of the heart and meet the new energy demands required by the body. Depending on the intensity required, the contributions will vary.

During submaximal exercise, such as moderate-paced jogging, heart rate will increase until it meets the demands of the body, plateauing when it reaches **steady state**. Steady state occurs during submaximal activity where the oxygen demands of the body are being met by the supply of the cardiorespiratory system. Heart rate may increase to approximately 140 bpm, with stroke volume peaking at about 120 mL/beat, giving a cardiac output of approximately 16–17 litres per minute.

$$140\,\text{bpm} \times 120\,\text{mL/beat} = 16.8\,\text{L/min}$$

As exercise intensity continues to increase beyond steady state, such as fast-paced running, heart rate will also increase linearly until it reaches maximum heart rate of values near 200 beats per minute. This in turn will increase the cardiac output of an individual.

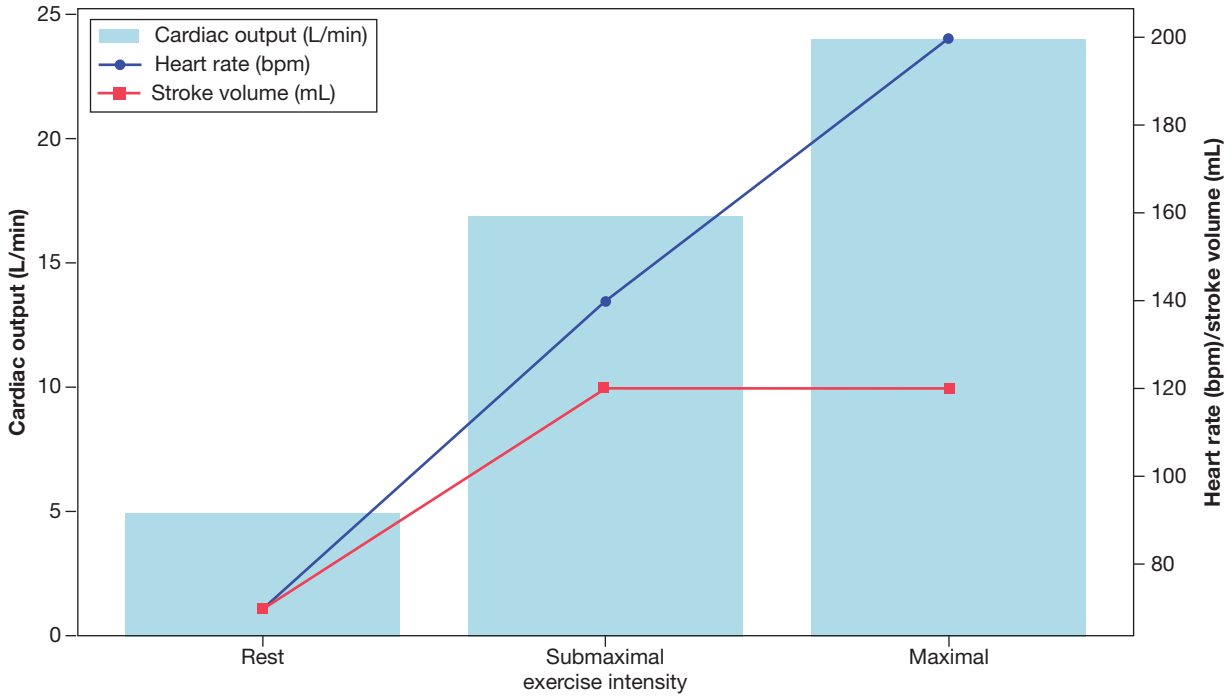
At high to maximal intensities, any increase in cardiac output is due to this increase in heart rate, not stroke volume. Stroke volume tends to plateau when exercise intensity reaches around 40–60 per cent of the individual's maximal exercise capacity.

$$200\,\text{bpm} \times 120\,\text{mL/beat} = 24\,\text{L/min}$$

cardiac output (Q̇) the amount of blood ejected from the left ventricle of the heart per minute. It is the product of stroke volume (SV) multiplied by heart rate (HR), so Q̇ = SV × HR, and is measured in litres per minute (L/min).

steady state the state in which oxygen supply equals oxygen demand and energy is being supplied aerobically

FIGURE 4.30 Understanding cardiac output



Increased systolic blood pressure (BP)

- Average BP at rest is $\frac{120}{80}$ mm Hg.
- During exercise, the systolic reading usually rises. This is due to increases in heart rate, stroke volume and cardiac output, and the fact that blood is being pumped more forcefully into the arteries.
- Under maximal intensity, systolic BP can reach around 200 mm Hg.
- The diastolic reading remains largely unchanged.

Increased blood flow and blood vessel diameter

- Speed of blood flow increases due to the increases in heart rate, stroke volume and cardiac output.
- Blood vessels will increase their diameter to accommodate the increase in blood flow (vasodilation). As depicted in figure 4.4, one-way valves in veins work to accommodate the increased blood flow's return to the heart.

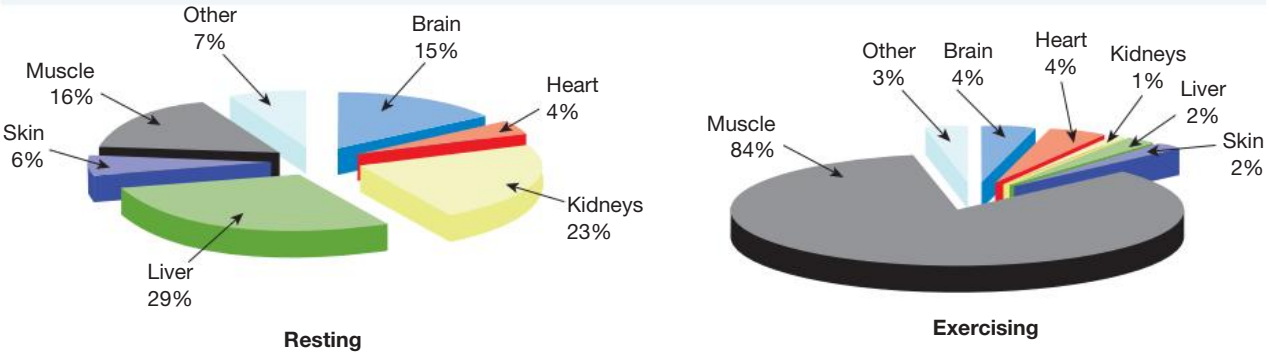
Blood flow redistribution

- During exercise, blood flow is redistributed to the working muscles and away from those areas of the body that are less needed for the activity, such as the gut and kidneys (see figure 4.31).
- At rest, blood flow to the muscles is approximately 12–15 per cent, or 1.5 L/min.
- As the intensity of physical activity and the demand for oxygen increase, blood flow to the muscles increases to 80–90 per cent, or about 10 L/min. This is achieved by the capillaries supplying the working muscles expanding in diameter (vasodilation) and blood flow to the organs is reduced by the narrowing (vasoconstriction) of the capillaries that supply them with blood.
- Removal of heat is also a reason for the redistribution of blood flow from the internal organs to the extremities (skin) shown in figure 4.31.

Decreased blood volume

During exercise, blood volumes decrease due to the decrease in blood plasma levels. This is caused by the loss of fluid through the thermoregulatory processes of sweat and evaporation, as well as the removal of metabolic by-products associated with energy production. The size of the decrease depends on the intensity and duration of the exercise, the hydration level of the individual and environment conditions, such as temperature and humidity.

FIGURE 4.31 Blood flow redistribution during exercise



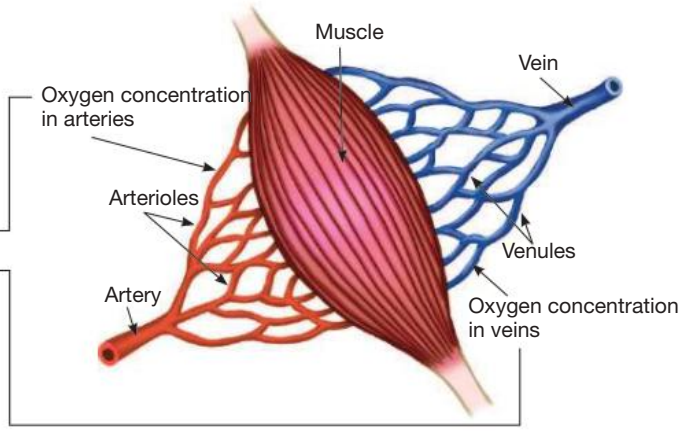
Increased arteriovenous oxygen difference (a-VO_2 diff.)

- The **arteriovenous oxygen difference (a-VO_2 diff.)** is a comparison of the amount of oxygen in the arteries with the amount of oxygen in the veins.
- It is measured in millilitres per 100 millilitres of blood.
- At rest, the arteries have an oxygen concentration of about 20 mL/100 mL of blood and veins about 13 mL/100 mL, a difference of 7 mL/100 mL.
- During exercise, the working muscles demand more oxygen for energy production, so the arterial blood will have more oxygen extracted by the working muscles than when they are at rest.
- The arterial blood entering the working muscle area during exercise will still have an oxygen concentration of 20 mL/100 mL, but the venous blood leaving the working muscles will have been drained of more oxygen and may have an oxygen concentration of about 5 mL/100 mL.
- Under exercise conditions, the a-VO_2 diff. could therefore be 15 mL/100 mL (see figure 4.32).

arteriovenous oxygen difference (a-VO_2 diff.) the difference between the concentration of oxygen in the arterial blood and the concentration of oxygen in the blood in the veins. This is measured in mL/100 mL of blood.

FIGURE 4.32 The arteriovenous oxygen difference during exercise

	Oxygen concentration in blood (mL/100 mL)	
	At rest	During exercise
In arteries	20	20
In veins	13	5
a-VO_2 diff.	7	15



EXAM TIP

Ensure that you state whether the acute response is increasing, decreasing, or plateauing during physical activity.

For example, blood volume decreases during physical activity.

doc-41919

PRACTICAL ACTIVITY Heart rate and exercise

Goal

To understand the relationship between heart rate and exercise intensity

Instructions

Before you begin the physical activities, sit down quietly and manually measure your resting heart rate (e.g. radial or carotid artery).

Perform each of the following activities, taking your pulse for 10 seconds immediately after you complete each activity. Rest until your heart rate has returned to its resting heart rate between each activity.

- Walking for 2 minutes
- Jogging for 2 minutes
- Sit-ups for 30 seconds
- Step-ups on a bench for 2 minutes
- Running for 3 minutes as fast as possible

Primary data/Reflection

Record and graph your results. Multiply by six to determine your heart rate.

Questions

1. Which activity resulted in the highest heart rate measured? Calculate this as a percentage of your maximum heart rate. Why did this activity result in the highest heart rate?
2. Discuss the relationship between your heart rate and the intensity of the activity. Provide examples.

on Resources

Digital document Physiological parameter (doc-18672)

4.4 Activity

4.4 Quick quiz on | **4.4 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 3	4	5, 6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Define** what is meant by an *acute response to exercise*.
2. Complete the table below by indicating whether the physiological parameter has increased, decreased or remained unchanged as a result of participating in exercise. Include the measurement values for rest and exercise.

Physiological parameter	Acute response	Measurement at rest	Measurement during submaximal exercise	Measurement during maximal exercise
Heart rate				
Stroke volume				
Cardiac output				
Blood pressure				
Blood flow and redistribution				
Body temperature				
Arteriovenous difference				

APPLY your understanding

3. **Describe** how stroke volume can be calculated.
4. **Describe** how heart rate affects stroke volume.
5. **Explain** why venous return would likely be higher during a 400-metre sprint than a 5-kilometre cross-country race.

4.4 Exam questions

Question 1 (1 mark)

At rest, an individual with a stroke volume of 60 mL and a heart rate of 70 bpm will have acardiac output of:

A. 70 + 60 = 130 L/min.
B. 70 – 60 = 10 L/min.
C. 70 × 60 = 4.2 L/min.
D. 70 × 60 = 4200 mm Hg.

Question 2 (2 marks)

Referring to heart rate, **explain** why an 80-year-old may find it more challenging to exercise at a high intensity than a 20-year-old.

Question 3 (1 mark)

Explain the term *acute responses* in relation to physical activity.

More exam questions are available in your learnON title.

4.5 Key skills

Key skills

- apply and use anatomical terminology to identify the structures and function of the cardiovascular and respiratory systems
- collect primary data to measure and analyse the changes to the cardiovascular and respiratory systems at rest compared with various exercise intensities
- examine the role and process of thermoregulation through participation in physical activity, sport and/or exercise

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

4.5.1 Tell me

To address these key skills, it is important to remember the following:

- know the correct anatomical names for the structures of the cardiorespiratory system
- understand the functions of all structures in the cardiovascular system including the heart, blood vessels and blood
- understand the importance of thermoregulation and the various mechanisms the cardiovascular system's structures use to maintain core temperature at healthy levels
- understand that heart rate, stroke volume and cardiac output are interrelated and their contribution to exercise is dependent on the intensity of exercise.

4.5.2 Show me

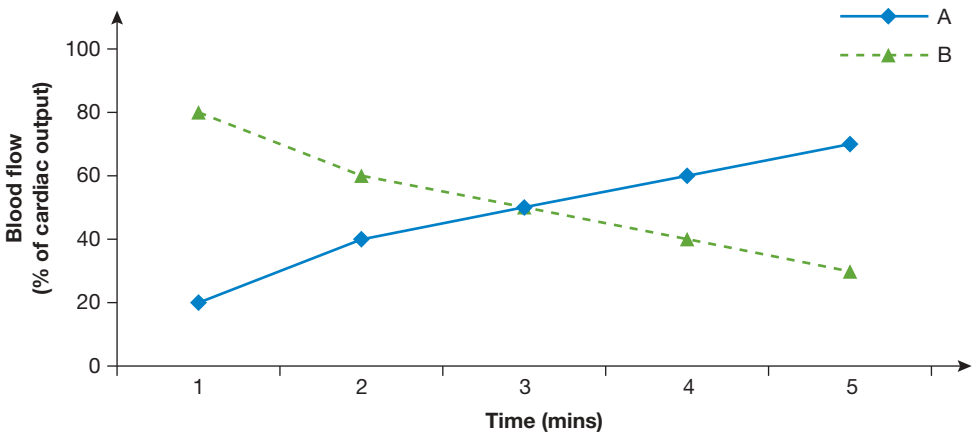
Practice question (7 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

Source: Adapted from *ACHPER 2011, Exam Unit 1, Section B, Q.2*; © ACHPER

The graph below shows the blood flow to the major organs and skeletal muscles during submaximal exercise.



a. **Outline** what is meant by cardiac output. (1 mark)

b. **Identify** the artery that receives oxygenated blood from the left ventricle and **explain** *how it contributes to* cardiac output. (2 marks)

c. **Identify** and **justify** which line, A or B, is most likely to represent blood flow to skeletal muscles. (2 marks)

d. **Outline** what *physiological changes* occur to allow the redistribution of blood flow during exercise. (2 marks)

Decode the question

Strategies to decode the question

- **Identify the action words:**
  Outline — general description but not in detail
  Identify — determine the key characteristics or features
  Justify — explain why the option you chose is the best option
- **Explain** — provide information to make the concept easy to understand
- **Key terminology** — *how it contributes, physiological changes*
- **Key concept/s** — cardiovascular system — cardiac output, blood flow to skeletal muscles, redistribution of blood flow
- **Marking scheme** — a. 1 mark, b. 2 marks, c. 2 marks — always check marking scheme for depth of response required, linking to key information highlighted in the question.

Sample response and marking scheme

a. Cardiac output is the amount of blood pumped around the body per minute (L/min).
Award 1 mark for a correct definition of cardiac output.

b. Aorta. The aorta distributes oxygenated blood from the left ventricle to start systemic circulation and *ensures that oxygen is delivered to the body tissues*.
Award 1 mark for identifying the aorta.
Award 1 mark for explaining how it contributes to cardiac output.

c. Line A. As exercise time increases, there is an *increased need* for blood carrying oxygen in the muscles.
Award 1 mark for identifying A as the line that represents blood flow to working muscles.
Award 1 mark for linking Line A to the information on the graph, *increase in time and increase in blood flow* required by muscles during exercise.

d. Vasoconstriction, decrease in blood vessel diameter, *therefore decreased blood flow* to the major organs; and vasodilation, increase in blood vessel diameter, *therefore increased blood flow* to the skeletal muscles.
Award 1 mark each for naming and describing the physiological adaptions of vasoconstriction and vasodilation and how they contribute to the redistribution of blood flow.

4.5.3 Let me do it

Question 1 (7 marks)

Source: Adapted from *ACHPER 2023, Trial Exam Unit 1, Section B, Q.6b*; © ACHPER

Tyler, an endurance athlete, is training for a half-marathon. At rest, his heart rate is at its lowest when there is a relatively low oxygen demand in his muscles. During training, his heart rate increases significantly, and his muscles require more oxygen to meet the elevated demand.

One of the functions of the cardiovascular system is to deliver oxygen to body tissues. During Tyler's training, his heart rate increases, speeding up this process.

a. **Identify** two other essential substances that Tyler's cardiovascular system transports to body tissues during his training. **(2 marks)**

b. **Explain** the difference between the blood flow to the muscles at rest and during exercise. **(2 marks)**

Source: Adapted from *ACHPER 2019, Trial Exam Unit 1, Section B, Q.1*; © ACHPER

Arteriovenous oxygen difference (A-VO_2 difference) increases with exercise.

c. **Explain** what arteriovenous oxygen difference is and outline why it would increase during Tyler's training. **(3 marks)**

4.6 Review

Hey students! Now that it's time to revise this topic, go online to:

Review your results

Watch teacher-led videos

Practise exam questions

Find all this and MORE in jacPLUS

4.6.1 Summary

Cardiovascular system structures

- The cardiovascular system has three main structures that help carry out its functions:
  - heart
  - blood vessels
  - blood.

Cardiovascular system functions

- The cardiovascular system has five main functions:
  - to circulate blood
  - to transport water, oxygen and nutrients
  - to transport wastes
  - to help maintain body temperature
  - to help fight disease.
- The heart is an involuntary muscle that pumps blood throughout the cardiovascular system. It has four chambers, two atria and two ventricles, a septum that divides the heart into two pumps and valves at the entrances of structures to allow only a one-way flow of blood.
- The heart works via contraction and relaxation of the atria and ventricles. This is known as the cardiac cycle.
- The three types of blood vessels are arteries, capillaries and veins.
  - Arteries carry blood away from the heart.
  - Capillaries are the site of exchange of gases between the cells and the cardiovascular system.
  - Veins return blood to the heart.
- Blood circulation occurs via two main circuits:
  - the systemic circuit (the body)
  - the pulmonary circuit (the lungs).

Role of the cardiovascular system in thermoregulation

- Thermoregulation is the maintenance of body temperature and heat exchange that occurs between the body and the environment.
- The cardiovascular system assists thermoregulation through the redirection of blood flow via the expanding of blood vessels (vasodilation) to increase heat loss or the reduction in size of blood vessels (vasoconstriction) to reduce heat loss.

Responses of the cardiovascular system

- There is a direct relationship between heart rate, stroke volume and cardiac output in response to increased demands to produce energy during exercise across a range of varying intensities.
- The cardiovascular system adapts to the onset of exercise via increases in heart rate, stroke volume, cardiac output, systolic blood pressure, arteriovenous difference (a-VO_2 diff.), blood flow and redistribution of blood flow.

Resources

Interactivity Structure and functions of the cardiovascular system quiz (int-6642)

4.6.2 Key terms

acute responses the body's immediate, short-term responses that last only for the duration of the activity and for a short time afterwards (recovery)
arteries large, thick-walled blood vessels that carry blood away from the heart
arterioles small blood vessels that branch off from arteries and extend to capillaries
arteriovenous oxygen difference (a-VO_2 diff.) the difference between the concentration of oxygen in the arterial blood and the concentration of oxygen in the blood in the veins. This is measured in mL/100 mL of blood.
atria the two upper chambers of the heart. They receive blood from the veins and pump it into the lower chambers (ventricles).
blood the fluid circulated by the heart around the body. It consists of plasma, red and white blood cells, and platelets.
blood vessels a transport network of arteries, capillaries and veins that carries nutrients and waste around the body
capillaries tiny blood vessels in the cardiovascular system between the ends of the arterioles and the venules. They are the site for the exchange of gases between the cells and the cardiovascular system.
cardiac cycle the movement of blood through the heart in one heartbeat. It consists of alternate systole and diastole of the atria and the ventricles.
cardiac output ($\dot{Q}$) the amount of blood ejected from the left ventricle of the heart per minute. It is the product of stroke volume (SV) multiplied by heart rate (HR), so $\dot{Q} = SV \times HR$, and is measured in litres per minute (L/min).
cardiovascular system the heart and blood vessels circulate blood throughout the body, delivering water, oxygen and nutrients to cells, and removing waste products such as carbon dioxide
coronary arteries the arteries that supply oxygen and nutrients to the cardiac muscle (heart)
deoxygenated oxygen-poor (carbon dioxide-rich) (blood)
diastole a relaxation of the heart muscle
heartbeat one contraction and relaxation of the heart muscle
homeostasis a constant internal environment for optimal functioning of the body and its systems
hyperthermia a rise in the body's core temperature above 37.5–38.3 °C
hypothermia a reduced core body temperature below 35 °C
oxygenated oxygen-rich (blood)
precapillary sphincters one-way valves that control blood flow within capillaries
pulmonary circulation the arteries and veins that feed blood from the heart to and from the lungs where blood is oxygenated
steady state the state in which oxygen supply equals oxygen demand and energy is being supplied aerobically
stroke volume (SV) the amount of blood ejected from the left ventricle with each heartbeat (contraction) of the heart. It is measured in millilitres per beat (mL/beat).
systemic circulation the arteries and veins that feed blood from the heart to the whole body and back to the heart again for reoxygenation
systole a contraction of the heart muscle, specifically the ventricles
systolic blood pressure the blood pressure recorded as blood is ejected during the contraction phase of the heart cycle. It is the higher of the two blood-pressure values.
thermoregulation the maintenance of core body temperature within a narrow range
vasoconstriction a process whereby blood vessels narrow or constrict, causing a decrease in blood flow
vasodilation a process whereby blood vessels increase their diameter, causing an increase in blood flow
veins blood vessels that carry deoxygenated blood and waste products from the body's cells back to the heart
venous pooling a collection of blood in the leg veins when high-intensity activity stops too suddenly
ventricles the two lower chambers of the heart. They receive blood from the atria and pump it to the lungs (right ventricle) and to the body (left ventricle).

4.6 Exam questions

4.6 Section A — Multiple choice questions

Question 1 (1 mark)

The heart is divided into four chambers called atria and ventricles. Atria are the:

A. upper chambers that eject the blood from the heart.
B. upper chambers that receive the blood into the heart.
C. lower chambers that eject the blood from the heart.
D. lower chambers that receive the blood into the heart.

Question 2 (1 mark)

One-way valves allow blood flow to travel from the:

A. aorta to the ventricles.
B. atria to the aorta.
C. atria to the ventricles.
D. aorta to the atria.

Question 3 (1 mark)

Arteries carry blood:

A. away from the heart.
B. to the heart.
C. away from the capillaries.
D. to the veins.

Question 4 (1 mark)

Deoxygenated blood travels via which structure of the heart to the lungs to be oxygenated?

A. Vena cava
B. Pulmonary vein
C. Aorta
D. Pulmonary artery

Question 5 (1 mark)

The function of the red blood cells is to:

A. fight infection.
B. clot the blood.
C. carry oxygen to the working muscles.
D. carry the blood cells around the body.

Question 6 (1 mark)

The main role of the cardiovascular system in thermoregulation is:

A. increasing the volume of blood.
B. warming the muscles.
C. reducing heart rate.
D. redirecting blood flow.

Question 7 (1 mark)

Which structure has a thin wall that allows oxygen and nutrients to pass into cells?

A. Aorta
B. Vein
C. Artery
D. Capillary

Question 8 (1 mark)

Blood vessels increase in diameter to accommodate increased blood flow during exercise. This is known as:

A. vasodilation.
B. vasoconstriction.
C. vasovagal.
D. valsalva.

Question 9 (1 mark)

To facilitate the removal of heat, the body redistributes blood flow:

A. from the heart to the lungs.
B. from the vital organs to the skin.
C. from the skin to the muscles.
D. from the vital organs to the head.

Question 10 (1 mark)

At high intensities, any increase in cardiac output is due to the linear increase in:

A. heart rate.
B. stroke volume.
C. heart rate and stroke volume.
D. blood pressure.

4.6 Section B — Short answer questions

Question 1 (3 marks)

Source: *ACHPER 2013, Trial Exam Unit 1, Section B, Q.4a*; © ACHPER

When comparing arteries to veins, the following differences can be observed. Use the table to fill in the relevant statements. The first one has been completed for you.

Arteries	Parameter	Veins
is oxygenated	Blood (is oxygenated/is deoxygenated)	is deoxygenated
	Transports blood (away from heart/towards the heart)	
	Valves (have them/don't have them)	
	Wall thickness (are thicker/are thinner)	

Question 2 (2 marks)

Source: *ACHPER 2013, Trial Exam Unit 1, Section B, Q.3*; © ACHPER

During an ironman event, an athlete's body temperature will increase significantly. **Explain** how the cardiovascular system assists in maintaining body temperature during exercise, such as an ironman competition.

Question 3 (2 marks)

Outline the relationship between heart rate, stroke volume and cardiac output, and **explain** how they respond to increases in exercise intensity from submaximal to maximal exercise.

Continue to build your exam skills

Access the Unit 1 Area of Study 2 Review at the end of Topic 6. This includes:
- Practice extended response
- Practice examination
- Practice school-assessed coursework.

5 Structure and functions of the respiratory system

5.1 Overview

Hey students! Bring these pages to life online

Watch videos

Engage with interactivities

Answer questions and check results

Find all this and MORE in jacPLUS

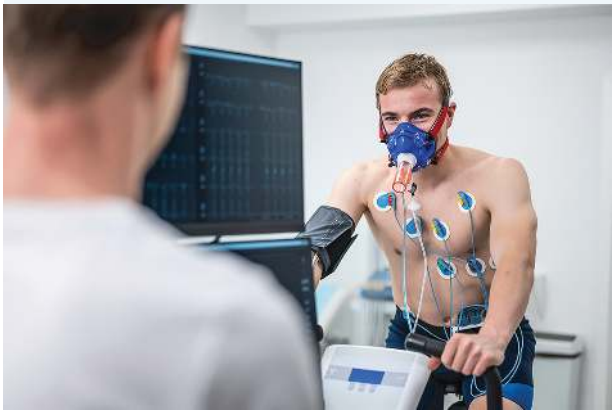
LEARNING SEQUENCE

5.1 Overview
5.2 The respiratory system — structure and functions
5.3 The respiratory system — mechanics of breathing and gaseous exchange
5.4 Responses of the respiratory system to physical activity
5.5 Summary of the interaction of the cardiovascular and respiratory systems during physical activity
5.6 Key skills
5.7 Review

5.1.1 Introduction

In this topic we dive into the relationship between exercise and the cardiorespiratory system. Aerobic-based activities, such as running or swimming, play a key role in improving your endurance and overall cardiorespiratory efficiency.

FIGURE 5.1 How does the respiratory system contribute to energy production for movement?



For peak physical performance to occur, our respiratory system must adapt quickly to the demands of physical exertion. The main function of the respiratory system is to bring in oxygen from the atmosphere and expel carbon dioxide.

We will study how the respiratory system works to meet the changes in the body's demand for oxygen with a focus on understanding the complex anatomical structures enabling air intake, the mechanics of breathing and gas exchange. We will also discuss how the cardiovascular system works in conjunction with this system to allow us to increase our oxygen uptake and remove carbon dioxide efficiently.

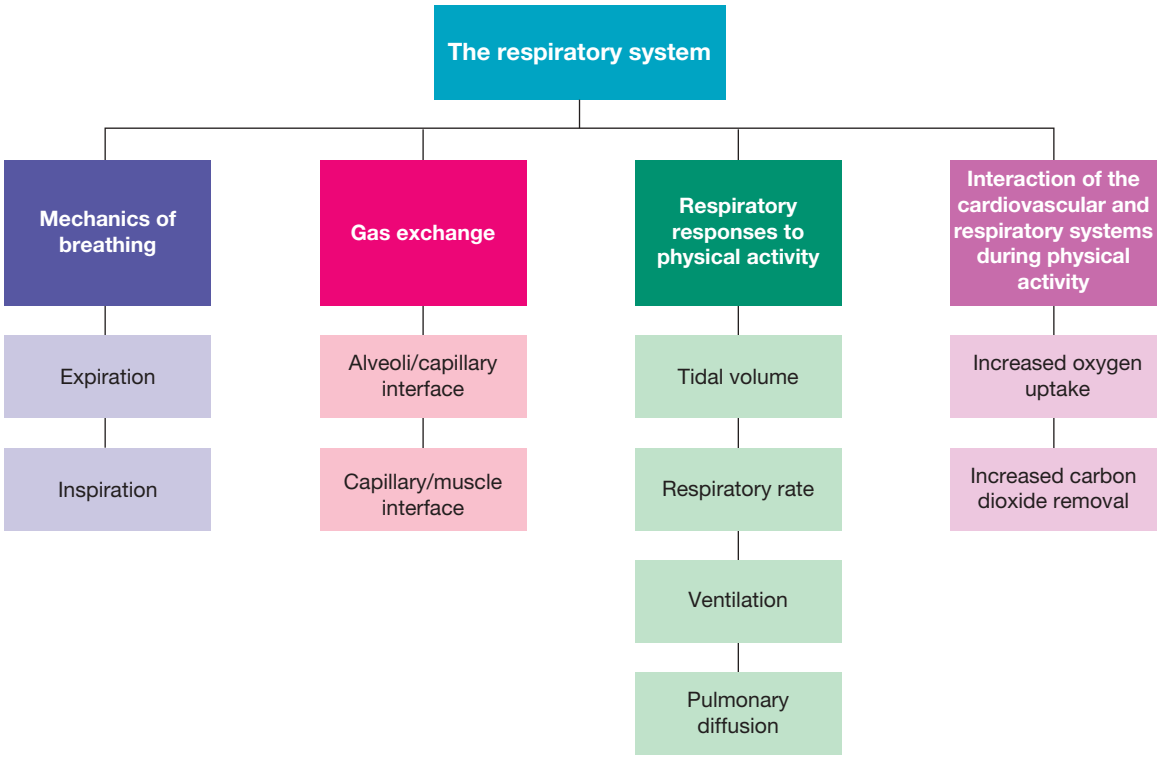
By the end of this topic you will be able make sense of the cardiovascular and respiratory adaptations that maximise performance (and which are studied later), and be able to explain why your own respiratory responses occur during different activities.

5.1.2 Key knowledge and Key skills

Key knowledge	Key skills	Subtopic
• the structure and function of the respiratory system, including the lungs, mechanics of breathing and gaseous exchange at the alveoli/capillary and the capillary/muscle interface	• apply and use anatomical terminology to identify the structures and function of the cardiovascular and respiratory systems	**5.2**
• the structure and function of the respiratory system, including the lungs, mechanics of breathing and gaseous exchange at the alveoli/capillary and the capillary/muscle interface	• investigate and describe the process of gaseous exchange	**5.3**
• the structure and function of the respiratory system, including the lungs, mechanics of breathing and gaseous exchange at the alveoli/capillary and the capillary/muscle interface	• use primary data to measure and analyse the changes to the cardiovascular and respiratory systems at rest compared with various exercise intensities	**5.4**
• the interaction of the cardiovascular and respiratory systems to transport oxygen around the body at rest and during physical activity, sport and/or exercise		**5.5**

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

5.1.3 Topic preview



5.2 The respiratory system — structure and functions

Key knowledge	Key skill
• the structure and function of the respiratory system, including the lungs, mechanics of breathing and gaseous exchange at the alveoli/capillary and the capillary/muscle interface	• apply and use anatomical terminology to identify the structures and function of the cardiovascular and respiratory systems

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

5.2.1 Functions of the respiratory system

The **respiratory system** has five important functions. It:

- brings air from the atmosphere into the lungs
- transfers oxygen into the blood
- removes carbon dioxide from the blood
- expels heat and water vapour in the air breathed out
- allows the vocal cords to create speech as air is breathed out.

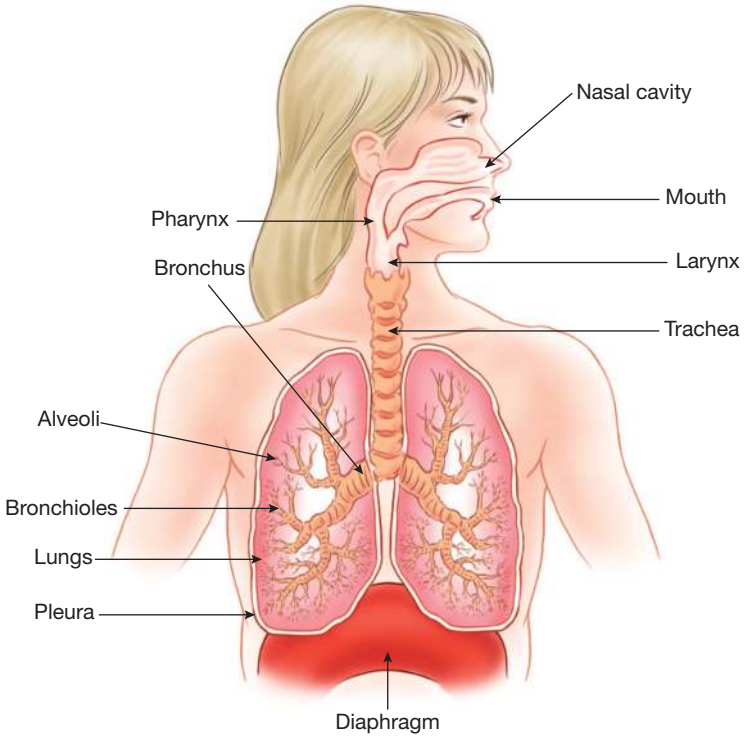
respiratory system the lungs and associated structures responsible for gas exchange in the body, bringing air into the body and removing waste products

5.2.2 Structure of the respiratory system

Figure 5.2 shows the basic structure of the respiratory system. The lungs are the major organs of the respiratory system. Located in the chest cavity behind the ribs, they consist of three main parts:

- the conducting system
- the pleura
- the diaphragm.

FIGURE 5.2 The respiratory system. Approximately 20 per cent of the air we breathe contains oxygen. Our nose and mouth serve as entry points for this life-sustaining element.



on Resources

Interactivity Respiratory system (int-6644)

5.2.3 The conducting system

The conducting system involves more than just the lungs. These elements can be seen in table 5.1 and figure 5.3.

TABLE 5.1 The structure and function of the different elements of the conducting system

Element	Structure	Function
Nasal cavity	The nose has layers of tissue called septa that are covered with cilia.	The nose is the initial pathway for air. Here, air is warmed and moistened. Cilia filter foreign particles from the air as it enters the respiratory tracts. Smoking destroys cilia, and their absence is the beginning of serious problems for the lungs of smokers.
Pharynx	This section of the throat is where the backs of the mouth and the nose combine.	The pharynx connects the back of the mouth and nose. It branches off so that food is channelled to the stomach, while the air moves into the larynx.
Larynx	The larynx contains the vocal cords. This structure is more evident in males with their 'Adam's apple'.	The larynx houses vocal cords that create the voice as air passes through them.
Trachea	The trachea consists of rings of hyaline cartilage enclosed by other cartilage and tissue. It sits mostly behind the sternum.	Often referred to as the windpipe, the trachea provides a well-protected medium for the passage of air into the lungs.
Bronchi	The trachea divides into two bronchi. Each bronchus feeds one of the lungs.	The bronchi maintain the air passage to the lungs.
Bronchioles	Each bronchus subdivides into a series of further subdividing bronchioles, similar to the branches of a tree.	The bronchioles deliver air to be diffused by the alveoli
Alveoli	These 'leaves' of the lungs are microscopic, cup-shaped sacs at the ends of the smallest bronchiole. Each alveolus is only one cell thick and surrounded by a rich network of capillaries that continually exchanges oxygen for carbon dioxide and water.	The alveoli are the site where the gas exchange of oxygen and carbon dioxide takes place.

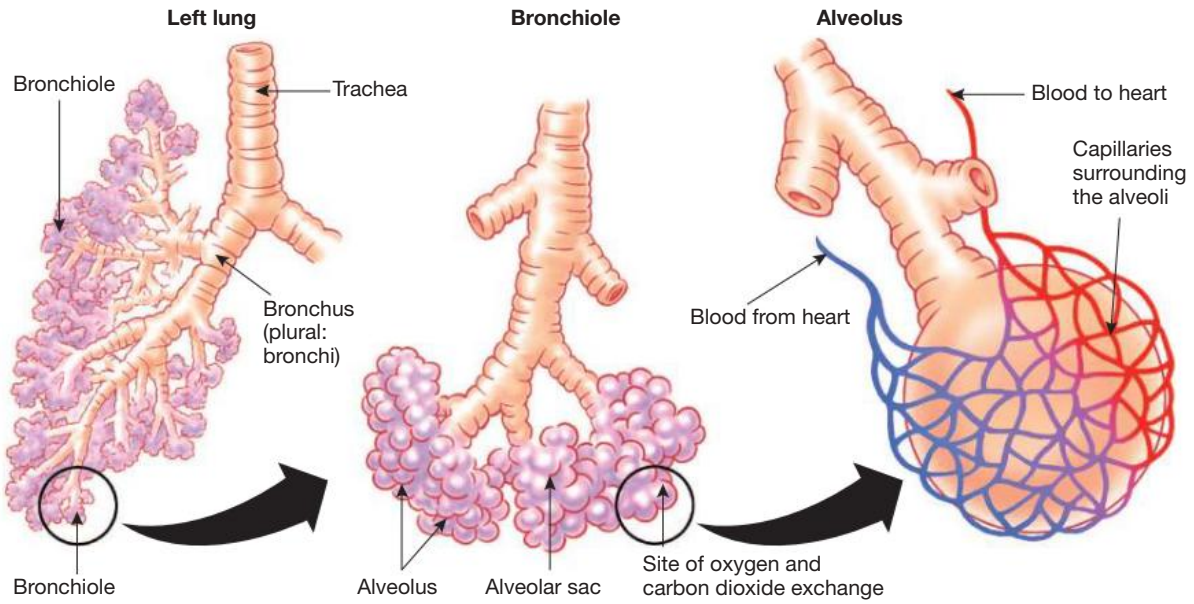
5.2.4 The pleura

The pleura covers each lung. The gap between the membrane and each lung is filled with a fluid that allows the lung to expand and contract with each breath, with minimal friction between the lung and its surrounding body tissue. The pleura is attached to the inside of the chest cavity and to the top of the diaphragm.

5.2.5 The diaphragm

This involuntary or smooth muscle contracts and relaxes to aid breathing, whether during sleep or consciousness. As the diaphragm moves up and down, the chest cavity decreases and increases in size, causing breathing (inspiration and expiration; see figure 5.4). A blow to the midriff during sport may hit the diaphragm, causing it to spasm. The individual in this case is 'winded' and may have difficulty breathing. The individual has to be encouraged to relax and wait for the muscle spasm to subside, which will happen in a short time and normal breathing will then return.

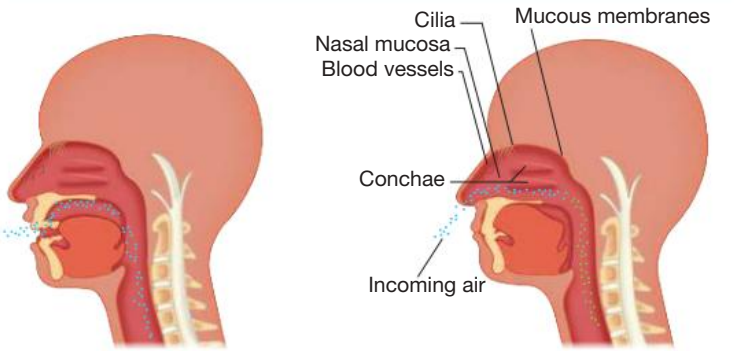
FIGURE 5.3 The structure of the lung



5.2.6 Maximising oxygen uptake: nasal breathing and mouth breathing

Have you ever wondered whether it is better to breathe through your nose or mouth? The structures within the nose (see figure 5.4), filter and humidify inhaled air (making it cleaner) while also contributing to the widening of the airways, which ultimately enhances oxygen uptake. With each breath, we take in more oxygen. Mouth and nose breathing may be appropriate when you are doing intense physical activity (e.g. 400-metre sprint), so you can get a higher volume of air in a shorter period of time. You may also find yourself breathing through the mouth more when you are sick and have to resort to mouth breathing because of nasal congestion (e.g. stuffy nose).

FIGURE 5.4 Mouth breathing versus nose breathing



CONCEPT CONNECTOR

Stretch out two balloons of the same shape and size and weigh each one. Keeping your mouth closed, breathe in through your nose, filling your lungs with as much air as possible. Then inflate the balloon until there is no air left in your lungs. Tie it up and re-weigh the balloon.

Taking the second balloon, breathe in through your mouth only, then inflate the balloon until there is no air left in your lungs. Tie it up and re-weigh the balloon.

To compare the mass of expelled air in the balloons, subtract the initial mass of the balloon. Was there any difference in the amount of air expelled when you breathed through your nose versus through your mouth?

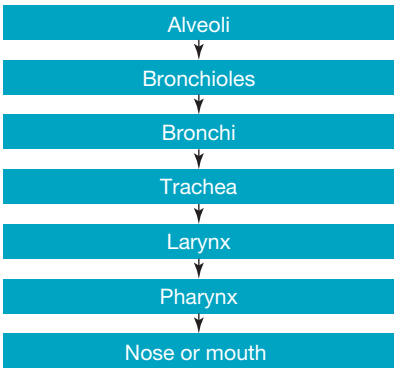
5.2.7 Removing carbon dioxide from the blood

The respiratory system functions to remove carbon dioxide from the blood. This helps the body maintain homeostasis. This is how it happens:

- *CO_2 production*: when your body turns glucose into energy (adenosine triphosphate), it produces CO_2. The mitochondria, found within the cells, are the main sites where these reactions take place.
- *CO_2 diffuses into the blood stream*: the CO_2 produced in the cells moves out of the cells and into the bloodstream.
- *CO_2 enters the lungs*: CO_2 is then transported from the blood to the alveoli.

As you breathe out, CO_2 travels up the respiratory system, and is expelled from the body as you exhale, as seen in figure 5.5.

FIGURE 5.5 The pathway of CO_2 through the respiratory system



on Resources

Digital document	Anatomy of the respiratory system (doc-1104)
Interactivity	The structure of the lung (int-9316)
Weblink	Basics of ventilation — Deadspace in breathing

5.2 Activity

5.2 Quick quiz on | **5.2 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 4	3, 7	5, 6

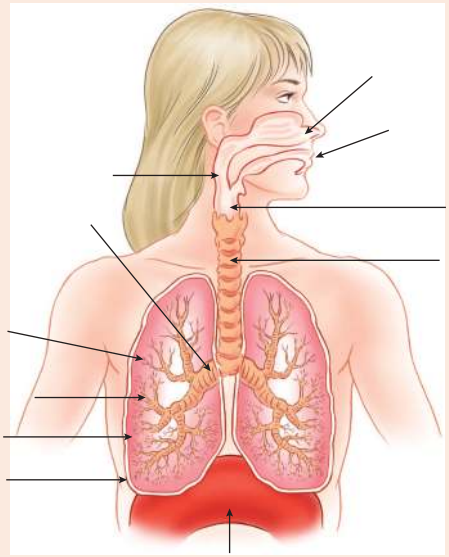
These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Label** the parts of the respiratory system.



2. **List** the five functions of the respiratory system.
3. **Discuss** how the diaphragm assists with breathing.
4. **Outline** the function of alveoli and where they can be found.
5. **Identify** the primary structure through which the respiratory system prefers to inhale air and **explain** why this is the preference.

APPLY your understanding

6. **Explain** why humans exhale a higher concentration of carbon dioxide than they inhale.
7. **Discuss** the potential impact of nasal congestion on physical activity.

5.2 Exam questions

Question 1 (1 mark)
What are the small hair-like structures found within the nasal cavity called?
A. Filia
B. Cilia
C. Micro-hairs
D. Formica

Question 2 (3 marks)
Identify a smooth muscle structure in the respiratory system and outline its function.

Question 3 (3 marks)
Explain why the alveoli's structure is capable of receiving large amounts of oxygen in a short period of time.

More exam questions are available in your learnON title.

5.3 The respiratory system — mechanics of breathing and gaseous exchange

Key knowledge	Key skill
• the structure and function of the respiratory system, including the lungs, mechanics of breathing and gaseous exchange at the alveoli/capillary and the capillary/muscle interface	• investigate and describe the process of gaseous exchange

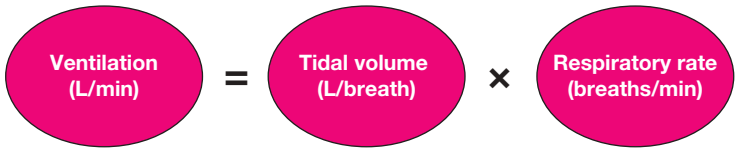
Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

5.3.1 Ventilation

Ventilation (V) is the amount of air breathed in (inspiration) and out (expiration) during a period of 1 minute. It is calculated by multiplying **tidal volume (TV)** and **respiratory rate (RR)**. That is, the amount of air per breath multiplied by the amount of breaths per minute as seen in figure 5.6.

ventilation (V) the amount of air that is inspired and expired during 1 minute
tidal volume (TV) the amount of air breathed in and out in one breath
respiratory rate (RR) the amount of breaths per minute

FIGURE 5.6 The ventilation equation



$$V = TV \times RR$$

For example, at rest ventilation could be:

$$V = TV \times RR$$
$$V = 0.5 \times 12$$
$$V = 6\,L/min$$

Ventilation will differ depending on whether the individual is at rest or is exercising and will be explored further in subtopic 5.4.

It can also be affected by environmental conditions, such as altitude, as it responds to varying levels of oxygen availability and air pressure (e.g. increased respiratory rate, compensating for tidal volume, which may sometimes result in hyperventilation). The impact altitude has on physical activity will be further explored in topic 6.

5.3.2 Inspiration

The diaphragm initiates **inspiration**. When the diaphragm contracts, it pulls downwards on the ribcage, thereby expanding the volume of the chest cavity. The intercostal muscles between each pair of ribs contract to help pull the ribcage outwards, also increasing the size of the chest cavity. The widening chest cavity decreases the air pressure inside the lungs, causing air from outside the body to be sucked into the chest cavity (see figure 5.7). This occurs because air, like any gas, always travels from high pressure gradients towards low pressure gradients.

A normal intake of a breath for an adult is about 500 millilitres; this is called the tidal volume. During heavy exercise, inspiration may increase about eight times to around 4 litres for each breath. Also, during exercise, extra muscles will work to help increase the size of the chest cavity even more to accommodate the need for a more forceful exchange of a greater volume of air. These muscles include those of the neck and upper chest area.

on Resources

Video eLesson Inspiration and expiration (eles-2573)

5.3.3 Expiration

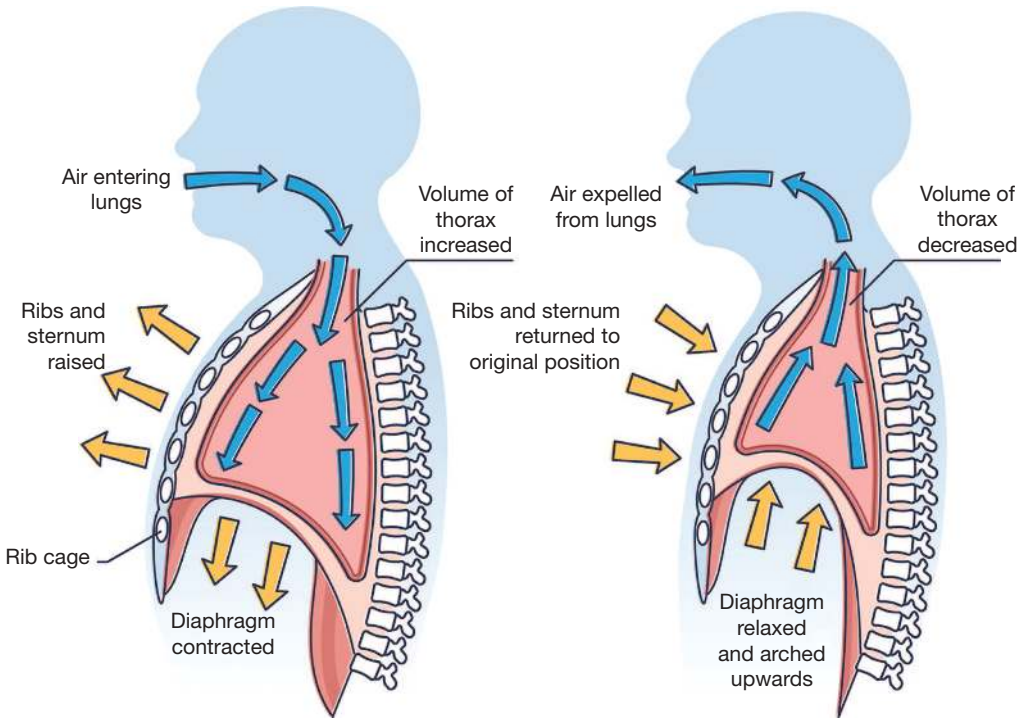
Expiration occurs when the diaphragm and intercostal muscles relax; that is, the diaphragm pushes up and creates a dome shape. This relaxation, along with the natural elasticity of the thorax (or chest area) is enough to squeeze the air within the chest cavity, create a higher pressure inside than out and force the air to leave the lungs (see figure 5.7).

Again, during exercise, more muscles will work to help magnify the change in chest cavity volume to promote higher rates and levels of air exchange. Thus, the abdominal muscles will contract to aid the speed and force of the chest restriction.

inspiration the movement of air from the external environment into the lungs (breathing in)

expiration the movement of air out of the lungs to the external environment (breathing out)

FIGURE 5.7 Inspiration and expiration of the lungs



on Resources

Interactivity Inspiration and expiration: structure and function (int-6645)

TABLE 5.2 Comparison of inspiration and expiration

Structure and/or function	Inspiration	Expiration
Air	Drawn into lungs	Forced out of lungs
Pressure inside lungs	Low	High
Ribcage	Expands up and out	Moves down and in
Intercostal muscles	Contract	Relax
Chest cavity and lungs	Expand	Relax
Diaphragm	Contracts, moves downwards	Relaxes, moves upwards

5.3.4 Lung volumes

The lungs have different levels of capacity (or lung volumes) for holding air from inspiration and for expelling air by expiration. Capacity varies according to the state of health, fitness and activity level of an individual.

- Total lung capacity is the volume of air that can be held in the lungs after maximum inspiration. It is approximately 6 litres for males and 4.2 litres for females.
- **Vital capacity** is the maximum amount of air that can be expired (breathed out) after a maximum inspiration. It consists of the inspiratory reserve capacity, the tidal volume and the expiratory reserve capacity. Table 5.3 shows the vital capacity for students in Australian schools. Generally, the larger the person, the higher their vital capacity, and large ribcages and chest cavities lead to larger lungs. Males generally have higher vital capacity readings than females because males usually have larger frames.

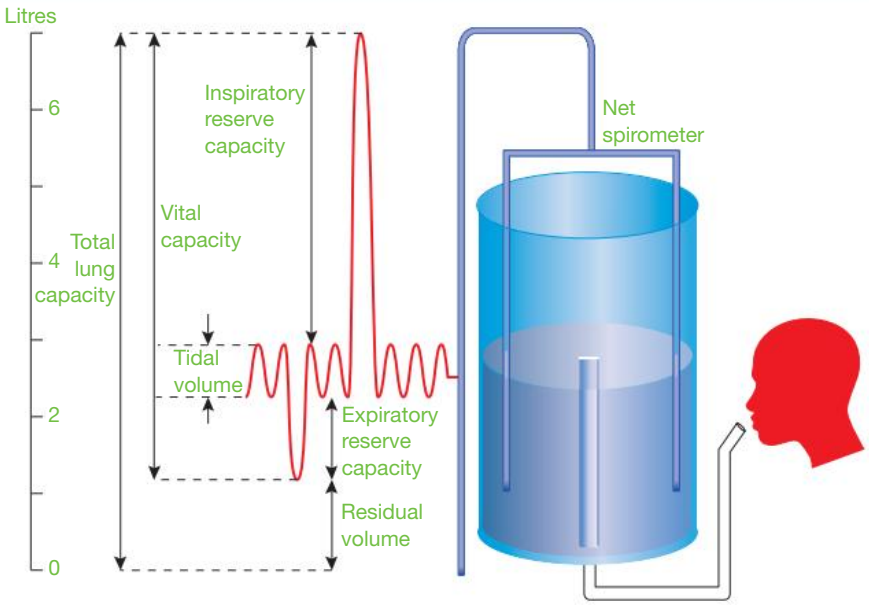
vital capacity the maximum amount of air that can be expired after a maximal inspiration

TABLE 5.3 Vital capacity readings for adolescent male and female students

Ranking	Males (litres)		Females (litres)	
	12 years	15 years	12 years	15 years
Top 10 per cent	3.65	5.5	3.6	4.25
Mid-range	3.0	4.5	2.9	3.6
Lowest	2.15	3.15	2.05	2.6

- Tidal volume is the amount of air inspired and expired with each breath. It is approximately 500 millilitres at rest, but can increase dramatically during exercise (see figure 5.8).

FIGURE 5.8 The relative amounts for each of the main lung volumes



CONCEPT CONNECTOR

How does a balloon resemble the mechanics of breathing? Blow up two balloons: one as big as you can and one a little bit smaller. As you blow up each balloon, think about the dot points below, then release the air from the balloon.

- Inhalation
- Exhalation
- Diaphragm
- Intercostal muscles
- Lung capacity

5.3.5 Maximum oxygen uptake

Maximum oxygen uptake (VO_2 max) is the maximum amount of oxygen per minute that can be taken in, transported to and used by the working muscles to produce ATP (adenosine triphosphate). This reading reflects aerobic power (or the body's ability to use oxygen). It is the usual measure for comparing different sports' or individuals' aerobic power levels. VO_2 max is different for males and females due to lung capacity differences; that is, males generally have a greater VO_2 max than females due to larger heart and lung capacity. VO_2 max tests are the best way to measure the efficiency of the cardiovascular, respiratory and muscular systems under exercise conditions.

maximum oxygen uptake (VO_2 max) the maximum amount of oxygen per minute that can be taken in, transported to and used by the working muscles to produce ATP (adenosine triphosphate)

VO_2 max is typically measured in millilitres of oxygen per kilogram of body weight per minute (mL/kg/min). By dividing the VO_2 max by kilograms we are able to understand how much oxygen the body can consume relative to its mass. For example, for a person weighing 70 kilograms to achieve a VO_2 max of 73.5 (considered very high VO_2 max), they would need to consume approximately 5145 millilitres of oxygen in a minute.

5.3.6 Gaseous exchange

The respiratory and the cardiovascular systems work together to transfer and transport gas molecules (in particular, oxygen and carbon dioxide) around the body. In order to do this, gases are exchanged through the process of **diffusion**. Diffusion involves the movement of a molecule from a higher concentration to a lower concentration across a thin membrane. The sites of exchange that are important for the delivery of oxygen for energy production and the removal of waste are the alveoli/capillary interface in the lungs and the capillary/muscle interface at the cell site.

5.3.7 Gas exchange at the alveoli/capillary interface

Pulmonary diffusion is the exchange of gases in the lungs (see figure 5.9). The alveoli/capillary interface is the specific location where the exchange of gases, including oxygen and carbon dioxide, occurs between the bloodstream and lungs.

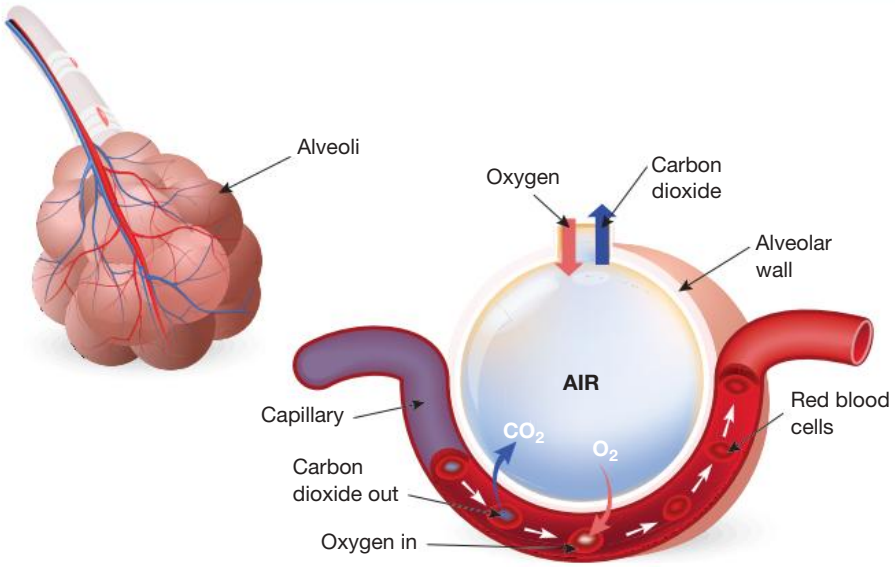
Inspiration involves air entering the lungs and travelling into the alveoli, then the capillaries surrounding the alveoli. Both structures have very thin walls, only one cell thick, that allow the oxygen to move from the higher concentration in the alveoli to the lower concentration of the surrounding capillaries. Once in the capillaries, the oxygen attaches to the haemoglobin in the red blood cells to be transported to the muscles and other cells in the body.

During expiration, the carbon dioxide in the capillaries is under higher concentration than the air in the alveoli. The carbon dioxide diffuses into the alveoli and is expelled in outward breaths.

diffusion the movement from a higher concentration to a lower concentration

pulmonary diffusion the process to describe the exchange of gases in the lungs

FIGURE 5.9 Pulmonary diffusion at the alveoli and capillary interface



Resources

Video eLesson Diffusion between the alveoli and capillary interface (eles-2574)

5.3.8 Gas exchange at the capillary/muscle interface

At the muscle (cell) site, the concentration of the gases inside and outside the capillaries is the reverse of those within the lungs (see figure 5.10). Oxygen-rich blood is transported to the muscles in response to the increased demand for energy production. The low levels of oxygen within the muscles attract the higher concentration oxygen from within the capillaries through the thin capillary wall. In reverse, the carbon dioxide produced as a by-product from energy production from the muscle is pushed into the capillary to be transported to the alveoli and expired.

FIGURE 5.10 Exchange of gases at the muscle cell/capillary junction

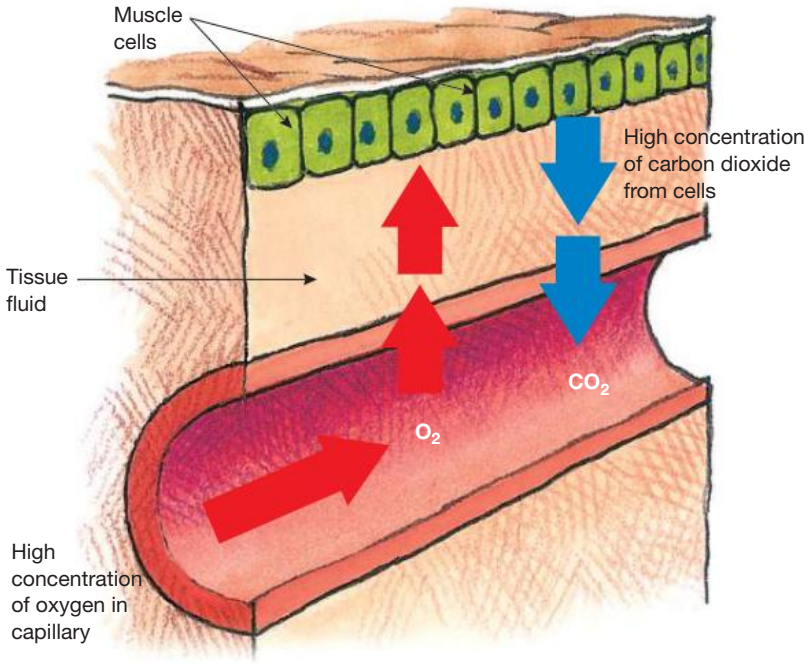


FIGURE 5.11 The alveoli/capillary interface and capillary/muscle interface

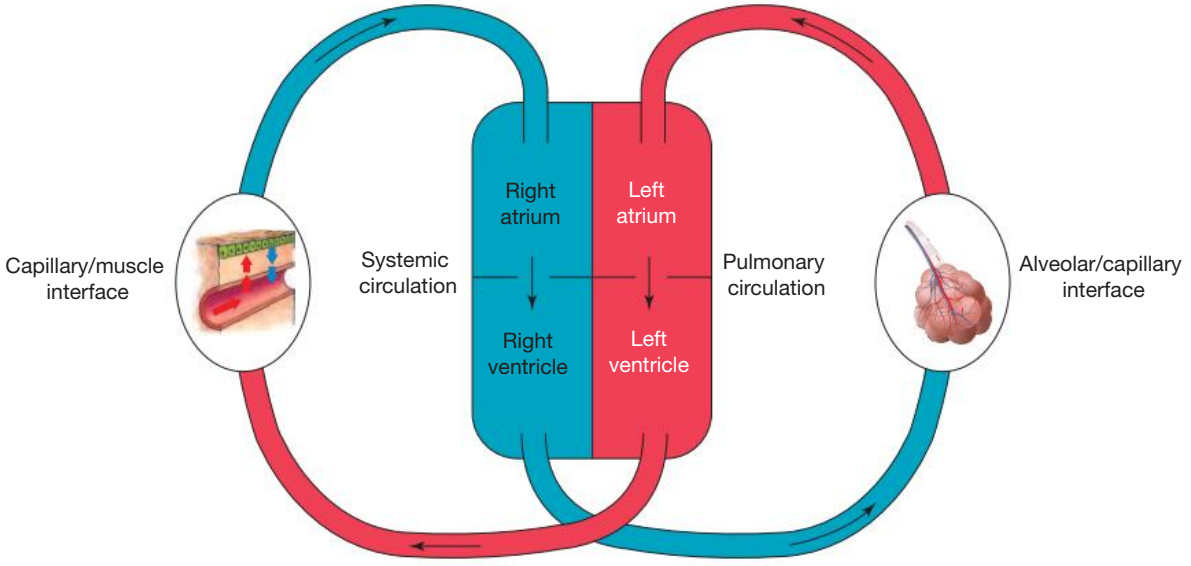
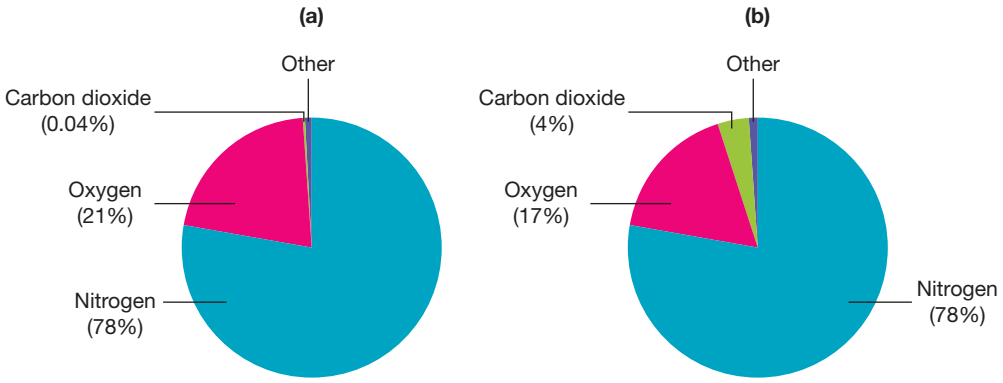


Figure 5.12 depicts the approximate composition of inhaled and exhaled air in the lungs.

FIGURE 5.12 The approximate composition of gases in **(a)** inhaled and **(b)** exhaled air



on Resources

Digital document Diagram of lung volumes (doc-1105)

doc-41936

PRACTICAL ACTIVITY Vital capacity

Goal

To determine your lung capacity

Equipment

- Spirometer or pocket spirometer (check your Science department)

Instructions

1. Using a clean mouthpiece, attach it to the spirometer and ensure it's set to zero.
2. Take a deep breath until you cannot take in any more air.
3. Place your mouth around the spirometer and exhale until you cannot exhale anymore.
4. Record your vital capacity.
5. Reset to zero, then do two more trials then calculate your average.
6. Use table 5.3 to compare your result to the values for adolescent male and female students.

Note: if you start feeling faint or dizzy, take a seat and do not complete any more trials.

Primary data/Reflection

TABLE Vital capacity (cc/mL)

Trial 1	
Trial 2	
Trial 3	
Average	

How did you feel after each trial?

Questions

1. How did your vital capacity measurement compare to the average for your age and gender?
2. What factors might have influenced your results? How would these factors have affected your results?
3. When looking at the class data, were there any trends or patterns in the results?

5.3 Activity

5.3 Quick quiz on | **5.3 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 3, 5	4	6, 7

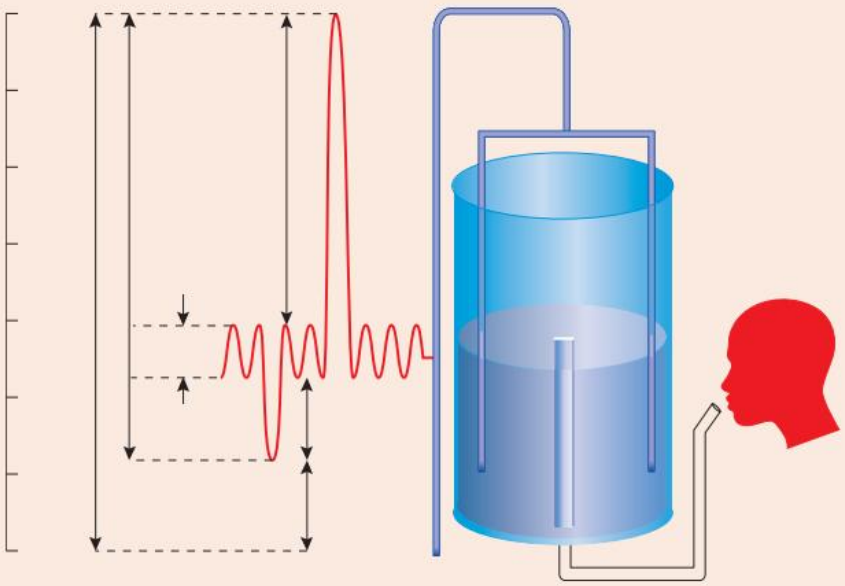
These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Define** ventilation and **outline** how it is calculated.
2. **Outline** the major differences in the gas content of inspired air compared to that of expired air.
3. **Define** maximum oxygen uptake (VO_2 max).
4. **Describe** the process of inspiration and expiration. Include the role of the diaphragm, intercostal muscles, air movements and air pressure both within and outside the lungs. Use a diagram to assist.
5. **Label** and **define** each of the types of lung volumes.



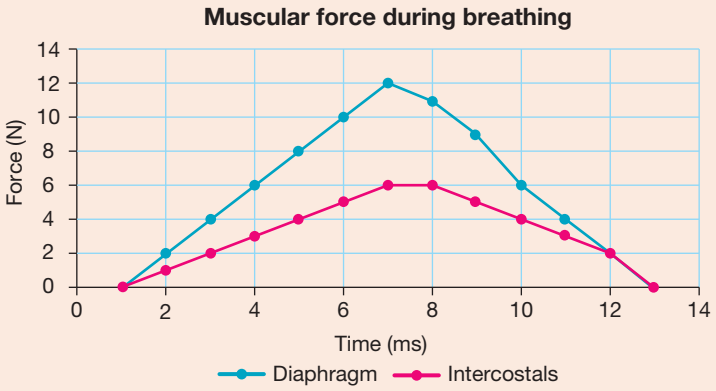
APPLY your understanding

6. **Explain** the impact a narrow chest cavity may have on inspiration.
7. Using an example, **explain** the importance of measuring VO_2 max relative to body weight.

5.3 Exam questions

Question 1 (1 mark)

Source: *ACHPER 2019, Trial Exam Unit 1, Section A, Q.13; © ACHPER*



What stage of the breathing process has occurred between the 2-minute and 7-minute stages in the graph above?

A. Inspiration
B. Expiration
C. Ventilation
D. Contraction

Question 2 (2 marks)

Explain the role of haemoglobin in gas exchange.

Question 3 (2 marks)

Describe the role of the diaphragm and intercostal muscles in the mechanics of breathing.

More exam questions are available in your learnON title.

5.4 Responses of the respiratory system to physical activity

Key knowledge	Key skill
• the structure and function of the respiratory system, including the lungs, mechanics of breathing and gaseous exchange at the alveoli/capillary and the capillary/muscle interface	• collect primary data to measure and analyse the changes to the cardiovascular and respiratory systems at rest compared with various exercise intensities

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

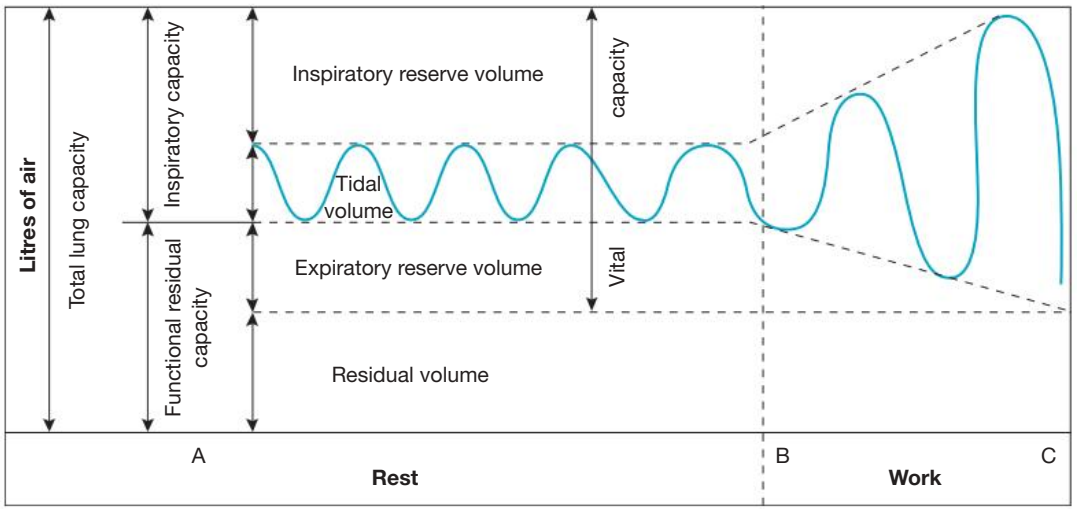
5.4.1 The respiratory system and physical activity

As an individual begins to exercise, a number of changes occur within the respiratory system to meet the requirements of the body. As with the cardiovascular system, these changes revolve around the greater demand for oxygen to be delivered to the working muscles to create energy, and the associated removal of waste products (see figure 5.13).

There are many factors that contribute to these changes including:

- *Intensity*. The magnitude of these changes depends on the intensity of the exercise; for example, an increase in intensity will result in an increase in respiratory rate.
- *Duration*. The duration of the exercise also influences these changes. The longer the exercise, the longer the respiratory system needs to adapt to meet the oxygen demands of the body.
- *Type*. The type of exercise affects the degree of changes.
- *Individual differences*. Factors such as fitness level and respiratory health conditions (e.g. asthma) are influential. An individual with a higher fitness level will have a respiratory system that adapts to exercise more efficiently.
- *Environmental differences*. Environmental aspects, such as temperature, affect the degree of changes; for example, a very cold climate can reduce the respiratory system's ability to warm air.

FIGURE 5.13 The change in lung volumes and function from rest to working levels



5.4.2 Increased respiratory (breathing) rate (RR)

- At rest, the adult respiration rate is 12–15 breaths per minute.
- Under high intensity exercise, RR can reach 35–45 breaths per minute due to the increased demand for oxygen and the need for removal of carbon dioxide.

5.4.3 Increased tidal volume (TV)

- Depth of breathing (tidal volume) at rest is approximately 0.5 litres per breath.
- This can increase to 4–5 litres per breath at maximal workloads in order to supply more oxygen to the blood to deliver to working muscles.

CONCEPT CONNECTOR

Paper-bag breathing: Breathe into a small paper bag continuously for 10 seconds. How does this change the:

- oxygen intake during inhalation and exhalation
- carbon dioxide uptake during inhalation and exhalation
- tidal volume?

5.4.4 Increased ventilation (V)

- Due to the increases in respiratory rate (RR) and tidal volume (TV), ventilation (V) will also increase.
- At rest, ventilation is approximately 6.0 L/min.
- During maximal exercise, this value can increase dramatically.
  For example, RR × TV = V
  45 × 4 = 180 L/min

TABLE 5.4 Comparison of respiratory rate, tidal volume and ventilation at rest and during exercise

	Respiratory rate (breaths/minute)	Tidal volume (L/breath)	Ventilation (L/min)
Rest	12	0.5	6
Submaximal exercise	30	2.5	75
Maximal exercise	45	4.0	180

5.4.5 Increased diffusion

During physical activity, the diffusion capacity at the alveoli/capillary and muscle/capillary interface is increased to allow greater amounts of oxygen and carbon dioxide to be exchanged at these sites.

This is crucial during intense exercise, as it compensates for the rapid depletion of oxygen in the muscles. This physiological response enables us to sustain vigorous activity by ensuring that the body's energy demands and oxygen requirements are adequately met.

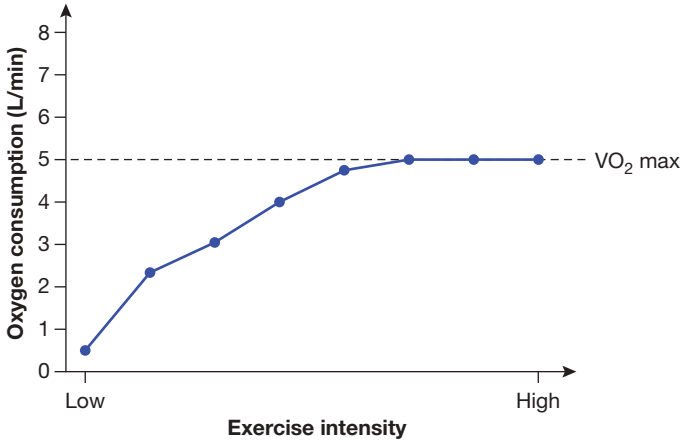
EXAM TIP

When mentioning diffusion as an acute response of the respiratory system to exercise, ensure that you specify the location. Pulmonary diffusion is very different to diffusion at the muscle site!

5.4.6 Increased oxygen uptake (VO_2)

- Oxygen uptake increases due to the greater demand for oxygen by the muscles. This increase is linear, but will not increase further once maximum levels of oxygen uptake are achieved (i.e. VO_2 max, see figure 5.14).
- At rest, the average amount of oxygen that an individual can take into the body is about 0.35 L/min.
- During submaximal exercise, this can increase to around 2.0–3.5 L/min.
- Under maximal exercise, depending on the individual's aerobic fitness levels, this can reach 4–6 L/min.

FIGURE 5.14 Oxygen consumption relative to exercise intensity



5.4.7 Increased efforts from ribcage muscles and diaphragm

- During physical activity, the external and internal intercostal muscles as well as the diaphragm will all work harder to enable increased expansion and contraction of the thoracic cavity.
- This increased movement of the cavity will accommodate the increased air volumes demanded by the working muscles in order to gain extra oxygen.

doc-41937

PRACTICAL ACTIVITY Respiratory rate and exercise

Goal

To evaluate the effect of exercise on your respiratory rate

Instructions

1. Working with a partner, sit down quietly and have your partner measure your resting respiratory rate before you begin the physical activities.
2. Perform each of the following activities below. Have your partner count your respiratory rate for 1 minute immediately after you complete each activity and record your results.
3. Rest until your respiratory rate returns to the initial resting levels recorded between each activity.
   - Walking for 2 minutes
   - Jogging for 2 minutes
   - Boxing for 30 seconds
   - Skipping for 2 minutes
   - Seated toe-touches for 30 seconds
   - Rowing for 5 minutes

Primary data/Reflection

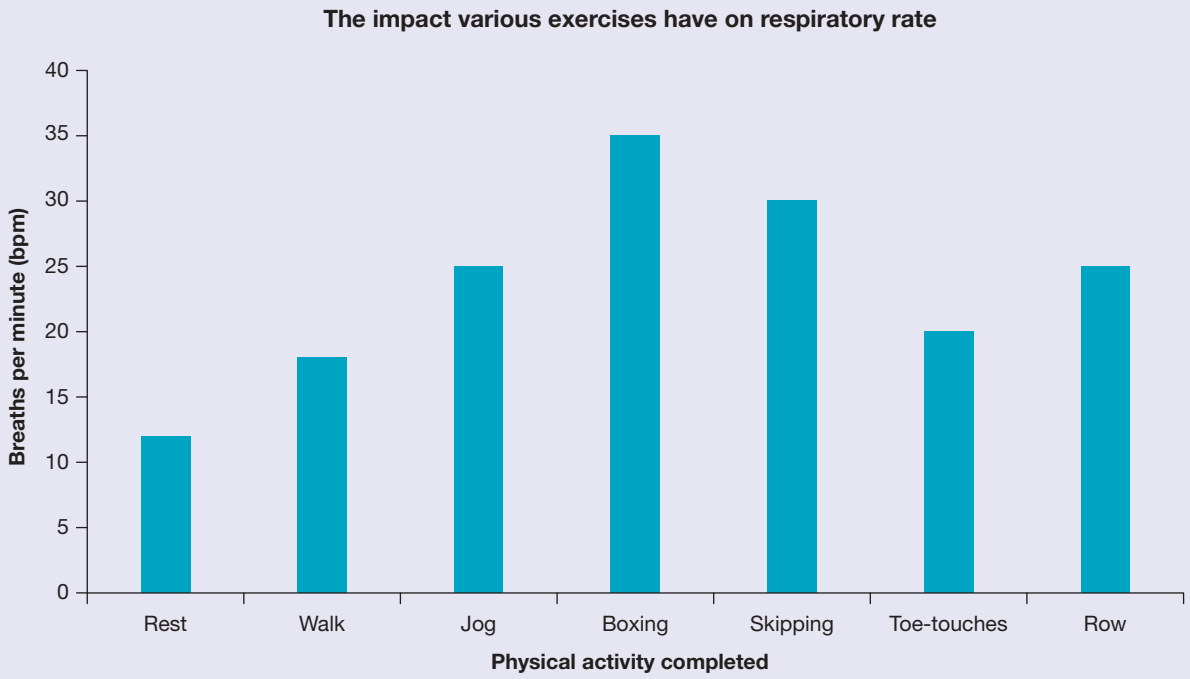
TABLE Respiratory rate for different activities

	Rest	Walk	Jog	Boxing	Skipping	Toe-touches	Row
Respiratory rate							

- Reflect on your personal experience during the activity. How did you feel at each level of exercise intensity in terms of breathlessness and overall effort?
- Were there any surprises or unexpected findings in your data? If so, what were they and how might you explain them?
- How did your respiratory rate change during the recovery period after vigorous exercise? Was the return to resting rate consistent or did it follow a different pattern?

Questions

1. Graph your results using the data recorded. Below is an example of how a graph might look.



2. Identify which activity caused the highest respiratory rate. Suggest reasons for this.
3. Discuss the relationship between your respiratory rate and the intensity of the activity. Provide examples.

5.4 Activity

5.4 Quick quiz on | **5.4 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 3	2, 6	4, 5

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. Copy and complete the table below. **State** whether the physiological parameter has increased, decreased or remained unchanged as a result of participating in exercise. Include the measurement values for rest and exercise.

Physiological parameter	Acute response	Measurement at rest	Measurement during submaximal exercise	Measurement during maximal exercise
Respiratory rate				
Tidal volume				
Ventilation				
Oxygen uptake				

2. **Explain** the impact of intensity on an individual's ability to maintain a steady state.
3. **Outline** the changes that will occur to an adults respiratory (breathing) rate (RR) when moving from rest to high intensity exercise.
4. **Explain** how the intercostal muscles work to increase tidal volume.

APPLY your understanding

5. **Explain** the relationship between respiratory rate (RR) and tidal volume (TV) during exercise.
6. Refer to figure 5.13 and **describe** what happens to the following measures of lung volume from points B to C:
   a. tidal volume
   b. inspiratory reserve volume
   c. expiratory reserve volume
   d. vital capacity
   e. total lung capacity.

5.4 Exam questions

Question 1 (1 mark)
Total lung capacity is equal to:
A. vital capacity + residual volume.
B. vital capacity – tidal volume.
C. inspiratory reserve volume × tidal volume.
D. expiratory reserve volume ÷ residual volume.

Question 2 (3 marks)
Define *respiratory rate* and **explain** how an increase in respiratory rate contributes to an increase in ventilation.

Question 3 (3 marks)
Describe how gas exchange changes at the alveoli/capillary interface during intense exercise **compared** to rest, and **outline** how this change helps support sustained physical activity.

More exam questions are available in your learnON title.

5.5 Summary of the interaction of the cardiovascular and respiratory systems during physical activity

Key knowledge	Key skill
• the interaction of the cardiovascular and respiratory systems to transport oxygen around the body at rest and during physical activity, sport and/or exercise	• use primary data to measure and analyse the changes to the cardiovascular and respiratory systems at rest compared with various exercise intensities

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

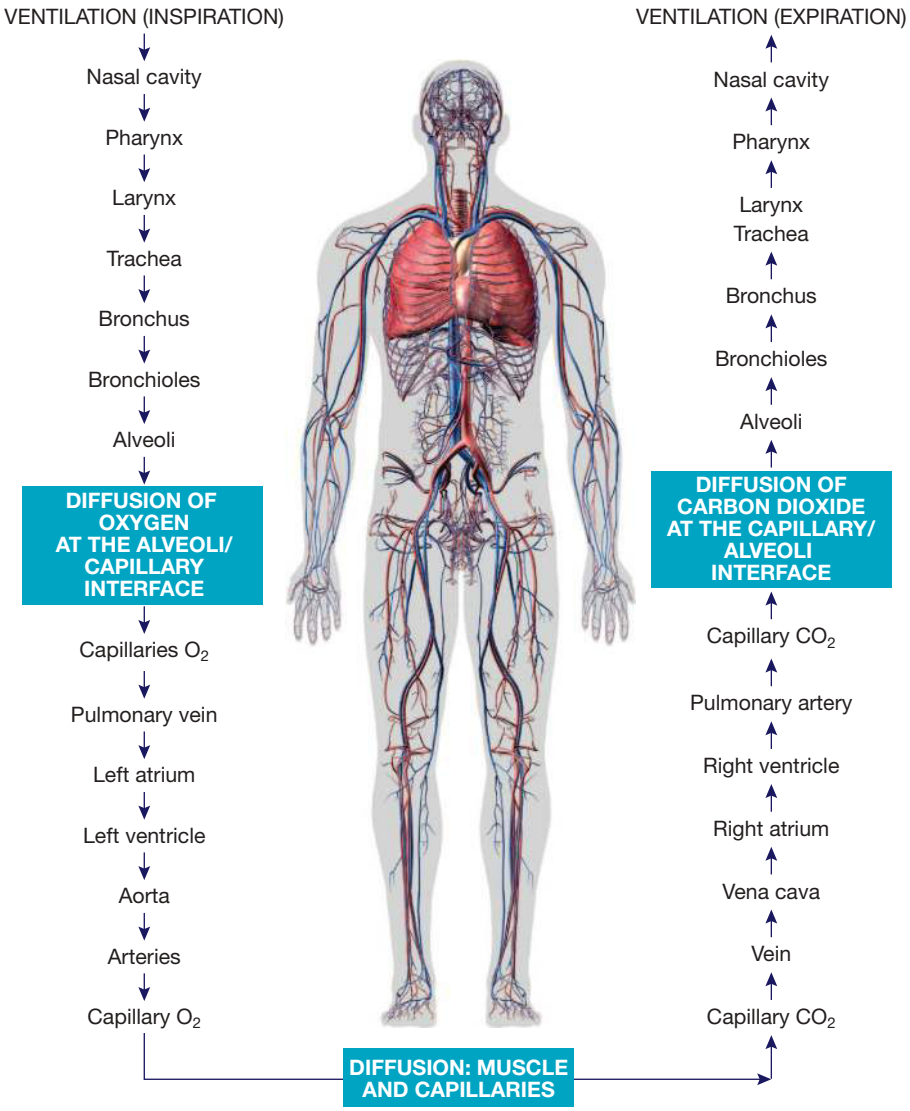
5.5.1 The relationship between the cardiovascular and respiratory systems

The cardiovascular system and the respiratory system work together to deliver oxygen to working muscles in the following way (see figure 5.15).

- The respiratory system transfers oxygen to and from the lungs from the atmosphere via the mechanisms of breathing — inspiration and expiration. This ventilation of air into and out of the lungs occurs at an average rate of 4 L/min during rest, increasing to 15–35 L/min during exercise and increasing intensities.

- Gaseous exchange (or diffusion) occurs at the alveoli and capillary interface where the oxygen breathed in is at a higher concentration in the alveoli and diffuses across the thin membrane wall into the capillaries. This is the point of entry into the cardiovascular system where the oxygen will be transported via the blood, blood vessels and heart around the body.
- Oxygen combines with haemoglobin in the red blood cells to be transported via the arteries and heart to the muscles. At rest, the cardiac output of the heart is 5 L/min, increasing to 20–30 L/min during exercise at increasing intensities.
- Oxygen enters the muscles at the capillary/muscle interface via diffusion where the concentration of oxygen is higher in the capillaries. Oxygen is used for energy production and carbon dioxide is produced as a result of this process. At this point, the carbon dioxide is in a higher concentration in the muscle than the capillaries, and also diffuses across the thin membrane into the capillaries to be transported away. Greater amounts of oxygen and carbon dioxide are used and produced during exercise in comparison to rest.
- Carbon dioxide travels via the veins and the heart back to the lungs where it is diffused into the alveoli and expired via the respiratory system.

FIGURE 5.15 Interaction of the cardiovascular and respiratory systems



5.5.2 The cardiorespiratory system in action — oxygen uptake during a 5-kilometre parkrun

As discussed, the cardiovascular and respiratory systems work together to transport oxygen around the body to meet the varying demands of different sports. An individual's performance in a 5-kilometre run, such as a 'parkrun' (see figure 5.16), depends on their ability to use oxygen efficiently. Below is an example of how the systems adapt and work together during a parkrun.

At the start of the run, the body's oxygen demand increases sharply from rest. To help meet this demand, the body increases its respiratory rate (takes more breaths) and tidal volume (breathes deeper). This response results in a higher volume of air being inhaled each minute, which results in more oxygen being brought into the lungs. When this occurs, gas exchange also increases because there is more oxygen available for diffusion to occur. This occurs at the alveoli/capillary interface in the lungs.

With more oxygen in the lungs, the efficiency of pulmonary gas exchange increases, allowing the cardiovascular system to deliver more oxygen to the working muscles in a shorter period of time. As the heart beats more rapidly and forcefully during the run, cardiac output (the volume of blood the blood pumps out per minute) increases. This is a combined result of increased heart rate and stroke volume, ensuring more oxygen-rich blood can be delivered to the working muscles. Arteriovenous oxygen difference (a-VO_2 difference) is also higher as the muscles extract more oxygen from the blood during exercise, an important component of VO_2 max (VO_2 max = cardiac output × a-VO_2 difference).

FIGURE 5.16 The cardiovascular and respiratory systems work together to ensure successful completion of a parkrun.

An individual's VO_2 max plays an important role in the run. A higher VO_2 max indicates a greater capacity to uptake and deliver oxygen to the working muscles per minute, which enhances the athlete's ability to sustain high speeds aerobically throughout the run.

Table 5.5 is an example demonstrating how the cardiovascular and respiratory system adapt during a 5-kilometre race. Do you notice how all respiratory system and cardiovascular responses increase from rest to promote oxygen delivery during the run? The cardiorespiratory system interacts to enable individuals to meet the sustained increase in demands from a range of physical activities.

TABLE 5.5 The cardiovascular and respiratory system respond and work together to help meet the increased demands of the body during a 5-kilometre run.

System	Response	Before activity (rest)	At the end of activity (5-km run)
Respiratory	Respiratory rate (breaths/min)	12	45
	Tidal volume (litres)	0.5	3.5
	Ventilation (L/min)	6	158
	Oxygen uptake (L/min)	0.21	2.85
	Pulmonary diffusion	Efficient	Increased efficiency
Cardiovascular	Heart rate (beats/min)	60	190
	Stroke volume (mL/beat)	70	100
	Cardiac output (L/min)	4.2	19
	a-VO_2 O_2 difference (mL O_2/100 mL blood)	5	15

on Resources

Interactivity Diffusion (int-1830)

doc-41938

PRACTICAL ACTIVITY Aerobic tests and the effects on the body

Goal

To measure the effects of an exhaustive aerobic test on the body

Equipment

- Spirometer or pocket spirometer
- Exercise bikes

Instructions

1. In small groups, pick one person to complete 5-minute work increments up to a total of 20 minutes on the exercise bike, gradually increasing the intensity over the exercise period.
2. The person completing the work will then need to measure their vital capacity (VC) using the spirometer.
3. The remaining group members are to be assigned different tasks for collecting and recording the following measurements at rest and after each 5-minute increment:
   - respiration rates
   - heart rates
   - blood pressure readings
   - any observable amounts and patterns of perspiration
   - any observation signs of fatigue or discomfort.
4. Once all the data has been collected, the group will then present their findings to the class on each of the parameters observed.

Primary data/Reflection

TABLE Measurements taken at rest and after each 5-minute increment

	Result				
	At rest	After 5 minutes of cycling	After 10 minutes of cycling	After 15 minutes of cycling	After 20 minutes of cycling
Vital capacity (mL)					
Respiration rate (breaths/min)					
Heart rate (beats/min)					
Blood pressure					
Perspiration					
Signs of fatigue or discomfort					

Questions

1. How did the measurements recorded change for the cyclist over time?
2. Compare and contrast the aerobic test results between different participants. What factors might account for variations in performance and physiological responses?
3. Reflect on the limitations of the aerobic test conducted and propose potential modifications or additional measures to enhance its validity and reliability.

5.5 Activity

5.5 Quick quiz on

5.5 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
3	1	2, 4, 5

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Discuss** the importance of the relationship between the cardiovascular and respiratory systems during physical activity.
2. **Explain** how gaseous exchange occurs between the cardiovascular and respiratory systems.
3. **State** the two variables that determine the VO_2 max.

APPLY your understanding

4. Using data from table 5.6, **analyse** how the cardiorespiratory system helps meet the oxygen demands of a 5-kilometre parkrun.
5. As we age our maximum heart rate typically decreases.
   Explain the impact this has on the respiratory system's ability to deliver oxygen to the working muscles during high-intensity exercise.

5.5 Exam questions

Question 1 (1 mark)

After passing through the nasal cavity, inspired air then passes through the:

A. trachea.
B. alveoli.
C. larynx.
D. pharynx.

Question 2 (3 marks)

Analyse how changes in ventilation and cardiac output work together to support increased demands during moderate to intense physical activity.

Question 3 (3 marks)

Discuss how the cardiorespiratory system works to remove carbon dioxide during physical activity and why this occurs.

More exam questions are available in your learnON title.

5.6 Key skills

Key skills

- apply and use anatomical terminology to identify the structures and function of the cardiovascular and respiratory systems
- investigate and describe the process of gaseous exchange
- use primary data to measure and analyse the changes to the cardiovascular and respiratory systems at rest compared with various exercise intensities

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

5.6.1 Tell me

To address these key skills, it is important to remember the following:

- know the correct anatomical names for the structures and functions of the cardiorespiratory system
- understand how gaseous exchange occurs and the structures where gaseous exchange can occur
- understand how the respiratory system responds at rest, compared to different intensities of physical activity
- understand how the cardiovascular and respiratory systems work together to perform essential bodily functions.

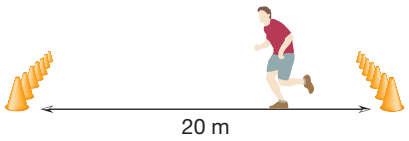
5.6.2 Show me

Practice question (8 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

The 20-metre shuttle run is a standardised test used to measure an individual's aerobic power and cardiorespiratory fitness. It involves continuous running between two lines 20 metres apart in time to recorded beeps. There is a strong relationship between an individual's score on the shuttle-run rest and their VO_2 max.



For the first few beeps in the beep test, individuals generally run at a submaximal pace and, as the test progresses, they are required to run at an increasingly faster speed, potentially working towards or reaching their VO_2 max, depending on their individual fitness level.

a. **Identify** one response from the respiratory system that you would expect in the first minute of the shuttle run. (1 mark)

b. **Explain** how the respiratory system's response in **part a** *assists* the individual in the test. (2 marks)

c. **List** the two structures between which gaseous exchange of *oxygen and carbon dioxide* takes place in the *lungs* during this test. (2 marks)

d. Using the above example, **explain** gaseous exchange in terms of the *concentration levels* of each *gas* and the *resultant movement*. (3 marks)

Decode the question

Strategies to decode the question

- **Identify the action words:**
  List — words, names or numbers arranged consecutively
  Identify — determine the key characteristics or features
  Explain — provide detail to show the relationship between concepts

- **Key terminology** — *assists, oxygen, carbon dioxide, lungs, concentration levels, gas, resultant movement*
- **Key concept/s** — respiratory system, gaseous exchange
- **Marking scheme** — 8 marks — always check marking scheme for depth of response required, linking to key information highlighted in the question.

Sample response and marking scheme

a.
- Increase in *tidal volume*
- Increase in *respiratory rate*
- Increase in *pulmonary ventilation*
- Increase in *ventilation*

Award 1 mark for identifying a response of the respiratory system.

b. Respiratory rate example:
- During submaximal activity there is an increased demand for *oxygen* and need to expel *carbon dioxide* at rest. An *increased respiratory rate* allows your body to take in more *oxygen* and remove *carbon dioxide* as a waste product more efficiently from the body, increasing the capacity of the individual to continue the shuttle run at the higher intensity.

Award 1 mark for explaining why the change occurs.
Award 1 mark for explaining how the change assists the individual in the shuttle run.

c. Alveoli and capillaries
Award 1 mark for each correct structure listed.

d. Gaseous exchange is the movement of *gas* from an area of *high concentration* to an area of *low concentration*. In the lungs after inspiration, the alveoli have a high concentration of *oxygen* and *low concentration of carbon dioxide*. This is compared to the blood in the surrounding *capillaries* which has a high concentration of *carbon dioxide* and *low concentration of oxygen*. As a result, the *oxygen diffuses* into the blood and the *carbon dioxide diffuses into the lungs*.
Award 1 mark for explaining what gaseous exchange is.
Award 1 mark for identifying the concentration levels of the gases (oxygen and carbon dioxide) within the structures.
Award 1 mark for discussing the movement of the gases between the structures.

5.6.3 Let me do it

Question 1 (8 marks)

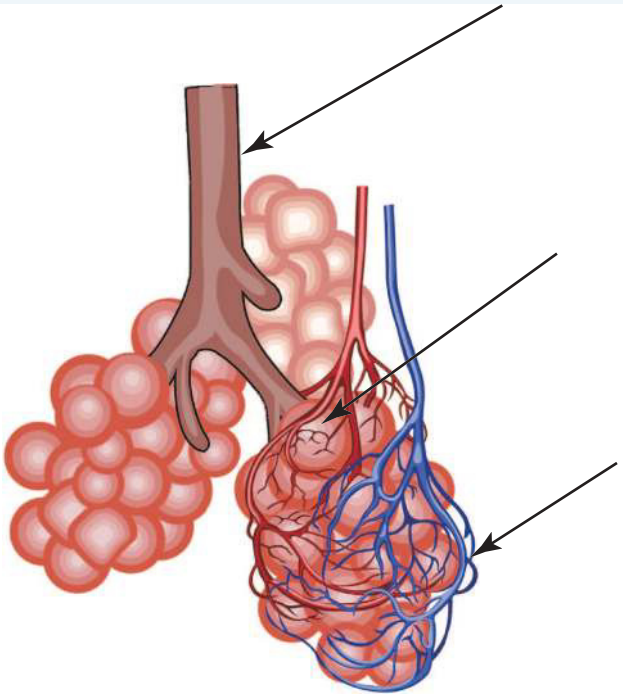
Source: *Adapted from ACPHER 2017 Exam Unit 1, Section B, Q.6;* © ACHPER

Parameter	AT REST		After 5 minutes of constant exercise-cycling at 25 km/h	
	Trained athlete	Untrained athlete	Trained athlete	Untrained athlete
Heart rate (bpm)	50	75	120	160
Stroke volume (mL/b)	120	80	129	100
Breathing rate (breaths/min)	12	18	36	42
Cardiac output (litres/min)	6	6	15.5	16

a. With reference to the data presented in the table above, for the trained athlete, **outline** the effect of exercise upon heart breathing rate. **(2 marks)**

b. Identify the three respiratory structures below. **(3 marks)**

FIGURE 5.17 Bronchiole, alveoli and capillaries



c. Explain how a change in breathing rate contributes to changes in gas exchange in two of the respiratory structures identified in **part b**, when an athlete increases intensity during exercise. **(3 marks)**

5.7 Review

Hey students! Now that it's time to revise this topic, go online to:

Review your results

Watch teacher-led videos

Practise exam questions

Find all this and MORE in jacPLUS

5.7.1 Summary

The respiratory system — structure and functions

- The respiratory system brings oxygen into the body and removes carbon dioxide from the body.
- The conducting system of the respiratory system includes the nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles and alveoli.
- The diaphragm contracts and relaxes to aid breathing.

The respiratory system — mechanics of breathing and gaseous exchange

- Inspiration is when the lungs take in air, while expiration is when air is forced out of the lungs.
- Gas exchange occurs at the alveoli and capillaries, and at the capillaries and muscles, and involves the movement of oxygen and carbon dioxide from areas of high concentration to areas of low concentration.
- Everyone has different lung volumes, and this affects their capacity for holding and expelling air.
- Vital capacity measures the maximum amount of air that you can breathe out after a maximum inhalation.
- Maximum oxygen uptake (VO_2 max) is the maximal amount of oxygen that can be used by the body in 1 minute.

Responses of the respiratory system to physical activity

- The respiratory system adapts to the onset of exercise via increases in respiratory rate, tidal volume, ventilation, pulmonary diffusion and oxygen uptake by the muscles.

Summary of the interaction of the cardiovascular system and respiratory systems during physical activity

- The heart, a key component of the cardiovascular system, plays a major role in receiving oxygen-rich blood from the lungs (respiratory system) and pumping it throughout the body. It then circulates deoxygenated, CO_2-rich blood back to the lungs to be exhaled.
- The respiratory system functions to inhale oxygen into the lungs and diffuses it into the bloodstream via the alveoli. This oxygen is then transferred to the cardiovascular system and delivered to body tissues from the capillaries.
- Both the cardiovascular and respiratory systems are essential for the efficient delivery of oxygen to tissues and the removal of carbon dioxide, which is crucial for maintaining the body's metabolic processes.

5.7.2 Key terms

diffusion the movement from a higher concentration to a lower concentration
expiration the movement of air out of the lungs to the external environment (breathing out)
inspiration the movement of air from the external environment into the lungs (breathing in)
maximum oxygen uptake (VO_2 max) the maximum amount of oxygen per minute that can be taken in, transported to and used by the working muscles to produce ATP (adenosine triphosphate)
pulmonary diffusion the process to describe the exchange of gases in the lungs
respiratory rate (RR) the amount of breaths per minute
respiratory system the lungs and associated structures responsible for gas exchange in the body, bringing air into the body and removing waste products
tidal volume (TV) the amount of air breathed in and out in one breath
ventilation (V) the amount of air that is inspired and expired during 1 minute
vital capacity the maximum amount of air that can be expired after a maximal inspiration

5.7 Exam questions

5.7 Section A — Multiple choice questions

Question 1 (1 mark)

Which is not a function of the respiratory system?

A. Brings air from the atmosphere to the lungs
B. Transfers oxygen into the blood
C. Transports oxygen to the muscles
D. Removes carbon dioxide from the blood

Question 2 (1 mark)

The diaphragm contracts and moves downwards during:

A. inspiration.
B. expiration.
C. ventilation.
D. diffusion.

Question 3 (1 mark)

The site of gaseous exchange in the respiratory system is the:

A. trachea.
B. bronchus.
C. alveoli.
D. diaphragm.

Question 4 (1 mark)

Ventilation is calculated by multiplying:

A. heart rate and respiratory rate.
B. respiratory rate and vital capacity.
C. tidal volume and vital capacity.
D. respiratory rate and tidal volume.

Question 5 (1 mark)

Source: *ACHPER 2017, Trial Exam Unit 1, Section A,* Q.*11*; © ACHPER

Select the correct term, from those below, that describes the process whereby oxygen diffuses from the alveoli sacs into the bloodstream.

A. Cellular diffusion
B. Inspiration
C. Pulmonary diffusion
D. Expiration

Question 6 (1 mark)

Source: *ACHPER 2021, Trial Exam Unit 1, Section A,* Q.*10;* © ACHPER

During the process of expiration, the intercostal muscles will:

A. relax while the diaphragm lifts upwards.
B. contract while the diaphragm contracts downwards.
C. contract outwards while the diaphragm lifts upwards.
D. lift upwards while the diaphragm contracts upwards.

Question 7 (1 mark)

During exercise, which muscles work harder to enable increased expansion and contraction of the chest cavity?

A. Sternum and ribcage
B. Heart and lungs
C. Intercostals and diaphragm
D. Abdominals and deltoids

Question 8 (1 mark)

The gas that diffuses across the capillary/muscle interface to be expelled from the body after energy production is:

A. oxygen.
B. carbon dioxide.
C. lactic acid.
D. myoglobin.

Question 9 (1 mark)

Respiratory rate increases during exercise due to the increased demand for:

A. food fuels.
B. haemoglobin.
C. oxygen.
D. all of the above.

Question 10 (1 mark)

Source: *Adapted from ACHPER 2022, Trial Exam Unit 1, Section A,* Q.*8*; © ACHPER

During maximal exercise, any changes occurring to ventilation are a result of changes to:

A. cardiac output.
B. respiratory rate.
C. tidal volume.
D. heart rate.

5.7 Section B — Short answer questions

Question 1 (4 marks)

Source: *Adapted from ACHPER 2022, Trial Exam Unit 1, Section B, Q.2a;* © ACHPER

The respiratory system is comprised of the lungs, diaphragm and other structures which enable oxygen to be inspired and carbon dioxide to be expired.

Outline the function of each structure below.

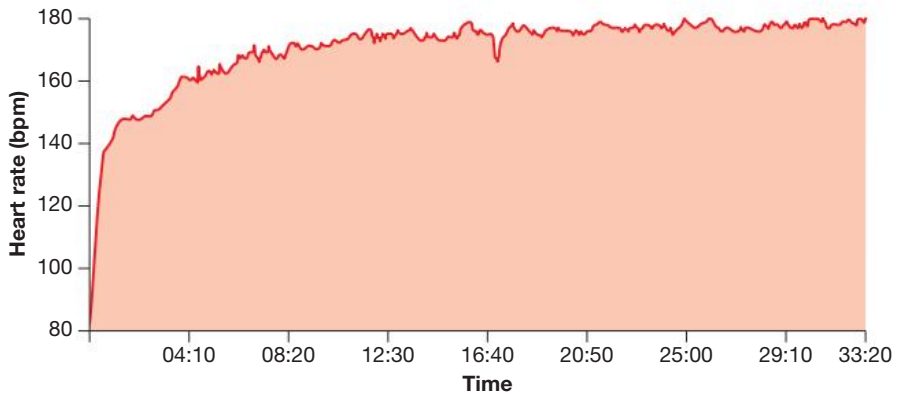
a. Trachea
b. Alveoli
c. Pleura
d. Diaphragm

Question 2 (5 marks)

Source: *ACHPER 2021, Trial Exam Unit 1, Section B, Q.12a;* © ACHPER

Discuss how the cardiovascular and respiratory systems work together during a 10 km fun run to transport oxygen to the working muscles.

Question 3 (6 marks)



To allow the above to occur, the cardiorespiratory system will make a number of changes.

a. **Describe** how the respiratory system would change in response to the exercise shown in the graph above. **(2 marks)**

b. **Outline** how these changes are made possible by referring to the following respiratory system structures: diaphragm and intercostals. **(2 marks)**

c. **Explain** why the above changes occur using your understanding of the relationship between the cardiovascular and respiratory systems. **(2 marks)**

Continue to build your exam skills

Access the Unit 1 Area of Study 2 Review at the end of Topic 6. This includes:

- Practice extended response
- Practice examination
- Practice school-assessed coursework.

6 Enhancing the performance of the cardiorespiratory system

6.1 Overview

Hey students! Bring these pages to life online

Watch videos

Engage with interactivities

Answer questions and check results

Find all this and MORE in jacPLUS

LEARNING SEQUENCE

6.1 Overview
6.2 The impact of regular aerobic exercise on the cardiovascular and respiratory systems
6.3 Enhancing the performance of the cardiorespiratory system: permitted substances and methods
6.4 Enhancing the performance of the cardiorespiratory system: prohibited substances and methods
6.5 Ethical and social considerations for using permitted and prohibited substances and methods
6.6 Key skills
6.7 Review

6.1.1 Introduction

In this topic, we examine the relationship between exercise, the cardiorespiratory system and performance enhancement in sports. Aerobic activities, such as running or swimming, play a key role in improving your endurance and overall cardiorespiratory efficiency. Yet, in the pursuit of better performance, some athletes turn to different (and sometimes prohibited) methods of performance enhancement.

FIGURE 6.1 How can an athlete maximise their oxygen-carrying capacity and the efficiency of their cardiorespiratory system to improve their performance in endurance-based events?

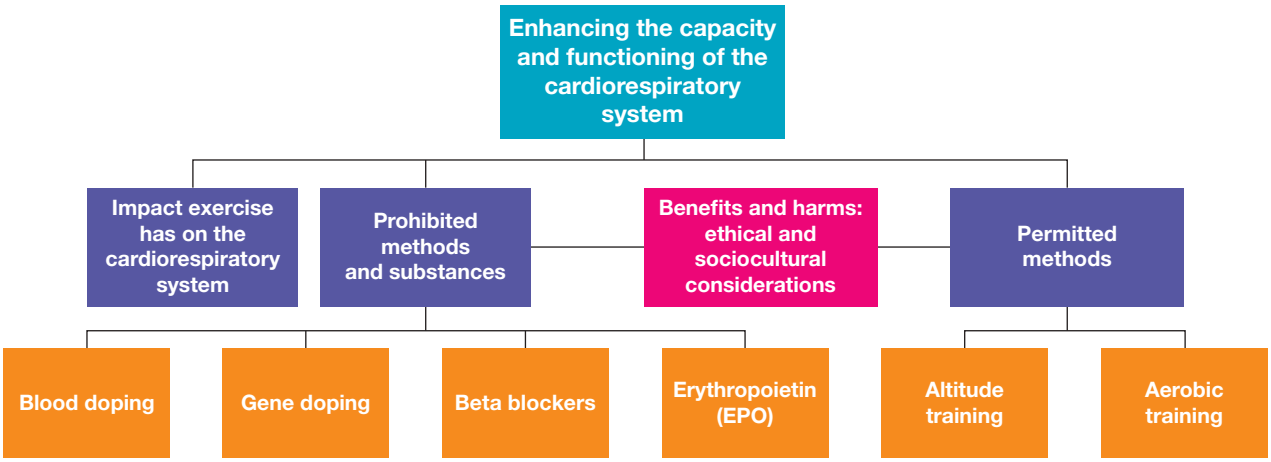
Training aerobically is an accepted way to enhance performance, but using prohibited substances raises ethical concerns. This topic isn't just about science; it's a considered exploration of the cultural influences that shape how we view enhanced performance in sports. Whether you're aiming to improve your Physical Education studies or picturing a future in sports, this topic will equip you with essential knowledge. It provides a well-rounded understanding of aerobic exercise, permitted and prohibited performance-enhancement methods, as well as the ethical and sociocultural aspects tied to enhanced sporting performance.

6.1.2 Key knowledge and Key skills

Key knowledge	Key skills	Subtopic
• the impact of regular aerobic exercise on enhancing the capacity and functioning of the cardiovascular and respiratory systems	• evaluate the impact of regular aerobic exercise on enhancing the capacity and functioning of the cardiovascular and respiratory systems	**6.2**
• potential benefits and harms of permitted and prohibited substances and methods that enhance performance of the cardiorespiratory system, such as altitude training, erythropoietin (EPO), beta-blockers, gene and blood doping	• investigate and evaluate a range of performance-enhancing substances and methods on the cardiorespiratory system from a physiological perspective	**6.3** **6.4**
• ethical and sociocultural considerations associated with the use of permitted and prohibited performance-enhancing substances and methods	• explore the ethical and sociocultural considerations on the use of permitted and prohibited performance-enhancing substances and methods	**6.5**

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

6.1.3 Topic preview



6.2 The impact of regular aerobic exercise on the cardiovascular and respiratory systems

Key knowledge	Key skill
• the impact of regular aerobic exercise on enhancing the capacity and functioning of the cardiovascular and respiratory systems	• evaluate the impact of regular aerobic exercise on enhancing the capacity and functioning of the cardiovascular and respiratory systems

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

6.2.1 Health benefits of exercise

Regular physical activity, such as power walking, swimming and cycling, provides a range of health benefits to the cardiovascular and respiratory systems.

With regular participation in moderate–vigorous exercise, the strength of the heart muscle increases, as well as the diaphragm and intercostal muscles of the lungs.

When you engage in physical activity, your body uses more oxygen and creates more carbon dioxide, meaning that your heart, lungs and adjoining muscles need to work harder. To cope with this extra stress, your respiratory rate increases, as well as your circulation, to deliver oxygen to the working muscles. Studies have shown that engaging in regular **aerobic exercise** can improve overall cardiorespiratory function — meaning you can pump more blood with each heart beat. This also allows more blood to flow to your lungs, resulting in a greater delivery of oxygen into the blood, and carbon dioxide out of the blood.

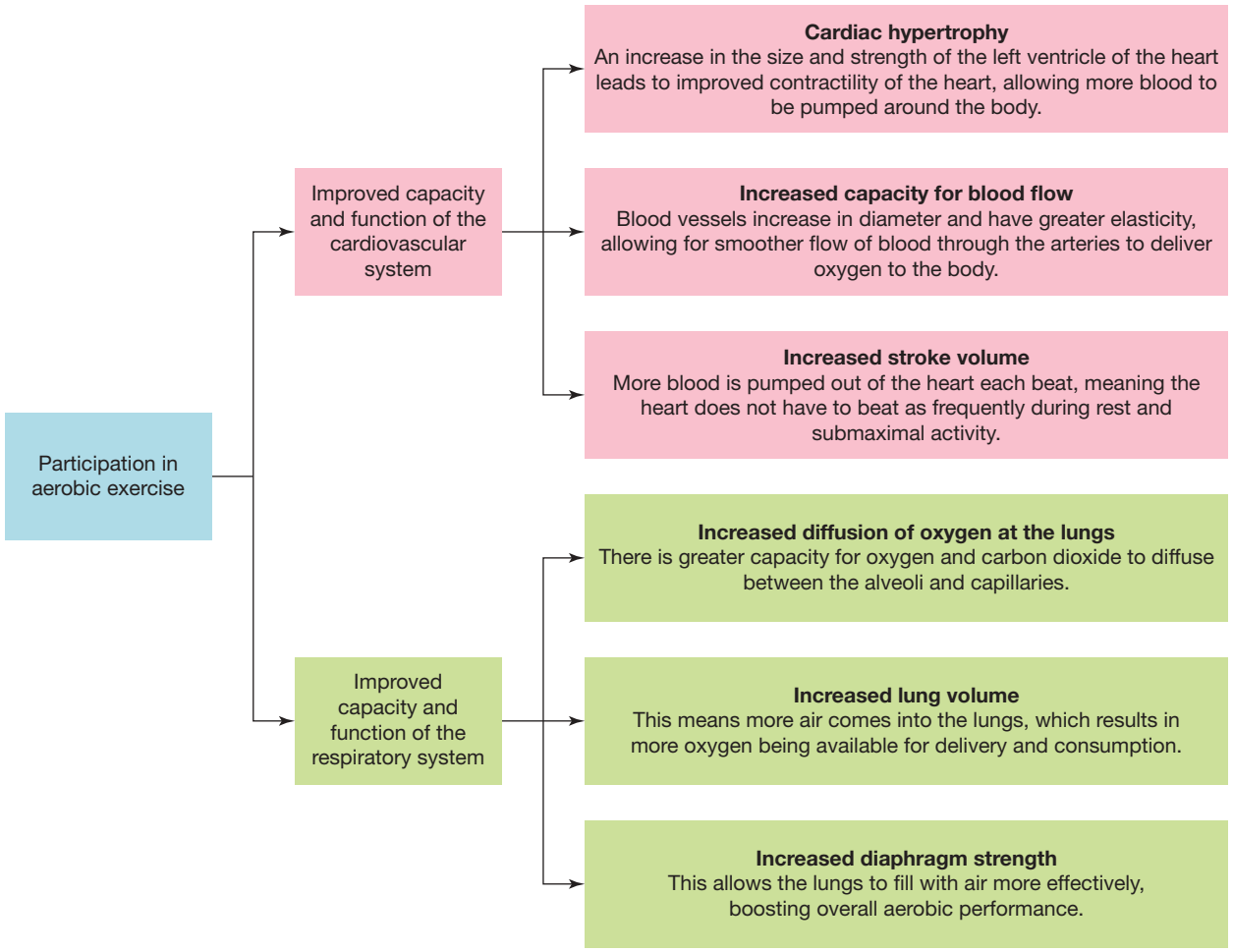
FIGURE 6.2 A variety of aerobic-type activities are recommended for cardiovascular and respiratory health.

Figure 6.3 highlights a range of **physiological adaptations** that occur to the cardiovascular and respiratory systems as a result of regular engagement in aerobic exercise.

aerobic exercise sustained physical effort which increases the rate that oxygen is inhaled and passed from the heart to the bloodstream

physiological adaptations the physical changes of the body's cardiovascular, respiratory and muscular systems due to regular exercise, over a period of time

FIGURE 6.3 The effects of aerobic exercise on the cardiovascular and respiratory systems



CONCEPT CONNECTOR

Using a whiteboard, brainstorm as many different types of aerobic exercise as you can. What is it that makes these activities aerobic? Now, use three different coloured markers to circle which of these activities would be considered physical activity, sport and/or exercise.

on Resources

Weblinks How to improve your cardiovascular system
Aerobic adaptations

6.2.2 What is considered regular aerobic exercise?

To reap the benefits of aerobic exercise, it needs to be done often. The Australian Physical Activity and Sedentary Behaviour Guidelines have been designed to provide individuals with information regarding the optimal intensity, frequency, duration and type of physical activity that is recommended for their age group. These guidelines are discussed further in Unit 2: Area of Study 1.

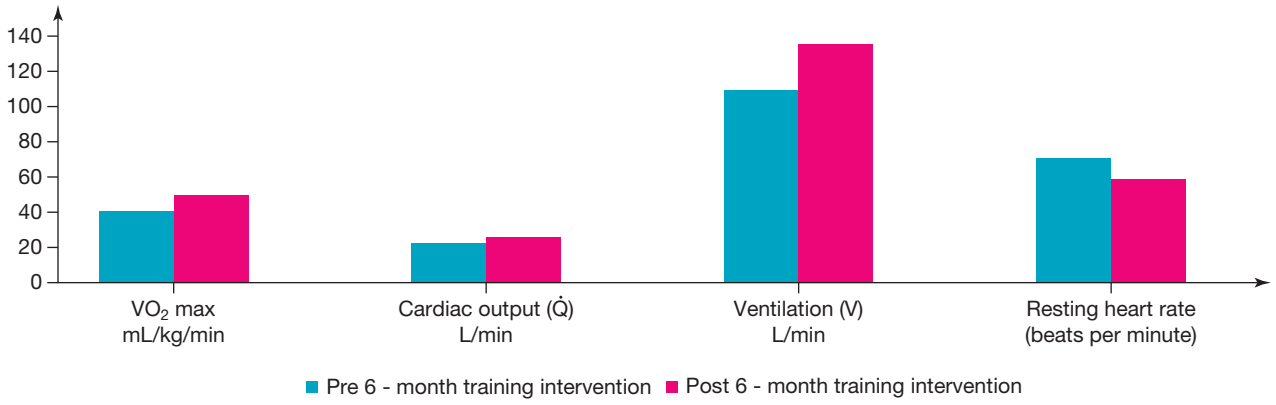
For someone who is relatively inactive, it will typically take 8–12 weeks to see improvements in cardiovascular and respiratory function. This is due to the complex physiological changes that occur within the body. Within the first few weeks of regular aerobic exercise, the body gradually adjusts to the consistent exercise stimulus. This induces cardiovascular adaptations, such as an expansion of the capillary network, improved circulation and increased mitochondrial density.

Simultaneously, a steady increase in **pulmonary diffusion** and lung volume contributes to the overall enhanced functioning of cardiovascular and respiratory systems. When both systems work optimally together, an improvement in **maximum oxygen uptake (VO_2 max)** will be observed. This enhanced capacity to take in and use oxygen results in increased energy production, meaning you can carry out aerobic exercise for a longer duration or with greater ease.

pulmonary diffusion the movement of oxygen and carbon dioxide from a high concentration to a low concentration between the alveoli and the surrounding capillaries

maximum oxygen uptake (VO_2 max) the maximum amount of oxygen per minute that can be taken in, transported and used by the body for energy production

FIGURE 6.4 Changes in physiological variables following a hypothetical 6-month endurance-training program in a previously sedentary man



doc-41939

PRACTICAL ACTIVITY Changes to cardiorespiratory function as a result of aerobic-based exercise

Source: Adapted from 2017 ACHPER SAMPLE SAC, Part B.

Goal

To undertake aerobic-based exercise and reflect on how regular participation in this form of exercise can improve cardiorespiratory function and capacity.

Instructions

- Form groups of two (one participant and one recorder). The participant will play an invasion game such as basketball, soccer or European handball for 10–15 minutes.
- The recorder will collect the participant's heart rate at rest prior to the game, then every 2 minutes. This can be measured either using a heart rate monitor or manually.
- The recorder will continue to gather heart rate data for 5 minutes post-game.

Primary data/Reflection

Create a table which will allow you to record heart rate data for the invasion game.

Questions

1. Construct a heart rate graph to demonstrate the changes that occurred to the heart rate during the activity undertaken.
2. Using your understanding of the cardiovascular system, outline two physiological responses that occurred to this system during the practical. You should refer to the primary data collected where possible.
3. Despite not collecting data on respiratory system functionality, infer two likely physiological responses that would have occurred in the practical.
4. Suggest how regular participation in this type of physical activity could improve cardiovascular and respiratory performance.

EXAM TIP

Keywords

When answering questions, the examiner wants to see you use subject-specific terminology. This will help you to focus your response and only answer what the question is asking of you.

For example, a question might ask, 'State a benefit of engaging in regular aerobic exercise'. Instead of answering 'your heart is more efficient at pumping blood', you could say 'your heart increases in size and strength, meaning your heart can contract more forcefully to allow more blood to be pumped around the body'.

6.2 Activity

6.2 Quick quiz on

6.2 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2	3, 4	5, 6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Outline** the physical benefits of participation in regular exercise in relation to the cardiorespiratory system.
2. **Outline** what the term *aerobic exercise* means.
3. How does an increase in stroke volume lead to an increase in athletic performance?
4. Referring to figure 6.3, choose one of the physiological variables analysed and **explain** why this change could have resulted after a 6-month endurance training program.

APPLY your understanding

5. Survey your classmates to find out which type of aerobic exercise is the most popular. Create an eye-catching and informative poster about the benefits of regular participation in this activity for the cardiovascular and respiratory systems.
6. Kayla, a 35-year-old office worker, has recently incorporated regular aerobic exercise into her routine. She has decided to start going for a 30-minute brisk walk in the morning before she starts work. After 12 weeks of consistent walking, she has noticed an improvement in the distance she can walk and in her overall energy levels. Using your knowledge of the impact that regular aerobic exercise has on the cardiovascular and respiratory systems, **analyse** Kayla's case. **Discuss** two specific physiological changes that may have occurred and **explain** how these adaptations have led to her reported outcomes.

6.2 Exam questions

Question 1 (1 mark)

Which of the following exercises would be considered an aerobic activity?

A. Shot-put
B. Weightlifting
C. 2000 m rowing race
D. Flipping in a gymnastics routine

Question 2 (3 marks)

Jacqui and Adrian are preparing to swim the 5-kilometre distance in the upcoming Danger Swim series in Torquay. Both have been training at the pool three times a week for the past 12 weeks. Adrian undertakes continuous training, swimming at a consistent pace for up to one hour. Jacqui undertakes short-interval training doing 5 × 50-metre sprints in the pool with a long rest in between each sprint.

Which person is likely to perform better in the 5-kilometre swim? **Justify** your answer.

Question 3 (2 marks)

A physiological adaptation that occurs from participation in regular aerobic physical activities is cardiac hypertrophy. **Outline** what occurs in this adaptation and how this is beneficial.

More exam questions are available in your learnON title.

6.3 Enhancing the performance of the cardiorespiratory system: permitted substances and methods

Key knowledge	Key skill
• potential benefits and harms of permitted and prohibited substances and methods that enhance performance of the cardiorespiratory system, such as altitude training, erythropoietin (EPO), beta-blockers, gene and blood doping	• investigate and evaluate a range of performance enhancing substances and methods on the cardiorespiratory system from a physiological perspective

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

6.3.1 Enhancing cardiovascular and respiratory performance

As previously discussed, the cardiorespiratory system plays an important role in delivering oxygen to muscles to create energy for movement. The respiratory system brings air from the atmosphere into the lungs and transfers oxygen into the blood, while the cardiovascular system transports the oxygen around the body to the working muscles. The cardiorespiratory system primarily contributes to aerobic energy production.

Athletes and coaches can use a variety of training methods to enhance performance of the cardiorespiratory system. Training methods that can specifically enhance this system include:

- **aerobic training** methods such as continuous training, fartlek, long-interval or high-intensity interval training to develop endurance
- **altitude training** to increase the production of red blood cells to allow for greater oxygen-carrying capacity.

aerobic training training that specifically targets the aerobic energy system and refers to a type of repetitive, rhythmical movement

altitude training involves training at levels greater than 1500 metres above sea level to induce physiological changes that enhance the oxygen-carrying capacity of the blood

Through specific training, a number of chronic cardiovascular and respiratory adaptations occur to enhance an athlete's performance. These are outlined in table 6.1.

TABLE 6.1 Chronic cardiorespiratory adaptations of aerobic training

Chronic adaptation	Benefit to performance
Cardiovascular: • Increased left ventricle size and volume • Increased stroke volume • Decreased heart rate at rest and submaximal workloads • Increased cardiac output during maximal exercise • Increased arteriovenous difference (a-VO_2 diff) • Increased blood and plasma volume • Increased red blood cell and haemoglobin levels	**Increased endurance and VO_2 max via:** • Increased blood flow and delivery of oxygen to working muscles • Increased oxygen-carrying capacity and waste removal • Increased diffusion from bloodstream into muscle resulting in greater uptake of oxygen by muscle to produce energy
Respiratory: • Increased pulmonary diffusion • Increased lung ventilation during maximal exercise • Increased maximum oxygen uptake (VO_2 max)	• Increased oxygen available for diffusion • Increased diffusion from alveoli into bloodstream
Potential harms	
Risk of potential injury due to: • Lack of adequate fitness • Incorrect application of training principles • Not enough recovery • Incorrect technique • Overtraining	

6.3.2 Aerobic training methods

Aerobic training methods can include continuous, **fartlek** and **high intensity interval training (HIIT)** and **long-interval training** (see table 6.2). Each of these methods aims to improve the delivery of oxygen to working muscles as well as increase oxygen consumption (VO_2 max) for energy production. The performance benefits of a more efficient cardiorespiratory system mean that, during aerobic activity, athletes will not have to work as hard at the same intensity, or they will be able to work at a higher intensity for longer while still using the aerobic system and therefore delaying fatigue (see figure 6.5). An athlete can reach steady state faster, accumulate lactate more slowly and recover more quickly.

FIGURE 6.5 Aerobic training improves the endurance of an athlete, allowing them to work for longer periods of time.

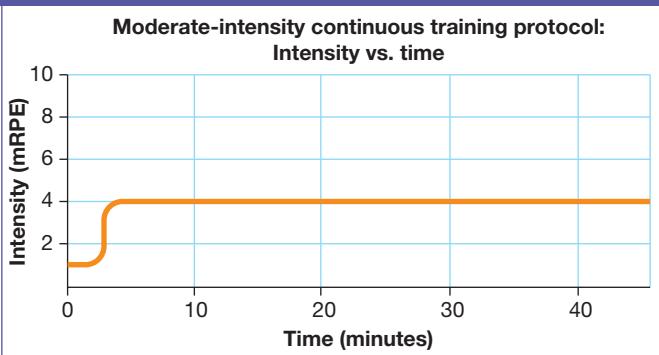
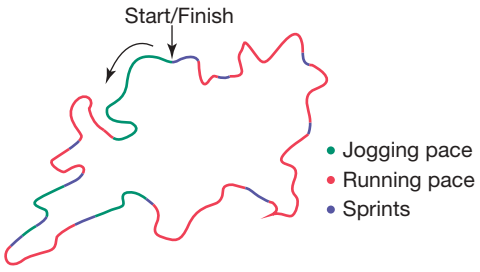
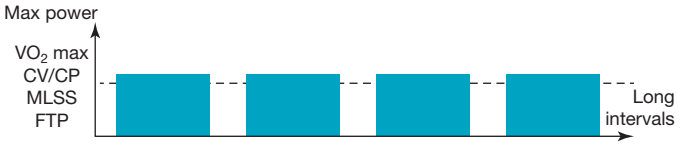
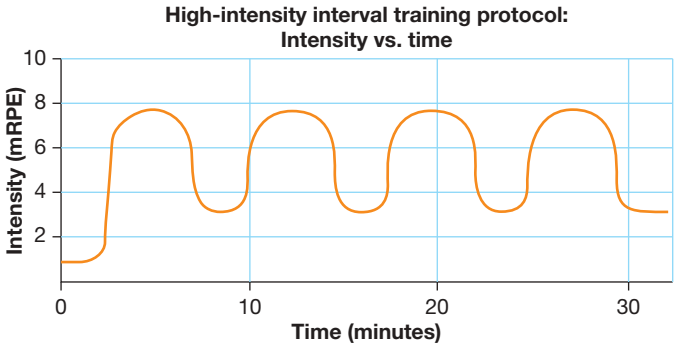
As with all training, there are potential harms associated with aerobic training. The athlete needs to develop a solid base relative to their level of fitness before working at higher intensities or increasing training distances. Overtraining or incorrect application of training principles, such as inadequate recovery between sessions, can increase the risk of injury.

fartlek training continuous training involving changes of intensity to work both the aerobic and anaerobic energy systems

high-intensity interval training (HIIT) training that involves repeated bouts of high intensity efforts followed by varying periods of complete rest or recovery at a lower intensity

long-interval training training that consists of intervals of work followed by equal intervals of rest or recovery to develop the aerobic energy system

TABLE 6.2 Aerobic training methods and their benefits

Training Method	Definition	Benefits of this training method	Graphical representation
Continuous	Non-stop, submaximal (70–85 per cent HR max) activity lasting longer than 20 minutes	Develops a sound aerobic base by improving aerobic power. Favoured by long-distance swimmers, runners and cyclists, but also as a pre-season training method for many team sports.	
Fartlek	Continuous training involving changes of intensity to work both the aerobic and anaerobic energy systems	Can simulate the interplay that occurs in many team and individual sports, such as Australian Rules football, basketball or trail running.	
Long interval	Consists of submaximal intensity intervals of work followed by equal intervals of rest or recovery to develop the aerobic energy system	Athletes can work at a higher intensity, closer to 85 per cent HR max, due to the longer rest period, generally involving an active recovery.	
HIIT	Involves repeated bouts of high-intensity efforts followed by varying periods of complete rest or recovery at a lower intensity	Athletes can gain similar cardiovascular adaptations to continuous training but in a shorter time frame and with less sessions.	

EXAM TIP

Connecting to the context

When you are presented with a scenario in an exam question, it is always important to acknowledge the context and include this in your response. This shows the examiner that you are able to apply your understanding.

Let's have a look at the example below:

Penny is training for a 21-kilometre half-marathon at the end of the year. Over the next three months she will complete an aerobic training program to prepare her for the event.

Explain how aerobic training can enhance her performance. (3 marks)

This question is worth 3 marks, so three pieces of information need to be included. A sample response is outlined below: **What** will aerobic training change in her body? How does this change impact performance?

Connect the answer back to the context of the question.

What?

Increased stroke volume

How?

Increases blood flow and delivery of oxygen to working muscles

Connect back

Penny reaches steady state earlier.

Put it together

Aerobic training can increase stroke volume, which increases blood flow and delivery of oxygen to working muscles. This will allow Penny to reach steady state earlier and therefore run with greater cardiorespiratory efficiency.

Altitude training

Altitude training is a **permitted** training method that involves training at levels greater than 1500 metres above sea level to induce physiological changes that enhance the oxygen-carrying capacity of the blood. The physiological adaptations that occur at altitude are thought to benefit performance at sea level. While this method is practised by a variety of athletes, research into the benefits for athletes performing at sea level is inconclusive.

permitted officially allowed
erythropoietin (EPO) a naturally occurring hormone secreted by the kidneys that stimulates the production of red blood cells. Can also be produced synthetically.
haemoglobin protein responsible for transporting oxygen in red blood cells

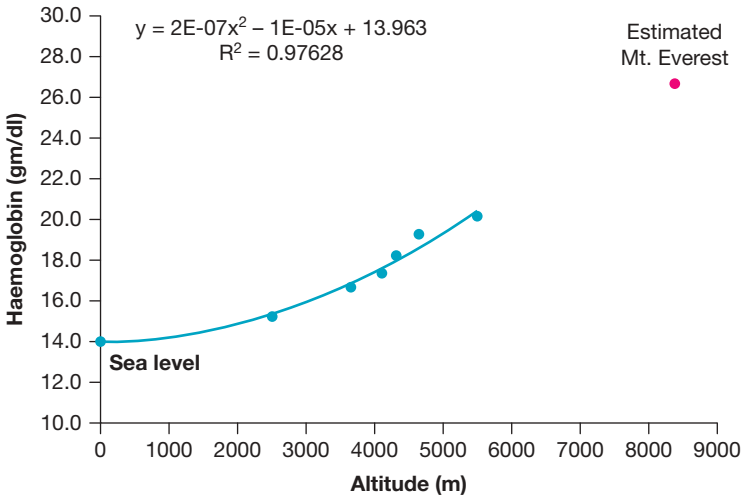
As there is a lower level of oxygen present in the air at altitude, the body must adapt (acclimatise) to this reduced oxygen level. Table 6.3 highlights some of these physiological changes that occur due to acclimatisation through altitude training.

TABLE 6.3 Physiological changes that occur due to acclimatisation through altitude training

Increase in…	Leads to…
Number of capillaries	Greater distribution of blood, therefore more oxygen to the muscles
Production of naturally occurring **erythropoietin (EPO)**	Increased stimulation of red blood cell production
Production of red blood cells and **haemoglobin**	Greater capacity to carry oxygen and nutrients to muscles and organs
Mitochondria	Increased rate of aerobic energy production
Myoglobin	Increased volume of oxygen stored in muscles
Oxidative enzymes	Increased rate of aerobic energy production
Buffering capacity	Increased waste removal

These changes contribute to improvements in the oxygen-carrying capacity of the blood, increasing the delivery to and use of oxygen by the muscles. This benefits the performance of the athlete via improved maximal oxygen uptake (VO_2 max), thus enhancing their endurance capacity. Figure 6.6 shows the increases of haemoglobin in relation to altitude.

FIGURE 6.6 The increase in haemoglobin in relation to altitude



A variety of techniques have been developed for training at altitude. However, the 'live high – train low' technique is the most common and involves the athlete living in a low-oxygen environment and training in a normal oxygen environment.

Training can occur at actual altitude (greater than 1500 metres elevation). For example, in Victoria, Falls Creek village is situated at 1850 metres above sea level. Australian rules football (AFL) clubs, Olympians and the Victorian Institute of Sport athletics teams have used it to train at this during their pre-season.

Training can also occur in altitude or **hypoxic** chambers, which can be rooms, houses or tents. These are specifically designed spaces that simulate altitude. Athletes can train or sleep in these artificially induced low-oxygen environments. As training at altitude is often costly and inconvenient, organisations such as the Australian Institute of Sport (AIS) and many AFL clubs have their own simulated altitude rooms in their training facilities.

hypoxic means that a low level of oxygen is available

FIGURE 6.7 Athletes train at altitude or in altitude rooms in an attempt to increase the oxygen-carrying capacity of their blood.

These rooms are designed for a number of athletes and can be used for:

- preparation for competition at high altitude
- maintaining the benefits of altitude training camps
- using the 'live high – train low' training technique (athletes can sleep at simulated altitude).

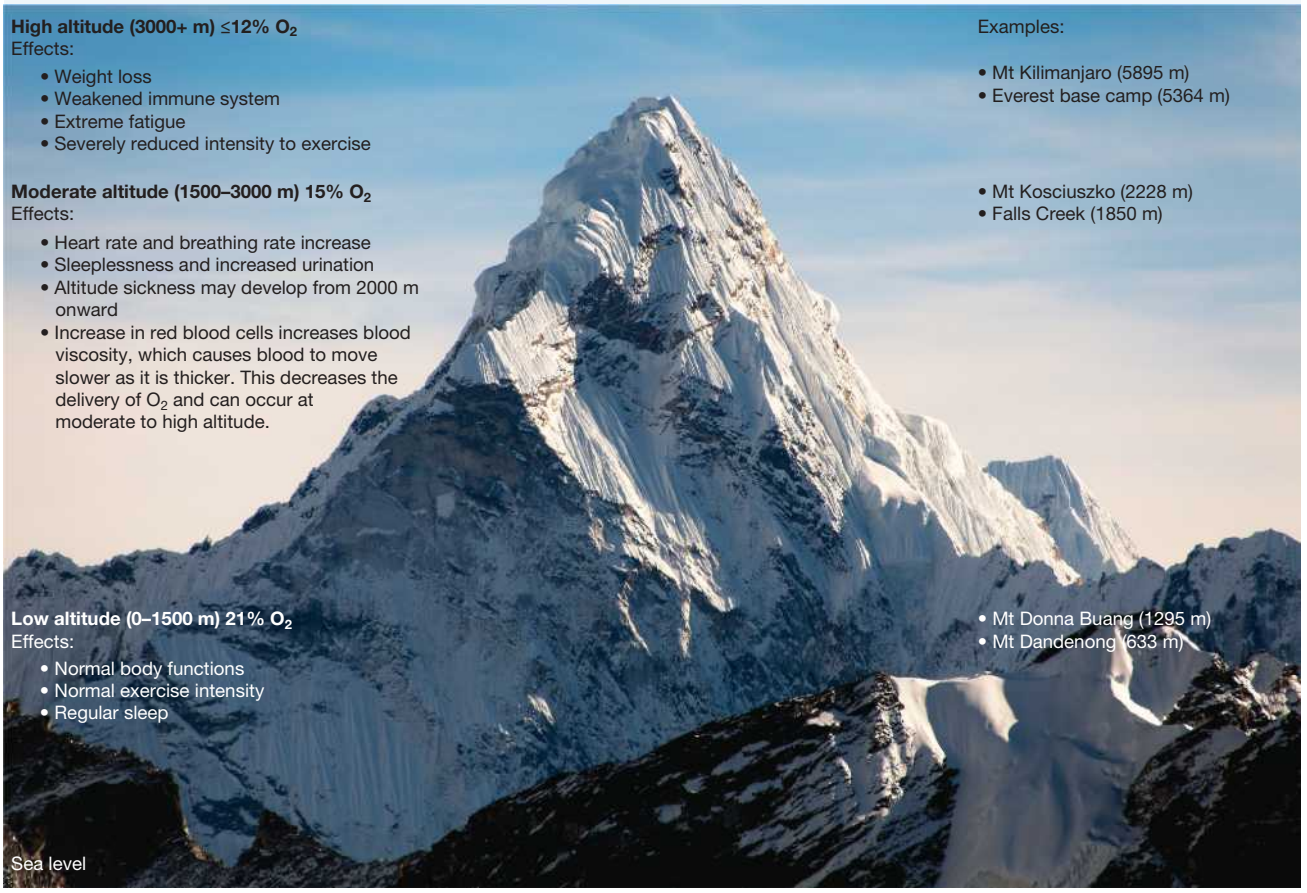
on Resources

Weblink Video on hypoxic chambers as SAIS

Impact of altitude on performance

While altitude training has many actual and perceived benefits, there are also potential harms from altitude exposure that an athlete must take into consideration. Figure 6.8 shows the effects of altitude on physical performance.

FIGURE 6.8 Effects of physical activity at altitude



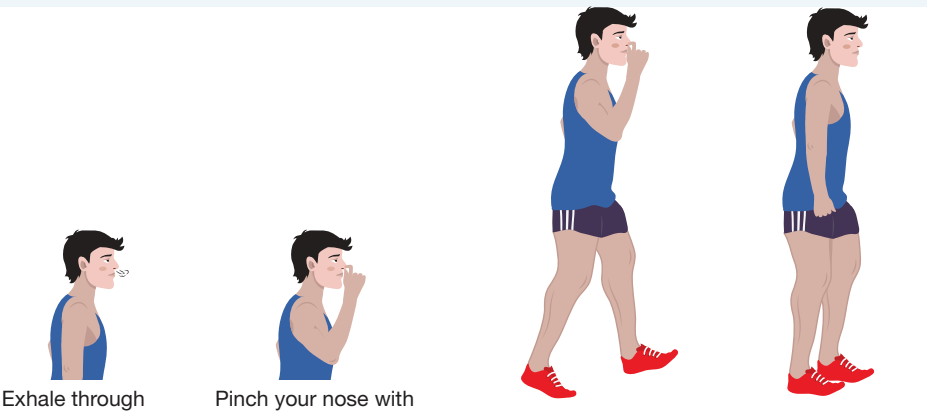
Simulated high-altitude training using breath holds

While hypoxic chambers are a great alternative to training at high altitude, for many of us access to these facilities is non-existent. An area gaining greater credibility is in the realm of breath work and its ability to improve aerobic performance.

In his book *The Oxygen Advantage*, Patrick McKeown explains how at sea level we can simulate the physiological effects of high-altitude training using breath-hold techniques. When we perform a breath hold after an exhalation it lowers the oxygen saturation of the blood. This stimulates the spleen to contract and release stores of red blood cells.

This then increases the concentration of haemoglobin, allowing for greater delivery of oxygen to the working muscles during exercise. After practising this technique, individuals have experienced being able to lower their oxygen saturation levels to less than 94 per cent, which is similar to the effects of living at an altitude of 2500 to 4000 metres.

FIGURE 6.9 Preparation for simulated altitude training exercise



CONCEPT CONNECTOR

Form six small groups and assign each group a different altitude: 500 metres, 1000 metres, 1500 metres, 2000 metres, 2500 metres and 3000 metres above sea level.

Refer to figure 6.7 which shows various altitudes. In your group, research a sporting event, such as the Olympics that has occurred at that altitude. Find out what concerns (if any) could have arisen for these athletes.

Present your findings to the class.

doc-41940

PRACTICAL ACTIVITY Evaluating long-interval training

Goal

To evaluate the effectiveness of long-interval training as an aerobic training method to enhance cardiorespiratory function

Instructions

Participate in the following long-interval training session. You may wish to conduct this using a stationary bike or by running.

- Complete a 3-minute warm-up on the bike or jogging.
- Repeat the following four times: run/cycle at a steady pace for 3 minutes then rest for 3 minutes (1:1).
- During the work phase, aim to keep your heart rate between 70–85 per cent max HR. Refer to topic 5 to remember how to calculate this.
- Complete a 3-minute active recovery

Primary data/Reflection

You may choose to record the HR data during the work and rest phases of the training session. Once recorded this can then be graphed and compared to the graph in the table for long-interval training. Reflect on any differences or similarities.

Questions

1. State the impact regular long-interval training would have on the functioning of the cardiovascular and respiratory systems.
2. Draw a Venn diagram to compare and contrast long-interval training with continuous training.

Resources

Weblink Altitude training

6.3 Activity

6.3 Quick quiz on | **6.3 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2	3	4, 5

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. Which of the following is NOT a permitted training method to enhance cardiorespiratory performance?
   A. Continuous training **B.** Altitude training
   C. High intensity interval training **D.** Flexibility training
2. **Define** the term *altitude training*.
3. **Outline** two physiological changes that could occur to the cardiorespiratory system as a result of altitude training.

APPLY your understanding

4. **Outline** the performance benefits of having an efficient cardiorespiratory system for an endurance-based athlete.
5. Cedric Dubler is an Australian decathlete who competes in 10 events over two consecutive days. In the men's competition, day 1 consists of 100-metre sprint, long jump, shot-put, high jump and 400 metres, while day 2 comprises 110-metre hurdles, discus, pole vault, javelin and 1500 metres.
   Out of the 10 events, for which could Cedric use continuous training to enhance his performance? **Justify** your answer.

6.3 Exam questions

Question 1 (1 mark)

Altitude training involves training at levels greater than 1500 metres above sea level, where oxygen levels are:

A. the same as at sea level.
B. higher than at sea level.
C. lower than at sea level.
D. non-existent.

Question 2 (2 marks)

Outline the training method of high-intensity interval training (HIIT).

Question 3 (1 mark)

Continuous training that is interspersed with random changes in intensity or speed is known as what type of training?

More exam questions are available in your learnON title.

6.4 Enhancing the performance of the cardiorespiratory system: prohibited substances and methods

Key knowledge	Key skill
• potential benefits and harms of permitted and prohibited substances and methods that enhance performance of the cardiorespiratory system, such as altitude training, erythropoietin (EPO), beta-blockers, gene and blood doping	• investigate and evaluate a range of performance-enhancing substances and methods on the cardiorespiratory system from a physiological perspective

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

6.4.1 Enhancing athletic performance

Athletes are always looking to gain an edge over their opponents, whether that be to enhance their capacity to train, perform or recover. Along with permitted substances and methods that improve performance, there are also prohibited interventions.

Substances and methods that enhance the cardiorespiratory system differ from those explored in topic 3. These interventions related to the enhancement of the musculoskeletal system. The methods discussed in this lesson primarily involve the enhanced delivery of oxygen to the working muscles, improving and/or altering the function of the cardiorespiratory system.

Substances and methods that increase the amount of red blood cells in the body, such as erythropoietin (EPO), gene and blood doping, are prohibited at all times under the World Anti-Doping Agency (WADA) code (see table 6.4). The use of substances to manipulate the functioning of the cardiorespiratory system, such as beta blockers, are prohibited in certain sports where they offer a competitive advantage.

Famous doping cases involving these types of substances and methods have been linked to endurance sports, such as the now infamous case of Lance Armstrong who was stripped of seven Tour de France titles due to doping violations, or those sports requiring accuracy and precision, such as pistol shooting. North Korean athlete Kim Jong-Su returned a positive test to beta blockers at the 2008 Beijing Olympics and was stripped of both a silver and bronze medal for pistol shooting (see figure 6.10).

For most prohibited practices, there are safer legal alternatives that can produce similar results but are neither banned nor illegal.

FIGURE 6.10 Athletes banned from their sports for using performance-enhancing substances include **(a)** Lance Armstrong and **(b)** North Korean athlete Kim Jong-Su.

TABLE 6.4 Prohibited methods used to enhance performance of the cardiorespiratory system

WADA classification	Examples	Potential benefits	Potential harm (side-effects)	Permitted alternative	Common sports
S2: Peptide hormones	Erythropoietin (EPO)	**Increased endurance and VO_2 max via:** increased red blood cell production, and thus oxygen-carrying capacity to working muscles	• Increased viscosity (thickening) of blood • Blood clots • Increased risk of stroke and heart attack • Dehydration • Cardiac failure	• Aerobic training methods • Altitude training	Any endurance event (e.g. ultramarathon, long-distance road cycling)
M1: Manipulation of blood and blood components	Blood doping	**Increased endurance and VO_2 max via:** increased red blood cell mass, thus improved oxygen delivery to muscles	• Increased viscosity (thickening) of blood • Blood clots • Increased risk of stroke and heart attack • Dehydration • Cardiac failure	• Aerobic training methods • Altitude training	Any endurance event (e.g. ultramarathon, long-distance road cycling)
P2: Beta blockers	Lopressor Propranolol	• Accuracy and a steady hand via reduced heart rate, tension, body tremors • Helps stop the hands from shaking	• Lowered blood pressure • Decreased heart rate • Tiredness • Decreased capacity in endurance sports • Cardiac failure	Psychological methods (breathing, mental rehearsal) to reduce arousal, aid concentration and relaxation	Clay target shooting, archery, golf, darts

6.4.2 Erythropoietin (EPO)

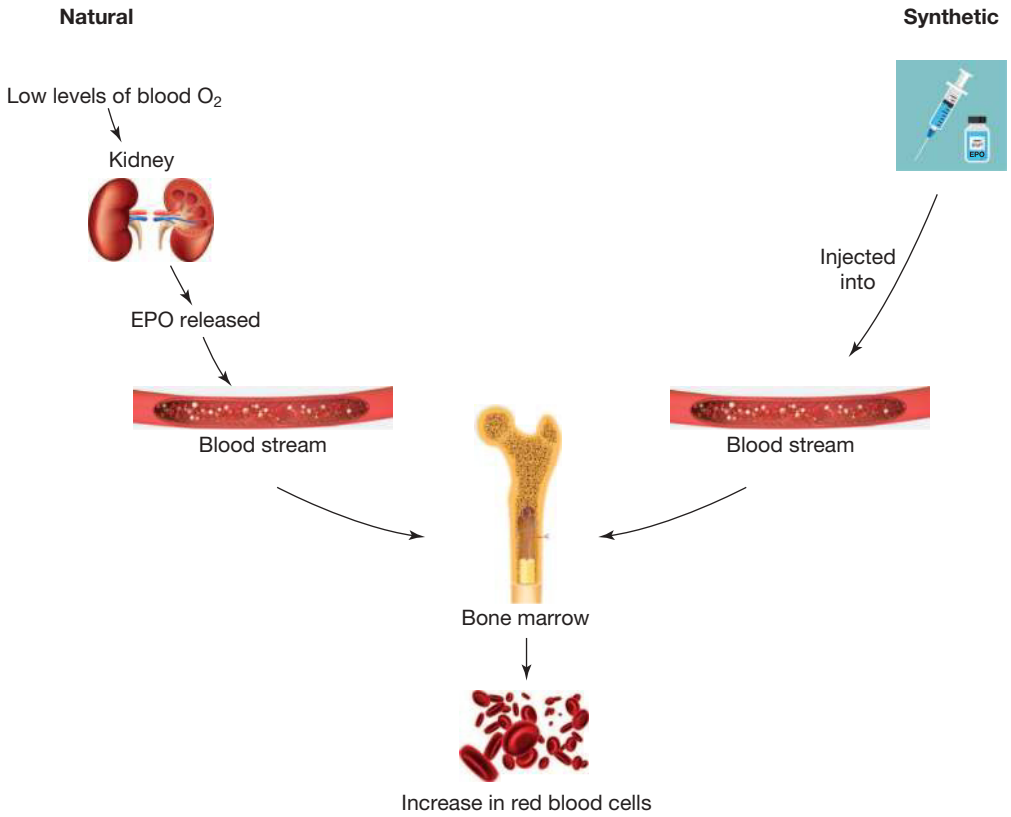
EPO is a naturally occurring hormone secreted by the kidneys. This hormone stimulates the production of red blood cells in bone marrow. A synthetic form of EPO also exists. This is used to treat people who have low levels of red blood cells as a result of anaemia or kidney disease. Endurance athletes may seek to use this synthetic version of EPO in order to gain an advantage over their competitors.

As the role of EPO is to stimulate an increase in red blood cell production (RBC), there is more haemoglobin available for oxygen to attach to, and be delivered to, working muscles. This increase results in better oxygen transportation and a higher rate of aerobic energy production. The performance benefit of EPO use is greater aerobic endurance and VO_2 max, as athletes can produce more energy aerobically at a higher level before relying on the anaerobic energy systems.

As the use of EPO increases the amount of red blood cells beyond normal level, it poses risks to the health of the athlete. Potential harms include increased viscosity (thickening) of the blood, blood clots, increased risk of heart attack and stroke, and dehydration. Synthetic EPO is administered by a series of injections over a period of time, so there is also the risk of infection and blood-borne disease if not administered correctly.

Permitted alternatives to the use of EPO (to increase the amount of red blood cells and their oxygen-carrying capacity) include aerobic or altitude training.

FIGURE 6.11 EPO: Natural production versus synthetic intervention



on Resources

Weblinks EPO and blood doping
Doping to win

6.4.3 Beta blockers

Beta blockers are medical drugs that block adrenaline hormones from binding to receptors on nerves, thus reducing the effect these hormones have on the heart and blood vessels. They are prescribed legally for people who have medical conditions such as high blood pressure, angina and cardiac arrhythmias.

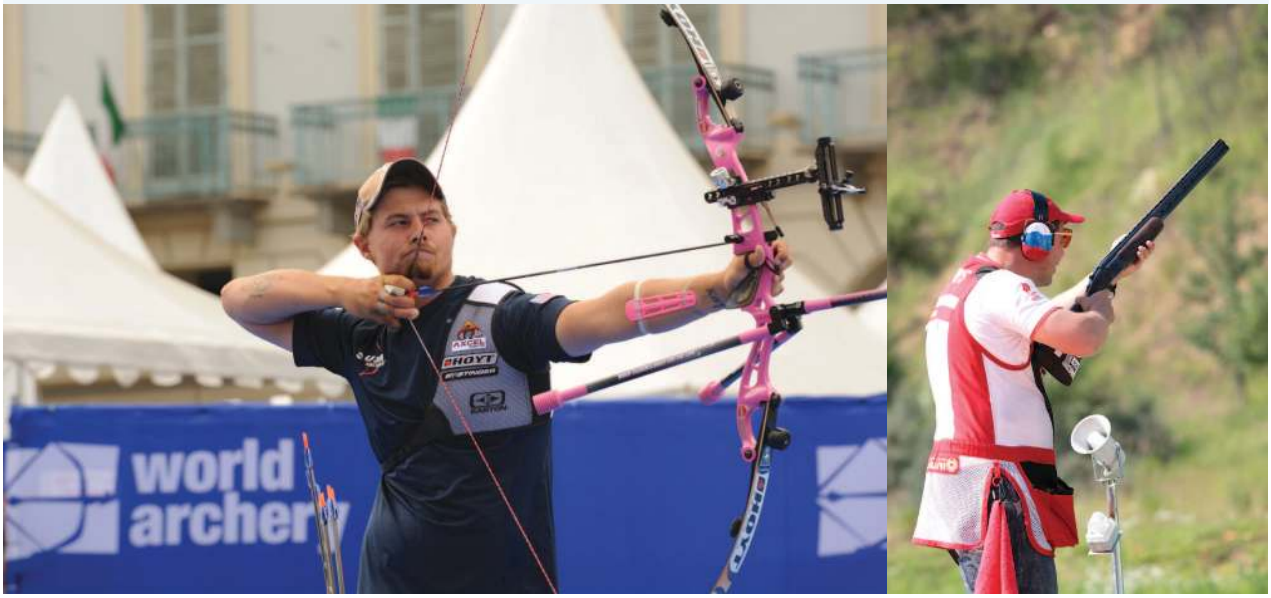
beta blockers drugs that block adrenaline hormones from binding to receptors on nerves, reducing the effect they have on the heart and blood vessels

WADA prohibits the use of these drugs in sports that require a great deal of precision and accuracy. Beta blockers can reduce pre-competition anxiety, lower the heart rate and reduce body tremors. This allows athletes in sports such as archery and shooting to fire arrows or shots between heartbeats with a steady hand.

Potential harms of using beta blockers include hypotension (low blood pressure), decreased heart rate, hypoglycaemia, cardiac failure, tiredness and decreased capacity in endurance sports.

A permitted alternative to the use of beta blockers to manipulate the functioning of the cardiorespiratory system is the use of psychological methods such as breathing techniques and mental rehearsal to reduce arousal and aid concentration and relaxation.

FIGURE 6.12 The sports of archery and shooting ban the use of beta blockers at all times.



CONCEPT CONNECTOR

Write the phrase 'gene doping' on the whiteboard. As a class, brainstorm what you think this is. You may already know if you have studied Biology.

Next, access the **Gene editing and the future of doping in sport** weblink in the Resources panel.

Return to your brainstorm on the whiteboard.

Remove: words/terms that do not align with gene doping

Add: any benefits and harms that were not already on your list

Ask: now develop 1–2 questions you have about gene doping.

6.4.4 Gene doping

Technological advancements are rapidly transforming various fields, and sport is no exception. The emergence of genetic manipulation tools and techniques has revolutionised biomedicine, leading to targeted therapies to treat diseases such as cystic fibrosis and anaemia. In recent years, this technology has attracted the attention of sporting bodies concerned that athletes may abuse these biotechnological tools to enhance their performance, by way of **gene doping**.

Gene doping involves using substances or techniques to manipulate cells or genes to improve athletic performance. It is emerging as a major threat to the integrity of sporting competitions due to the irreversible and potentially undetectable nature of this method. Despite there being no reported cases of gene doping, WADA has prohibited its use since 2003. WADA classifies gene and cell doping as: 'the use of **nucleic acids** or **nucleic acid analogues** that may alter genome sequences and/or alter gene expression by any mechanism. This includes but is not limited to gene editing, gene silencing and gene transfer technologies' and 'the use of normal or genetically modified cells'.

gene doping the use of substances or techniques to manipulate cells or genes to improve athletic performance

nucleic acids nucleotides that are the building blocks of DNA

nucleic acid analogues compounds that are structurally similar to naturally occurring DNA

In 2004, Thomas Springstein, a German athletics coach, was arrested on suspicion of attempting to develop Repoxygen, an experimental gene therapy drug originally developed to treat anaemia. This product consisted of a segment of **deoxyribonucleic acid (DNA)**, which was designed to stimulate the synthesis of EPO. It is likely that Springstein hoped that when this segment of DNA was integrated into the cells' own DNA, it would instruct the cells to create more EPO. Consequently, this would increase red blood cell numbers, which would result in greater oxygen-carrying capacity and therefore aerobic power for his athletes. Repoxygen has not been tested on humans and has not been developed any further since.

deoxyribonucleic acid (DNA) molecule that carries genetic information for the development and functioning of an organism

CRISPR-Cas9 a gene editing tool that allows scientists to selectively modify the DNA of living organisms. It makes it possible to switch genes on and off and correct errors in the genome.

More recently, the development of the gene editing tool **CRISPR-Cas9** has given scientists the ability to tweak DNA sequences and alter their functions. This process involves creating a 'new' genetic sequence and attaching it to a protein called Cas9. Cas9 can scan the DNA and then, like a pair of scissors, cut the DNA at its target and introduce the new sequence. This technique gained much attention when its developers were awarded the 2020 Nobel Prize in Chemistry. While it has the capacity to address genetic disorders and advance medical treatments, in the realm of sport it could enable athletes to manipulate their genetic make-up to improve their endurance, speed and strength.

FIGURE 6.13 Athletes risk a four-year ban if found guilty of gene doping.

Gene doping is still highly experimental and, unlike the other prohibited substances and methods discussed in this topic, it is extremely difficult to detect. The proteins created in the body from gene doping compared with what occurs naturally can be very similar, if not identical. This is what makes it appealing to would-be dopers.

However, WADA aims to stay one step ahead, deterring athletes from gene doping by means of a four-year ban if found guilty; the possibility of sequencing athletes' entire genomes to establish genetic baseline profiles; and PCR testing. The health risks associated with gene doping are largely unknown, which raises the question — who is willing to play the role of 'human guinea pig' in pursuit of sporting glory?

CONCEPT CONNECTOR

Access the **Anti-Doping Fundamentals Course** weblink in the Resources panel. Create an account with Sport Integrity Australia and complete the Anti-Doping Fundamentals Course.

Check out the other courses that are available, such as Clean Sport 101.

on Resources

Interactivity Illegal methods used to enhance the performance of the cardiorespiratory system (int-6649)

Weblinks Gene editing and the future of doping in sport
Anti-Doping Fundamentals Course

6.4.5 Blood doping

Blood doping is the process of infusing extra human blood (red blood cells) into the body prior to performance. It can be an athlete's own blood or someone else's (as long as they are the same blood type) (see figure 6.14). If using their own blood, the athlete will remove some blood, then concentrate, freeze and store the blood to be re-infused at a later date. In the meantime, the body replaces removed red blood cells with new red blood cells. WADA prohibits this method at all times.

FIGURE 6.14 Blood doping involves the removal and reinfusion of an athlete's blood to increase the red blood cell count.

As with EPO, the increased amount of red blood cells leads to improved oxygen delivery to the muscles via the increased amount of haemoglobin in the blood. This has the potential to increase endurance via enhancement of the VO_2 max and aerobic capacity of the athlete.

The potential harms associated with blood doping are similar to those of EPO and include increased viscosity (thickening) of the blood, blood clots, increased risk of heart attack and stroke, and dehydration. In addition to these risks, there is an associated risk with blood transfusions of infectious diseases or the blood becoming toxic due to incorrect storage.

Permitted alternatives that produce the same effect as blood doping, albeit not as fast, include aerobic and/or altitude training.

blood doping the process of infusing extra human blood (red blood cells) into an athlete's body prior to performance

EXAM TIP

Just because the multiple-choice section appears at the beginning of the exam doesn't mean you have to answer it first. During reading time, high-performing students read all the questions and then choose the ones they feel most sure of to answer first.

This allows confidence levels to build and answers to flow, so that once you reach those trickier ones you are mentally prepared.

doc-41941

PRACTICAL ACTIVITY Accuracy and precision

Goal

To evaluate the impact pre-performance activities have on accuracy and precision when completing a task involving fine motor skills

Instructions

Participate in an activity that requires accuracy and precision, such as corn hole, archery, darts or golf putting.

Prior to completing the actual skill (e.g. shooting at the archery target) complete the following tasks in these two different scenarios.

(i) Sit down quietly for 1 minute visualising the task you are about to complete.

(ii) Engage in high-intensity exercise, such as sprinting, for 1 minute prior to completing the task.

- Take your heart rate immediately before executing your shot. Record your heart rate.
- Perform the skill.
- Record your result.

Primary data/Reflection

Collect heart rate and success rate data using the table below.

Skill being completed: _____

	Pre-skill execution heart rate (bpm)	Success (hit/miss)	Further comments (e.g. how you felt, whether the shot was a near miss)
i)			
ii)			

Questions

1. Discuss your heart rate in relation to the results you achieved.
2. Identify one permitted and one prohibited substance or method that an athlete might use to assist their performance in the activity you participated in.
3. Outline the benefits and harms an athlete needs to be aware of if using the prohibited substance or method identified in **part b.**

6.4 Activity

6.4 Quick quiz on

6.4 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 5	3, 6	4

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Outline** the performance benefits for each prohibited substance and methods that can be used to enhance the cardiorespiratory system.
2. **Explain** the term *enhancement of oxygen transfer*.
3. **List** an event or activity that would benefit from the use of beta blockers and explain how this would affect performance.
4. **Discuss** the similarities and differences in potential benefits and harms of EPO use and blood doping for an athlete.

APPLY your understanding

5. Using examples of prohibited substances that can enhance the performance of the cardiorespiratory system, **explain** why some substances and methods are banned all the time, but others are only prohibited in certain sports.
6. While the lure of gene doping has been widely reported, no athlete has tested positive to gene doping yet. WADA, however, has banned its use in sport. **Discuss** the concerns around the use of gene doping from a physiological perspective.

6.4 Exam questions

Question 1 (1 mark)

Blood doping usually involves the athlete removing a certain amount of their blood. Once removed, it is then:

A. stored and re-injected at a later date.
B. mixed with EPO and immediately re-injected.
C. dissolved and used as a powder for increasing performance.
D. thrown out to allow the body to replenish more white blood cells.

Question 2 (1 mark)

A side effect of injecting EPO is that the blood becomes more viscous (thick). **Identify** a potential risk to an athlete from injecting EPO.

Question 3 (3 marks)

Brenton is a hammer thrower training for the World Athletics Championships to be held in Japan. A fellow athlete suggested he should use EPO to enhance his performance in the lead up to the championships.

Disregarding the legal consequences associated with EPO usage, **justify** the accuracy of this guidance for a hammer thrower.

More exam questions are available in your learnON title.

6.5 Ethical and social considerations for using permitted and prohibited substances and methods

Key knowledge	Key skill
• ethical and sociocultural considerations associated with the use of permitted and prohibited performance-enhancing substances and methods	• explore the ethical and sociocultural considerations on the use of permitted and prohibited performance-enhancing substances and methods

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

6.5.1 Performance-enhancing substances

The use of performance-enhancing substances and methods in sport, whether they are permitted or prohibited, remains a hotly debated topic. Performance-enhancing practices have the potential for both positive and negative outcomes. They can bring physiological benefits as well as potential harms to the athlete.

The big question facing many athletes is whether to use performance-enhancement tools and, if they choose to do so, which ones will be of most benefit to them. As outlined in this topic and topic 3 there are a number of permitted and prohibited substances and methods available to improve the functioning of the musculoskeletal and cardiorespiratory systems.

The debate surrounding the use of both permitted and prohibited performance-enhancing substances and methods is not as simple as whether using them is right or wrong. Instead, it is a complex web involving ethical and sociocultural considerations that extend beyond the sporting field.

FIGURE 6.15 US sprinter Justin Gatlin tested positive for a testosterone-based substance and served a four-year ban before returning to athletics in 2010.

Ethics, in this context, refers to the moral principles that guide decision-making as well as questioning what is right or wrong in the pursuit of athletic excellence. The term **sociocultural** relates to how these choices and practices are influenced by societal and cultural norms. When we talk about athletes seeking that extra edge through performance-enhancing methods and substances, we're not just discussing rules and regulations. We are engaging in a conversation about fairness, values and the broader societal consequences of the choices athletes make in the relentless pursuit of success.

sociocultural relating to the social and cultural norms prevalent in society

6.5.2 Ethical considerations of performance-enhancing substances and methods

Ethical behaviour in sport requires fairness, integrity, responsibility and respect. This involves playing by the rules, demonstrating good sportsmanship and adhering to the relevant code of ethics. When the goal of sport generally is to win, the regulation of performance-enhancing substances and methods must be closely monitored; this allows for a fair and level playing field. Some substances and methods are considered ethical and permitted, while others are deemed unethical and prohibited by WADA and the Australian Sports Anti-Doping Agency (ASADA). Decisions regarding what is ethical and what is unethical can sometimes be a grey area.

There are many different opinions about whether a substance should be classified as prohibited or not. The International Olympic Committee (IOC) and many professional and amateur sporting organisations subscribe to the WADA Anti-Doping Code, which states that if a substance has the capacity to:

- enhance the performance of the athlete
- place the health of the athlete at risk, or
- violate the spirit of sport, it should be banned.

Supporters of the code believe that the use of any prohibited substance or method is wrong and amounts to cheating, as it provides an unfair advantage. Athletes who have been involved in the use of banned substances, such as anabolic steroids (to improve the functioning of the musculoskeletal system) or blood doping (to enhance the functioning of the cardiorespiratory system) have been stripped of their medals and banned from their chosen sport.

FIGURE 6.16 Pro-triathlete Collin Chartier tested positive for EPO in 2023 and admitted to using it. He is now serving a three-year ban from the sport.

The assumption that the use of EPO in endurance-based events is widespread has led to the suggestion that all athletes be permitted to use this substance at a medically safe, determined level. This would create a level playing field and reduce the risk of misuse and possible future deaths.

Ethicist Julian Savulescu argues that:

> We should allow doping within safe, measurable physiological parameters. For example, if an athlete's haematocrit is under, say, 50 per cent, we should not worry about whether she reached that level by altitude training, hypoxic tent use, genetic good luck, or EPO. We should focus resources on drugs which are unreasonably risky for athletes, or which are against the spirit of the individual sport (by which I mean they substantially remove the human component of a given sport). The doping we allow should be supervised by a medical professional, within prescribed safe ranges, and tested by independent accredited and monitored laboratories.

While most of the debate centres on the use of prohibited substances and methods, there are also ethical considerations regarding the use of permitted substances and methods. Access to specialised equipment, expert coaches and financial support for some but not others is inequitable. The practice of altitude training and use of altitude chambers involves significant costs. Athletes from less privileged backgrounds, or those who don't have the financial support of clubs or sporting organisations, may not have the resources to partake in this type of training. Is there a fair and level playing field for all athletes to begin with?

FIGURE 6.17 The Sydney Swans AFL team in their $260 000 altitude room at the SCG, which simulates low-oxygen environments. Facilities such as this one are not available to many athletes.

CONCEPT CONNECTOR

In pairs or small groups, discuss the following four questions. As a class, share your opinions.

1. Just because a substance or method is permitted, does that mean it's right to use it?
2. Should all permitted methods and substances be available or given to all athletes? What about junior athletes?
3. In Australia there are both drug-tested and non-tested powerlifting federations. Melbourne-born athlete Aron D'Souza intends to launch an Olympic-style 'Enhanced Games' with five sports categories: track and field, swimming, weightlifting, gymnastics and combat sports. There will be no drug testing. D'Souza argues that, as adults, athletes should have freedom over their own bodies. What are some ethical considerations regarding this proposal?
4. In 2015, two Flemington-based racehorse trainers faced charges for administering cobalt to horses, a substance known to elicit effects similar to EPO in humans. From an ethical standpoint, what concerns would arise regarding the use of cobalt in this context?

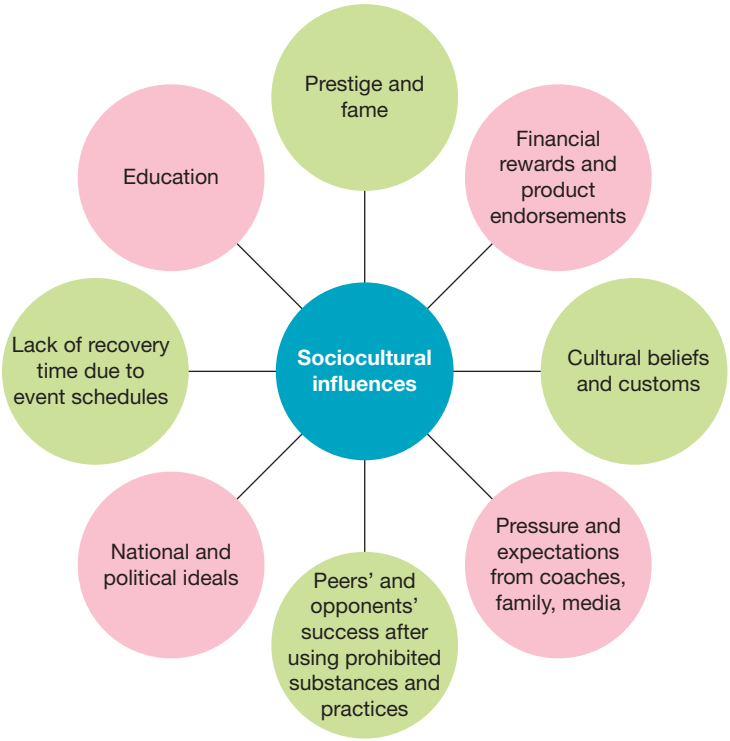
on Resources

Weblinks Julian Savulescu: Ethics and performance-enhancing drugs
Ethical Decision-Making in Sport mini-course

6.5.3 Sociocultural influences on the use of performance-enhancing substances and methods

While improved sporting performance is one of the most commonly cited reasons for an athlete using a performance-enhancing substance or method, there are other factors that influence an athlete's decision-making. Sociocultural influences arise from the power structures and relationships within society. This creates shared ways of thinking and doing. Some of the sociocultural influences that relate to sport are highlighted in figure 6.18.

FIGURE 6.18 Examples of sociocultural influences on the use of performance-enhancing methods and substances



All athletes strive to achieve their best, but the pressure placed on athletes to succeed may greatly influence the decisions they make about the most effective way to achieve those goals. In 2023, after testing positive for EPO, American pro-triathlete Collin Chartier posted the following statement on Instagram: 'In the moment I was injured and sick and felt like I had to do this if I was going to have the success I wanted to in 2024.' He said there were 'feelings of intense pressure and expectations to win the biggest races in 2024'. Although Chartier competes as an individual athlete, he belongs to a larger society that is capable of influencing behaviours and decisions, particularly concerning his athletic performance.

There have been many cases in history where athletes, clubs and even entire nations have used prohibited substances or methods to gain an advantage. A few examples are highlighted in the following section.

Tour de France's culture clash with doping

The 'culture of cycling' is a term often used to describe the long history of performance-enhancement use and misuse in this sport. The scandals around the alleged misuse of amphetamines during the 1960s, followed by blood doping and EPO from the late 1980s onwards have dogged the sport. As Chris Froome discovered during his success in the 2015 Tour de France, in which he was accused by the media of taking prohibited substances, trust in cyclists to compete without some form of prohibited enhancement has diminished. As a result, they are constantly questioned about the authenticity of their success (see figure 6.19).

FIGURE 6.19 2015 Tour de France winner Chris Froome was constantly questioned by the media about performance enhancement.

This public doubt has arisen because of a number of doping scandals. The highest profile was Lance Armstrong's admission to a variety of doping offences during his time as a professional cyclist. The fallout of this investigation involved a number of cyclists admitting to using performance-enhancing substances, particularly EPO.

The pressure of team expectations and the knowledge and/or belief that others were using prohibited substances have often been cited as major influences on their decisions. In a gruelling event such as the Tour de France, it is conceivable that athletes would agree to almost anything to give them a competitive advantage and a chance to wear the yellow jersey.

Essendon Football Club supplements saga

The Essendon Football Club supplements saga has highlighted the strong influence a coach, their support personnel and the sporting organisation can have on athletes (see figure 6.20).

FIGURE 6.20 James Hird, former coach of Essendon Football Club, received a 12-month suspension for his role in prohibited drug use by players under his leadership.

Thirty-four players received WADA bans for alleged use of the performance-enhancing substance thymosin beta 4 — a banned peptide that can enhance healing via production of new cells. The introduction of this drug, along with other supplements in 2012, was part of a program to assist the football club to gain an edge over other teams and bring them closer to a premiership. The players were told by the club that the supplements were legal and there was no risk of infringing the WADA Anti-Doping Code. The blind faith and, possibly misplaced, trust of the players highlights the pressure that an athlete can face, especially in a team sport, to win at all costs.

Russia's ban from the world stage

At the end of 2015, the Russian athletics team made headlines around the world. The medals won by Russian athletes at the 2012 London Olympics and the methods by which they were able to achieve their success were questioned. A number of endurance athletes, particularly those competing in the 20-kilometre and 50-kilometre walk races, had returned samples with elevated haemoglobin values, suggesting the use of EPO or blood doping prior to the Olympics. However, they were still allowed to compete (see figure 6.21). A WADA investigation into both the Russian Athletics Federation and the International Amateur Athletic Federation (IAAF) suggested there was a culture of 'state-sanctioned doping', where athletes were given banned substances and authorities turned a blind eye.

Life bans were given to particular individual athletes, and Russia's athletics team was banned from the 2016 Rio Olympic Games. The IOC further punished Russia through a ban on all athletes competing under its colours at the Pyeongchang Winter Olympics in 2018, the Tokyo 2020/2021 Summer Olympics and the 2022 Beijing Winter Olympics, along with all major international sporting competitions. Athletes not involved in the Russian doping scandal were permitted to participate in these Olympic Games as unaffiliated athletes of the Russian Olympic Committee (ROC). If an ROC athlete secured a medal, they were restricted from displaying the Russian flag or playing Russia's national anthem.

With such pressure as this, it raises the following questions: Did these athletes have an opportunity to *not* use prohibited performance-enhancing substances? Or was it an expectation that, as part of the Russian team, they would do whatever it took to be successful?

FIGURE 6.21 Russian race walk athletes were implicated in the 'state-sanctioned doping'.

FIGURE 6.22 Russian athletes compete as 'neutrals' under the ROC due to the WADA ban on Russia.

on Resources

Weblink Swans' altitude room

EXAM TIP

When answering questions, be sure to check the number of marks allocated. The number of marks indicates not only the amount of detail required but also how much time you should spend on the question.

For example, if a question is worth 1 mark, the examiner is looking for one piece of information. Generally, the questions worth the most marks will require more detail. Get a stopwatch ready and test this out with questions in Activity 6.5

doc-41942

PRACTICAL ACTIVITY Prohibited performance-enhancing substances

Goal

To explore attitudes towards the use of prohibited performance-enhancing substances and methods in sport

Instructions

1. Create a three-question survey that explores attitudes towards the use of performance-enhancing substances and methods and their use in sport.
2. Conduct the survey with at least 20 different people within the school, aiming to get a balance of genders.
3. Collate your findings and present these in a visual manner (e.g. graph, table, diagram).

Primary data/Reflection

- The data collected should be easy to interpret. Consider using a Likert scale (strongly agree, agree, neither agree nor disagree, disagree, strongly disagree) or questions requiring one of two answers — for example, a simple 'yes' or 'no' response.
- Once all data has been collected, analyse the results and write a short paragraph on any patterns or trends that you discovered in the data.

Questions

1. How did the overall results align with your attitudes toward the use of prohibited performance-enhancing substances and methods?
2. Is there anything that surprised you about the results? If so, what?
3. Was there a difference between the results gathered from different genders? If so, why?
4. If you were to conduct this survey again, which question/s would you change or which question would you add in?

6.5 Activity

6.5 Quick quiz on

6.5 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2	3, 4	5, 6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. Sociocultural influences enable performers to turn to the use of illegal performance-enhancing substances. Select the most correct answer when it comes to these influences.
   - **A.** Drug culture
   - **B.** The demanding qualifying standards required to make selection at a national level
   - **C.** A and B
   - **D.** Psychological dependence

2. **State** two reasons why WADA may ban a substance for use in sport.
3. The 'culture of a sport' is often cited as a reason for accepting or dismissing the behaviours that may occur within it. **Discuss** the sociocultural influences that may be present within the culture of a sport that would result in an athlete using performance-enhancing substances and methods.
4. Explain the phrase 'state-sanctioned doping'. **Discuss** how this may influence an athlete in relation to performance enhancement.

APPLY your understanding

5. Using the **Swans' altitude room** weblink in the Resources panel, read the article and answer the following questions.
   a. **Outline** the advantage to an athlete or team of having unlimited access to an altitude room, as the Sydney Swans football team does.
   b. Access and equity are cited as factors that may have an impact on creating a level playing field for all athletes. **Discuss** this in relation to the use of permitted performance-enhancing methods such as altitude training.
6. Read the following case study and answer the questions that follow.
   Romanian Simona Halep, the Women's 2018 French Open and 2019 Wimbledon champion, has been suspended from tennis. This action follows a positive test for the prohibited blood-doping substance Roxadustat at the 2022 US Open. Roxadustat, while legitimately used to treat anaemia, is on the WADA banned list due to its ability to produce more of the hormone EPO.
   The former world number one is claiming her innocence, stating that a supplement she was taking had been contaminated; however, the levels of Roxadustat were too high to support this argument. Halep was then also found to have irregularities in her athlete's biological passport after the analysis of blood samples.
   Note: A biological passport monitors an athlete's blood indicators over a long period of time in order to identify abnormalities that could suggest doping.
   a. What ethical dilemma does Simona Halep's suspension from tennis present?
   b. **Explain** how societal pressures within the professional sports community could influence an athlete such as Simona Halep. Consider her status as a former world number one and Grand Slam champion.
   c. The average women's grand slam tennis match lasts for 1 hour and 40 minutes. One of the markers measured in an athlete's biological passport is their haematocrit levels. These indicate the concentration of red blood cells in the blood.
   Suggest a permitted performance-enhancing method or substance that could be used to elevate an athlete's haematocrit levels.

6.5 Exam questions

Question 1 (1 mark)

Which of the following factors is most likely to deter an athlete from using or taking a prohibited performance-enhancing substance?

A. Increased prize money
B. Reduced frequency of testing
C. Fewer accredited coaches appointed to professional athletes
D. Better education for athletes on the risks associated

Question 2 (1 mark)

Identify a sociocultural influence on an athlete that may lead to them using a prohibited substance.

Question 3 (2 marks)

Cyclists, in particular riders in the Tour de France, have frequently been accused of and often found guilty of using EPO to improve performance.

Discuss how the sociocultural influences of income and prize money could lead to a cyclist deciding to use this prohibited method.

More exam questions are available in your learnON title.

6.6 Key skills

Key skills

- evaluate the impact of regular aerobic exercise on enhancing the capacity and functioning of the cardiovascular and respiratory systems
- investigate and evaluate a range of performance-enhancing substances and methods on the cardiorespiratory system from a physiological perspective
- explore the ethical and sociocultural considerations on the use of permitted and prohibited performance-enhancing substances and methods

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

6.6.1 Tell me

To address these key skills, it is important to remember the following:

- regular aerobic exercise can enhance the performance of the cardiovascular and respiratory systems' ability to take in and use oxygen
- understand the potential benefits and harms of a range of permitted and prohibited strategies that can be used by an athlete to enhance the capacity and functioning of the cardiorespiratory system
- physiological refers to changes that occur within the body, specifically to the cardiovascular or respiratory system
- performance enhancement relates to improvements in the functioning of the cardiorespiratory system
- ensure that you provide a clear link between the cardiorespiratory physiological adaptation and how it can enhance performance
- there are a range of ethical and sociocultural influences on an athlete when making the choice to use or not use performance-enhancing substances and methods.

6.6.2 Show me

Practice question (5 marks)

KEY

- **green** identify the action word
- blue key concepts
- *purple* key terminology
- light orange marks/marking scheme

Source: *ACHPER 2023, Trial Exam Unit 1, Section B, Q13*; © ACHPER

Blood doping is a prohibited practice which has been commonly used by cyclists competing in endurance cycling events.

a. **Outline** how blood doping is used as a *prohibited performance-enhancing substance* and **explain** how it could improve the efficiency of the *cardiorespiratory system*. (2 marks)

b. **Identify** *one permitted training method* and **outline** how it could be used to enhance the performance of the cardiorespiratory system. (3 marks)

Decode the question

Strategies to decode the question.

- **Identify the action words:**
  Outline — general description, but not in detail
  Explain — to make the meaning of something clear and understandable
  Identify — determine the key characteristics or features

- **Key terminology** — *prohibited performance-enhancing substance*, *cardiorespiratory system*, *permitted training method*
- **Key concepts** — blood doping, cardiorespiratory system
- **Marking scheme** — 5 marks — always check the marking scheme for depth of response required, linking to key information highlighted in the question.

Sample response and marking scheme

a. Blood doping involves a *blood transfusion* whereby the athlete injects blood, or components of blood, to increase the concentration of red blood cells to *increase haemoglobin levels* and the *oxygen carrying capacity* of the blood. The increased amount of red blood cells leads to improved oxygen delivery to the muscles, enhancing the aerobic capacity of the cyclist.
Award 1 mark for outlining how blood doping is used as a performance-enhancing substance.
Award 1 mark for explaining how blood doping enhances the efficiency of the cardiorespiratory system.

b. A cyclist could incorporate continuous training into their training to enhance performance. Continuous training can improve an athlete's *aerobic power* and the delivery of oxygen to working muscles. Increased *oxygen* delivery to working muscles allows the athlete to work at a higher intensity for longer using the *aerobic energy system*.
Other *permitted training methods* include:
- fartlek training
- long-interval training
- high-intensity interval training (HIIT).

Award 1 mark for identifying one permitted training method used to enhance the performance of the cardiorespiratory system.
Award 2 marks for outlining how the permitted performance-enhancing method is used to enhance the performance of the cardiorespiratory system.

6.6.3 Let me do it

Question 1 (10 marks)

Source: *ACHPER 20023, Trial Exam Unit 1, Section B, Q14*; © ACHPER

Any elite athlete who tests positive to EPO after failing an out-of-competition drugs test is given a suspension.

a. **Identify** and **explain** two sociocultural factors which may contribute to an athlete considering the use of a prohibited performance-enhancing method such EPO. **(4 marks)**

b. **Contrast** the potential benefits and the potential harms associated with an endurance athlete using EPO. **(4 marks)**

c. **Discuss** how training at high altitude may benefit an endurance athlete. **(2 marks)**

6.7 Review

Hey students! Now that it's time to revise this topic, go online to:

Review your results

Watch teacher-led videos

Practise exam questions

Find all this and MORE in jacPLUS

6.7.1 Summary

Impact of aerobic exercise on the cardiorespiratory system

- Performance benefits of a more efficient cardiorespiratory system include not having to work as hard at the same intensity during aerobic activity or being able to work at a higher intensity aerobically for longer, delaying fatigue.
- Aerobic exercise involves repetitive movements, such as walking or swimming, which increase the rate of oxygen delivery from the lungs to the blood. This allows for greater efficiency of the cardiorespiratory system.
- Long-term physiological changes to the cardiorespiratory system occur when exercise is done regularly, such as an increase in heart size and lung volume.

Permitted substances and methods

- Training methods to enhance the functioning of the cardiorespiratory system include aerobic training methods, such as continuous training, fartlek training, long-interval and high-intensity interval training, as well as altitude training.
- Altitude training is a permitted training method that induces physiological changes to enhance the oxygen-carrying capacity of the blood, thus increasing the delivery of oxygen to the muscles. This training can occur at actual altitude (greater than 1500 metres above sea level) or in specifically designed chambers or rooms that simulate altitude.

Prohibited substances and methods

- Prohibited methods used by athletes to enhance performance include EPO, blood doping, gene doping and beta blockers.
- EPO and blood doping increase the red blood cell count, creating more sites to carry oxygen, which results in better oxygen transportation and a higher rate of aerobic energy production.
- The use of beta blockers is prohibited in precision sports such as archery and shooting as they can increase the competitor's accuracy and steadiness, and reduce body tremors and pre-competition anxiety.
- Gene doping involves the use of substances or techniques to manipulate cells or genes, with the potential to improve athletic performance. This technology is rapidly transforming various fields.

Ethical and sociocultural influences

- There are a variety of reasons why athletes may feel the pressure to use performance-enhancing substances. Sociocultural influences on athletes' decision-making include income; education; family and peers; the influence of coaches and sporting organisations; cultural norms in society or the particular sporting culture; and national and political ideologies.
- When deciding if a substance or method is permitted from an ethical standpoint, it is important to uphold the integrity of the sport by keeping a fair and even playing field as well as prioritising the health of the athletes.

6.7.2 Key terms

aerobic exercise sustained physical effort which increases the rate that oxygen is inhaled and passed from the heart to the bloodstream
aerobic training training that specifically targets the aerobic energy system and refers to a type of repetitive, rhythmical movement
altitude training involves training at levels greater than 1500 metres above sea level to induce physiological changes that enhance the oxygen-carrying capacity of the blood
beta blockers drugs that block adrenaline hormones from binding to receptors on nerves, reducing the effect they have on the heart and blood vessels
blood doping the process of infusing extra human blood (red blood cells) into an athlete's body prior to performance
continuous training continuous, submaximal (70–85 per cent HR max) activity lasting longer than 20 minutes
CRISPR-Cas9 a gene editing tool that allows scientists to selectively modify the DNA of living organisms. It makes it possible to switch genes on and off and correct errors in the genome.
deoxyribonucleic acid (DNA) molecule that carries genetic information for the development and functioning of an organism
erythropoietin (EPO) a naturally occurring hormone secreted by the kidneys that stimulates the production of red blood cells. Can also be produced synthetically.
fartlek training continuous training involving changes of intensity to work both the aerobic and anaerobic energy systems
gene doping the use of substances or techniques to manipulate cells or genes to improve athletic performance
haemoglobin protein responsible for transporting oxygen in red blood cells
high-intensity interval training (HIIT) training that involves repeated bouts of high intensity efforts followed by varying periods of complete rest or recovery at a lower intensity
hypoxic means that a low level of oxygen is available
long-interval training training that consists of intervals of work followed by equal intervals of rest or recovery to develop the aerobic energy system
maximum oxygen uptake (VO_2 max) the maximum amount of oxygen per minute that can be taken in, transported and used by the body for energy production
nucleic acids nucleotides that are the building blocks of DNA
nucleic acid analogues compounds that are structurally similar to naturally occurring DNA
permitted officially allowed
physiological adaptations the physical changes of the body's cardiovascular, respiratory and muscular systems due to regular exercise, over a period of time
pulmonary diffusion the movement of oxygen and carbon dioxide from a high concentration to a low concentration between the alveoli and the surrounding capillaries
sociocultural relating to the social and cultural norms prevalent in society

6.7 Exam questions

6.7 Section A — Multiple choice questions

Question 1 (1 mark)

Training methods to best enhance the performance of the cardiorespiratory system include:

A. continuous training, resistance training, flexibility training.
B. continuous training, speed training, fartlek training.
C. continuous training, fartlek training, plyometrics.
D. continuous training, fartlek training, long-interval training.

Question 2 (1 mark)

Altitude training causes which of the following physiological adaptations to occur in the body?

A. Increased muscle mass
B. Increased blood plasma, red blood cells and white blood cells
C. Increased production of erythropoietin (EPO) and increased red blood cells
D. Decreased heart rate

Question 3 (1 mark)

There are many sociocultural factors that can influence an athlete's decision to use prohibited performance-enhancing substances. One of these could be:

A. the prestige and fame that comes with being the best in your chosen sport.
B. the availability of specialised sporting equipment.
C. having specific dietary requirements.
D. weather conditions.

Question 4 (1 mark)

Aerobic training is likely to result in which of the following chronic adaptations to improve performance of the cardiorespiratory system?

A. Increased left ventricle size, increased fast-twitch fibres, increased haemoglobin levels
B. Increased pulmonary diffusion, decreased heart rate during submaximal loads, increased stroke volume
C. Increased muscle mass, increased stroke volume, increased red blood cells
D. Increased haemoglobin, decreased maximal oxygen uptake, increased left ventricle size

Question 5 (1 mark)

A continuous training method that includes changes of intensity to work both the aerobic and anaerobic energy systems is called:

A. aerobic training.
B. long-interval training.
C. fartlek training.
D. flexibility training.

Question 6 (1 mark)

In recent years some endurance athletes have been found guilty of using the prohibited substance erythropoietin (EPO) to gain an edge over their competitors. A potential harm of using this drug is:

A. low blood pressure.
B. increased risk of blood clots.
C. male infertility.
D. decreased muscle mass.

Question 7 (1 mark)

Beta blockers have been used in sports that require precision and accuracy such as archery, shooting and golf. They are banned by WADA as they have the potential to:

A. reduce body tremors.
B. reduce perception of effort and fatigue.
C. increase focus and attention.
D. increase heart rate.

Question 8 (1 mark)

WADA has prohibited the use of a number of substances and methods by athletes, as they have the potential to:

A. artificially enhance the performance of an athlete.
B. be potentially harmful to the health of an athlete.
C. be contrary to the spirit of sport.
D. all of the above.

Question 9 (1 mark)

A perceived benefit and potential harm of blood doping is:

A. increased maximal oxygen uptake and decreased heart rate.
B. increased haemoglobin levels and decreased tremors.
C. increased endurance and increased infertility.
D. increased amount of red blood cells and increased risk of stroke.

Question 10 (1 mark)

Prohibited methods used to enhance the transfer of oxygen include:

A. EPO and beta blockers.
B. EPO and blood doping.
C. EPO and altitude training.
D. blood doping and beta blockers.

6.7 Section B — Short answer questions

Question 1 (6 marks)

Source: *ACHPER 2021, Trial Exam Unit 1, Section B, Q10*; © ACHPER

Kate and Frankie are coaches of an Under 14's soccer team. Recently in games, they notice their players have been getting tired during long runs, puffing lots when running and the players are often chased down by opposition players, resulting in a loss of possession. The players are able to complete short sprints when necessary and dodge players effectively. Kate and Frankie both agree they need to improve the fitness of their team but they can't decide on the appropriate type of training.

Kate thinks they should focus on anaerobic training to improve performance, whereas Frankie thinks they should focus on aerobic training.

a. Who is correct? **(1 mark)**
b. **Justify** your response to **part a**. **(3 marks)**
c. **Identify** two chronic adaptations which would occur through undertaking the training identified in **part a.** over 8 weeks **(2 marks)**

Question 2 (6 marks)

Source: *ACHPER 2022, Trial Exam Unit 1, Section B, Q14;* © ACHPER

A severe muscle strain can take several months to heal. An athlete may consider a weekly corticosteroid injection which is an anti-inflammatory drug used to relieve pain. These injections are prohibited during the competition period for an athlete according to WADA's 2022 Prohibited List.

a. Other than blood doping and EPO use, name a prohibited substance a weightlifter may choose to use and **identify** one perceived benefit and one potential harm of using this substance. **(4 marks)**

b. **Identify** two reasons an athlete may choose to use corticosteroids in competition despite them being prohibited. **(2 marks)**

Question 3 (4 marks)

Source: *ACHPER 2021, Trial Exam Unit 1, Section B, Q11;* © ACHPER

Tasha has been competing for many years at an international level in high jump. Over the past 3 years, her performance has plateaued, and she has had a number of serious injuries which have inhibited training load.

a. **Identify** and discuss a prohibited method or substance Tasha may consider using to enhance her performance in high jump **(3 marks)**

b. **Outline** an ethical consideration for Tasha regarding the use of illegal performance-enhancing methods or substances. **(1 mark)**

Continue to build your exam skills

Access the Unit 1 Area of Study 2 Review at the end of Topic 6. This includes:

- Practice extended response
- Practice examination
- Practice school-assessed coursework.

AREA OF STUDY 2 What role does the cardiorespiratory system play in movement?

OUTCOME 2

On completion of this unit, the student should be able to participate in and analyse information from a variety of practical activities to explain how the cardiovascular and respiratory systems function and interact, and evaluate the use of performance enhancement substances and methods.

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission

REVIEW CONTENT SEQUENCE

U1 AOS2 Extended response — Build your exam skills
U1 AOS2 Practice examination online only
U1 AOS2 Practice school-assessed coursework online only

U1 AOS2 Extended response — Build your exam skills

Tell me

To address these questions, it is important to remember:

- correct anatomical names for the structures and functions of the cardiorespiratory system.
- heart rate, stroke volume and cardiac output are interrelated and their contribution to exercise is dependent on the intensity of exercise.
- gaseous exchange involves the diffusion of oxygen and carbon dioxide, both at the alveoli–capillary interface and the capillary–muscle interface
- regular aerobic exercise enhances the functioning of the cardiovascular and respiratory systems
- there are potential benefits and perceived harms of a range of permitted and prohibited strategies that can be used by an athlete to enhance the functioning of the cardiorespiratory system
- physiological refers to changes that occur within the body, specifically to the cardiovascular or respiratory system
- performance enhancement relates to improvements in the functioning of the cardiorespiratory system
- provide a clear link between the cardiorespiratory physiological adaptation and how it can enhance performance

Show me

Practice question (8 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

According to professor of sports science, Dr Aughey, a 'live high, train low' program enables athletes to reap the benefits of high altitude living while training outside the simulated environment at their usual intensity. The Altitude Hotel simulates an altitude of up to 3500 metres and can be extended to higher altitudes. The experience lowers the oxygen levels from the normal 20.9% typically down to 15.5%. Using this technique, athletes live in the hotel for 12 to 14 hours a day for five to 10 days. At the same time, they maintain their standard training regime in Melbourne's low altitude setting of around 40 metres above sea level.

'Altitude training typically leads to performance improvements of one to two per cent. This sounds small but is quite a big change for an elite athlete,' says Dr Aughey. 'With the smallest worthwhile change in athletic performance 0.3 per cent, a change of one to two per cent is really good.'

Analyse how altitude training, utilising facilities like the Altitude Hotel, could *influence the interrelationship* between cardiac output, heart rate and stroke volume for a long-distance runner preparing for the 10 km event in the Olympic Games

Decode the question

Strategies to decode the question

- **Identify the action words:**
  Analyse — identify and draw out essential knowledge and explain how they connect
- **Key terminology**
  influence — have an effect on,
  interrelationship — the way in which different concepts are connected and affect each other
- **Key concepts**
  altitude training — being exposed to low-oxygen conditions to enhance oxygen utilisation and increase endurance capacity,
  cardiac output — the amount of blood exiting the left ventricle of the heart per minute,
  heart rate — the number of times the heart contracts per minute,
  stroke volume — the amount of blood exiting the left ventricle with each contraction,
- **Marking scheme** — 8 marks — always check the marking scheme for depth of response required, linking to key information highlighted in the question.

Sample response

The Altitude Hotel promotes the benefits of altitude training via 'live high, train low' strategy. Because the High Altitude Hotel reduces oxygen levels 'down to 15.5%', the *body's physiological responses* to low oxygen are triggered, specifically *improving the efficiency* of the cardiovascular system to promote an *increased* cardiac output, however there are potential side effects to this training method.

An *increased number of red blood cells* from the *elevated production of erythropoietin* and an *increased number of capillaries*, from altitude training at the Altitude Hotel, enhances the capacity for oxygen to be extracted and transported to the working muscles. This efficiency in oxygen delivery means that for each heart beat, a *greater volume* of oxygen-rich blood is pumped (stroke volume), enabling an individual to sustain higher exercise intensities aerobically in training for the 10 km race. This physiological adaptation allows for more efficient use of oxygen by the muscles, potentially reducing the need for the heart to increase its rate excessively to meet oxygen demands. Consequently, even though the heart rate may not significantly decrease, the *efficiency of each beat improves*, leading to a more effective and economic cardiac output ($Q = HR \times SV$), the total volume of blood pumped by the heart per minute. Enhanced by the increased stroke volume and optimised heart rate, the *increased capacity* to sustain a higher cardiac output directly contributes to *improved endurance and performance* (likely seen when 'training low'), enabling the athlete to *maintain or increase pace with less perceived effort*, and to the one to two percent change in performance in events like a 10 km run.

Although there are many *benefits* to altitude training there are some *potential harms*. One of them is an *increase in blood viscosity* as a result of the *increase in red blood cells*. This can mean blood isn't transported to the working muscles *efficiently*, which means that the body may increase heart rate and stroke volume to compensate for the lack of oxygen being delivered to the working muscles, and therefore increasing the cardiac output. However, due the *reduced speed of blood flow* the individual is less capable of maintaining a higher intensity, therefore needing to slow down (with the athlete likely working harder), *negatively impacting* their performance in 10 km run.

Marking guide

High range response	• Thorough analysis of altitude's impact on performance on a 10 km fun run, including limitations of the method • Demonstrates an extensive understanding of the physiological impacts of altitude training (minimum of three discussed) • Clear and accurate connection is made between physiological adaptations from altitude training and improvement in performance • Frequently uses correct terminology that is written in a sophisticated manner
Mid range response	• Incorporates multiple parts of the stimulus material into the response • A satisfactory analysis of altitude's impact on performance on a 10 km fun run (at least two impacts are discussed) • Connection between 10 km run, altitude training and Q = SV × HR is considered • Correct use of terminology in most parts
Low range response	• Makes reference to the stimulus material • Identifies a physiological response from altitude training • Identifies an altitude training impact on the relationships between Q = SV × HR • Response is difficult to follow • Limited use of terminology

Let me do it

Extended response question learn on

Question 1 (8 marks)

Brandon has been preparing to compete in the 220 km endurance cycling race, 'Around the Bay in a Day'. When Brandon competed in this event last year, he did minimal training and crossed the finish line after 10 hours and 14 minutes. This year he is hoping to beat his time by at least 30 minutes. With this goal in mind, he has been focusing on improving his cycling efficiency and fitness through training multiple times a week. To adequately condition his body for the distance and terrain, he incorporates a variety of aerobic-based training methods.

Analyse how regular aerobic exercise influences the interaction between Brandon's cardiovascular and respiratory systems, and discuss the type of training Brandon may be employing to lead to achieving his goal.

Hey students! Now that you have completed the Extended Response, access the following in learnON

Practice examination

Practice SAC

Receive immediate feedback

Find all this and MORE in jacPLUS

Hey teachers! Now access learnON to assign the quarantined school-assessed coursework

Assign the quarantined school-assessed coursework

Track your students' results

Identify strengths and weaknesses

Find all this and MORE in jacPLUS

UNIT 2

AREA OF STUDY 1

How do physical activity, sport and exercise contribute to healthy lifestyles?

OUTCOME 1

On completion of this unit, the student should be able to collect and analyse data related to individual and population levels of participation in physical activity and sedentary behaviour and conduct an FMA to create, undertake and evaluate a personalised plan that promotes adherence to the relevant physical activity and sedentary behaviour guidelines.

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

TOPIC SEQUENCE

7 Physical activity and sedentary behaviour: sociocultural influences, enablers and barriers ... 238

8 Strategies to increase physical activity and reduce sedentary behaviour ... 290

9 Promoting physical activity through a personalised plan ... 324

UNIT 2 AREA OF STUDY 1 REVIEW

Extended response — Build your exam skills ... 353

Practice examination ... online only

Practice school-assessed coursework ... online only

7 Physical activity and sedentary behaviour: sociocultural influences, enablers and barriers

7.1 Overview

Hey students! Bring these pages to life online

Watch videos

Engage with interactivities

Answer questions and check results

Find all this and MORE in jacPLUS

LEARNING SEQUENCE

7.1 Overview
7.2 Types of physical activity
7.3 Benefits of maintaining an active lifestyle
7.4 Sociocultural enablers and barriers to physical activity
7.5 Physical activity and sedentary behaviour guidelines
7.6 Prevalence and trends in physical activity, physical inactivity and sedentary behaviour
7.7 Methods of assessing physical activity and sedentary behaviour
7.8 Key skills
7.9 Review

7.1.1 Introduction

Physical activity isn't just about sports or structured exercise; it's about all the ways we move and the benefits of movement throughout our lives. In this topic, we'll uncover the diverse sociocultural influences on our physical activity choices, detail the recommended guidelines for both active and sedentary behaviours, for all age groups, and highlight the wide range of health benefits associated with movement.

Understanding and keeping track of our physical activity levels are key to ensuring we're staying active enough to maintain good health. Thanks to advancements in technology, monitoring our activity has never been easier. We'll guide you through the various innovative tools and methods available to track both your physical activity and sedentary habits, empowering you with the knowledge to stay engaged and healthy.

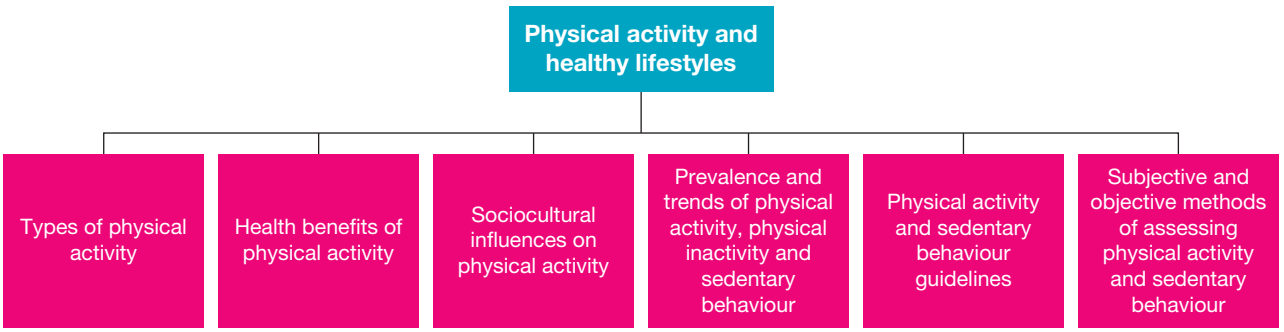
FIGURE 7.1 What determines whether you are physically active or sedentary? Is it possible to be both?

7.1.2 Key knowledge and Key skills

Key knowledge	Key skills	Subtopic
• types of physical activity such as play, games, sports (formal and informal), transportation, chores, exercise and recreational activities	• participate in and explain different types of movement experiences including a variety of culturally diverse and inclusive physical activities	**7.2**
• physical, social, mental, emotional and spiritual benefits of regular participation in types of movement	• participate in a variety of movement experiences to reflect on and record information related to the physical, social, mental, emotional and spiritual benefits of physical activity	**7.3**
• sociocultural enablers and barriers to individual physical activity behaviour, such as gender, family, peers, socioeconomic status, community and cultural norms	• investigate, through participation, the sociocultural influences on physical activity behaviour across the lifespan	**7.4**
• physical activity and sedentary behaviour guidelines for different age population groups	• describe the physical activity and sedentary behaviour guidelines for different age population groups	**7.5**
• prevalence and trends of physical activity, physical inactivity and sedentary behaviour	• analyse and interpret secondary data related to physical activity behaviour to explain outcomes of physical activity and sedentary behaviour	**7.6**
• subjective and objective methods of assessing physical activity and sedentary behaviour such as recall surveys or diaries, pedometry, observation tools, digital tools and wearable technology	• justify and use appropriate methods to measure and analyse physical activity and sedentary behaviour at the individual and population level	**7.7**

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

7.1.3 Topic preview



7.2 Types of physical activity

Key knowledge	Key skill
• types of physical activity such as play, games, sports (formal and informal), transportation, chores, exercise and recreational activities	• participate in and explain different types of movement experiences including a variety of culturally diverse and inclusive physical activities

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

7.2.1 Being physically active

There are many ways to move and expend energy and, therefore, many different ways to be physically active. Most **physical activities** can be categorised as one of the following forms: play, games, sports (formal and informal), transportation, exercise, chores and recreational activities. Table 7.1 summarises these different types of physical activity.

physical activity any movement of the body produced by skeletal muscles, resulting in energy expenditure

TABLE 7.1 Types of physical activity

Type of physical activity	Description	Characteristics	Examples
Play	• Activities engaged in for enjoyment and recreation rather than a serious or practical purpose	• Spontaneous • Enjoyable • Flexible • Intrinsically motivated	• Playground games • Monkey bars • Sandbox play
Games	• Activities engaged in for enjoyment	• Rules exist • Goal-oriented	• Virtual reality games • Octopus tag and yard games
Sports	• Activities involving physical exertion and skill, in which an individual or team competes against another or others for entertainment	• Highly organised • Structured • Strict rules • Competitive	• Australian Rules football • Basketball • Soccer • Tennis
Informal sports	• Self-organised activities with adaptable rules and organisation	• Self-organised • Casual • Flexible rules • Less structured • Operates independently from formal structures	• Street soccer • 3-on-3 basketball • Beach cricket • Spikeball at the beach

Type of physical activity	Description	Characteristics	Examples
Transportation	• Travel between destinations that involves physical movement	• Practical • Purpose-driven	• Walking • Cycling • Running • Skateboarding
Exercise	• Activities requiring physical effort that are carried out to sustain or improve health and fitness	• Health-focused • Routine • Involves physical exertion	• Aerobics • Weightlifting • Running • Cycling
Chores	• Routine tasks, for example, jobs done around the home	• Repetitive • Task-oriented • Necessary	• Gardening • Cleaning • Grocery shopping
Recreational activities	• Leisure activities. Leisure is discretionary time, which is time outside of work and study commitments.	• Relaxing • Fun • Diverse	• Fishing • Dancing • Sky-diving • Surfing • Paragliding • Hot-air ballooning • Scuba diving

FIGURE 7.2 Sports are classified as either formal or informal, each distinguished by the degree of organisation and structure involved. Soccer could be placed in either category.

The type of physical activity people predominately engage in generally changes as they move through different stages of their lives. For example, it is likely that young children will be physically active through play and games, and rarely through exercise or organised sport. This is because their physical and cognitive capabilities are still developing.

Primary school children are likely to engage in some play and games. Many also have plenty of opportunities to try sports through Physical Education (PE) classes and modified sports. Some children engage in active transport, but most probably don't engage in much structured exercise. By the end of primary school, many children are engaged in team sports, such as netball, football, soccer and tennis.

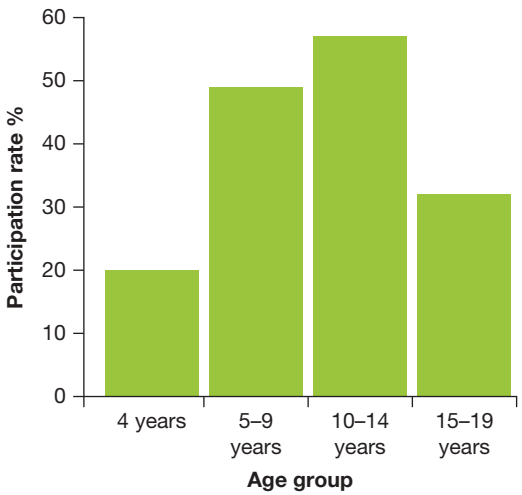
Teenagers are likely to engage in less play and fewer games, preferring to participate in sport, active transport, exercise, recreational activities and some chores around the house.

FIGURE 7.3 Recreational activities, such as surfing, have more appeal than play as teenagers get older.

Adults are unlikely to engage in play and games, and are likely to be most active through sport, active transport, exercise, recreational activities and chores, which may include physical activity in the workplace, such as walking as a waiter or strength work as a builder. Older people (65+ years) are most likely to be active through active transport (mainly walking), recreational activities and chores, such as gardening.

Figure 7.4 shows that organised sports are most popular among children aged 4–14, who make up 51 per cent of all sports participants. However, the graph also shows that participation significantly decreased to 32 per cent during late adolescence. According to VicHealth, males generally participate in sports more than females across all ages, with participation rates of 17 per cent and 9 per cent, respectively. Additionally, sports participation is more common in regional Victoria, with a rate of 16 per cent, compared to 12 per cent in metropolitan Melbourne.

FIGURE 7.4 Participation, based on age, in organised sport in Victoria in 2021



Source: Vic Health, *Sport Participation in Victoria 2015–2022 Research Summary*, 2024.

on Resources

Interactivity Forms and concepts of physical activity (int-6651)

Weblinks Games
Fit for a Feast

7.2 Activity

7.2 Quick quiz on | **7.2 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 3, 4	5, 6, 7	8, 9

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Describe** what is meant by *recreational activity* and provide two examples.
2. **List** six different examples of games.
3. **List** four different forms of active transport.
4. **Outline** two differences between informal and formal sports.
5. Use the information from figure 7.4 to answer the following questions.
   a. **Describe** the changes in sport participation between the ages of 4 and 19.
   b. **Suggest** a reason why there may be a difference in sports participation between males and females.
   c. **Suggest** a reason why sport participation rates peak between the ages of 10 and 14.

APPLY your understanding

Source: *ACHPER 2018, Trial Exam Unit 2, Section B, Q.7*; © ACHPER

6. Physical activity can be classified according to different characteristics, such as the level of competition involved in the particular physical activity.
   Compare the following forms of physical activity by describing their similarities and differences:
   - active transportation
   - recreational activities
   - play.
7. Set up and play a variety of games. In groups, choose a game to teach your classmates (e.g. octopus tag, hopscotch, duck, duck, goose). Explain the rules of the game and then run the game for your classmates for 5–10 minutes.
   a. **Describe** how games are different to sport and play.
   b. **Outline** one advantage and one disadvantage of play.
   c. **Identify** when throughout the lifespan you would be most likely to engage in games. **Justify** your answer.
8. Using the sport soccer as an example, **compare** the role of an umpire in a sport compared to an informal sport.
9. Using cricket as an example, **explain** why the venue in a formal sport is often different to an informal sport.

7.2 Exam questions

Question 1 (1 mark)

Which of the following is an example of an informal sport?

A. Riding a bicycle
B. Netball
C. Backyard cricket
D. Boot camp

Question 2 (2 marks)

Explain how running can be classified as an exercise and a method of transportation.

Question 3 (2 marks)

Define the term *exercise* and provide an example.

7.3 Benefits of maintaining an active lifestyle

Key knowledge	Key skill
• physical, social, mental, emotional and spiritual benefits of regular participation in types of movement	• participate in a variety of movement experiences to reflect on and record information related to the physical, social, mental, emotional and spiritual benefits of physical activity

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

7.3.1 Benefits of regular participation in types of movement

Moving in a variety of different ways helps your brain, mood and energy levels. It also enables you to connect with others. Today, there is a growing awareness of the link between physical activity and mental, social, emotional and spiritual health (see figure 7.5). In this subtopic we will explore the benefits of each.

FIGURE 7.5 Physical activity boosts overall wellbeing beyond just physical health.

7.3.2 Physical benefits of regular physical activity

Physical activity can be defined as any form of movement that expends energy. This includes incidental activity that occurs throughout the day, such as chores around the home, moving from one classroom to another at school or getting up out of bed and having a shower. In addition to incidental activity, people expend energy via other activities, such as gardening, playing sport, active transport and involvement in other recreational activities.

Physical health, like the other dimensions of health, can benefit from regular physical activity. Physical health is not only the absence of illness or disease, but also the efficient functioning of the body. This includes the capacity of a person to undertake desired activities on a daily basis without experiencing undue stress or fatigue.

From a physical perspective, engaging in regular activity has multiple benefits for the human body (see figure 7.6). These benefits include weight management, building and maintaining healthy bones, muscles and joints and a reduction in the risk of suffering from chronic and life-threatening conditions, such as diabetes mellitus, obesity, cardiovascular disease, osteoporosis, hypertension and some cancers.

FIGURE 7.6 Regular physical activity promotes physical health in many ways.

7.3.3 Mental benefits of regular physical activity

Mental health and wellbeing refers to the state of a person's mind or brain, and relates to the ability to think and process information. Optimal mental health and wellbeing enables an individual to form opinions, make decisions and use logic. Optimal mental health and wellbeing might include managing day-to-day activities with low levels of stress, having positive thought patterns, and high levels of confidence and self-esteem.

Engaging in regular physical activity not only reduces the impact of stress-related hormones, such as cortisol, but also improves concentration, and can lead to more optimistic thinking and efficient information processing. Whether it's participating in team sports or pursuing solo workouts, physical activity helps individuals to achieve their goals, which boosts self-confidence. Furthermore, by consistently engaging in regular exercise, we reduce the risk of obesity. This, in turn, cultivates self-esteem, reflecting the profound benefits of physical fitness for our overall mental health.

There is increasing evidence that shows participation in physical activity can improve brain function and subsequent learning. Schools that have more regular PE classes have proven academic gains over those schools with less PE time.

FIGURE 7.7 Regular physical activity promotes mental health in many ways.

7.3.4 Emotional benefits of regular physical activity

Emotional health and wellbeing is defined as the ability to express emotions and feelings in a positive way. Emotional health and wellbeing is about the positive management and expression of emotional actions and reactions, as well as the ability to display resilience. Emotional health and wellbeing is 'the degree to which you feel emotionally secure and relaxed in everyday life'. People who have positive emotional health and wellbeing are usually resilient, and have the ability to recover from events such as illness, change or misfortune.

Regular physical activity releases various hormones, including endorphins, dopamine and norepinephrine. These hormones assist in mood regulation. Regular physical activity often evokes a wide range of emotions. Individuals have to learn to manage feelings of frustration and anger if they do not achieve their goals, along with the feelings of exhilaration that accompany victory or the achievement of a goal. This provides an opportunity for people to learn to manage these emotions and display resilience in everyday life.

FIGURE 7.8 Regular physical activity promotes emotional health in many ways.

7.3.5 Social benefits of regular physical activity

There are strong links between being physically active and improved social health, particularly for people who use physical activity as a tool for engaging with others. Social health and wellbeing is the ability to form meaningful and satisfying relationships with others, and the ability to manage or adapt appropriately to different social situations. Engagement in physical activity, either as a member of a sports team or club or exercising with others, can improve social health and wellbeing.

For example, participating in a team sport can provide many opportunities to strengthen bonds with new and different people who share a common goal. Once these meaningful relationships are developed, feelings of loneliness and isolation may be reduced.

FIGURE 7.9 Regular physical activity promotes social health in many ways.

7.3.6 Spiritual benefits of regular physical activity

Spiritual health relates to the ideas, values and ethics that arise in the minds and consciousness of human beings. Regular physical activity promotes a sense of belonging, peace and a sense of purpose, which are all integral to an individual's spiritual health.

Engaging in outdoor physical activities, such as hiking, can allow individuals to feel a sense of spirituality in nature and appreciate its energising effects. Furthermore, regularly engaging in physical activity alongside others can be a great way to not only build a social network, but also cultivate a sense of belonging. This can be an entry point for individuals to immerse themselves in a community that shares a passion, such as a running or netball club.

FIGURE 7.10 It is essential that visitors to First Nations Country respect the sacred land they are walking on. First Nations guides support visitors in incredible locations, such as Kakadu National Park (pictured), to ensure they are respectful to the land and its extensive history and culture.

First Nations Peoples have a strong connection to the land. Participating in physical activities such as walking on Country or traditional hunting can reinforce cultural connections to the land and promote a deep sense of spirituality.

FIGURE 7.11 Regular physical activity promotes spiritual health in a variety of ways.

7.3 Activity

7.3 Quick quiz on | **7.3 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 4, 5	3, 6	7, 8

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **List** three physical health benefits of regular physical activity.
2. **Describe** the difference between emotional and mental health.
3. **Discuss** one way regular physical activity can help an individual work towards their purpose in life.
4. **List** the social benefits of being involved in a sports or recreational club.
5. **Explain** how physical activity could improve your emotional health.

APPLY your understanding

6. **Compare** the physical and spiritual health benefits of regular physical activity.
7. **Explain** how playing a sport for a local sporting club could benefit mental health and wellbeing.
8. Schools that have more regular PE classes and sport programs included in their curriculum show proven academic gains over school with less PE and sport time.
   Provide a **justification** for this relationship.

7.3 Exam questions

Question 1 (1 mark)

What is not a benefit of regular physical activity?

A. Muscle building
B. Weight management
C. Stronger bones
D. Increased risk of osteoporosis

Question 2 (2 marks)

Discuss how local and state governments investing in facilities and programs that promote physical activity could reduce the risk of obesity.

Question 3 (3 marks)

Analyse how regular physical activity promotes resilience and **explain** how this benefit promotes social health.

7.4 Sociocultural enablers and barriers to physical activity

Key knowledge	Key skill
• sociocultural enablers and barriers to individual physical activity behaviour such as gender, family, peers, socioeconomic status, community and cultural norms	• investigate, through participation, the sociocultural influences on physical activity behaviour across the lifespan

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

7.4.1 The importance of understanding enablers and barriers

Research has identified that those least likely to be physically active are women, people from lower socioeconomic backgrounds, older adults, people born overseas, people with a disability and First Nations Peoples. However, it is important that we understand the influences on behaviour and the **enablers** and **barriers** to physical activity. Only then can we begin to plan for change.

7.4.2 Sociocultural factors: enablers and barriers

Sociocultural factors encompass the social and cultural norms within which people are born, grow, live, work and age. These include family, peer influences, gender, socioeconomic status, community and cultural norms. Collectively, they play a pivotal role in shaping our levels of physical activity by serving as both enablers and barriers.

FIGURE 7.12 Family members can encourage participation in physical activity in a range of ways, such as engaging in the activity, providing transport, coaching and acting as a role model.

Research has shown that children of parents who are physically active are more likely to be physically active themselves. If your siblings are active, you are also more likely to be active, because you are exposed to physical activity through their participation. Active parents and siblings create greater opportunities; however, a lack of role models and support from parents can be a barrier for children.

Schools provide meaningful physical education and sports programs, along with access to activity facilities throughout the school day. This gives students both the motivation and opportunity to experience a wide variety of activities and become involved in physical activity. A peer group's favourable attitude to participation in physical activity will be an enabling influence on individual members of the group, and a peer group's negative attitude to participation will be just as powerful a barrier.

enabler something that makes it possible for a particular thing to be done

barrier something that prevents progress or makes it difficult for an individual to achieve something

One of the most significant social influences on adults is the workplace. Some employers recognise the benefits of having a healthy workforce and develop strategies in the workplace to help employees maintain or work on their fitness (e.g. by providing free gym memberships and promoting corporate fun runs). Your colleagues, not unlike your peers at school, also influence your behaviour. Having workmates who walk or ride to work or during lunch breaks can be an enabler of physical activity. Having workmates who prefer to engage in sedentary behaviour during lunch breaks or who drive to work can act as a barrier.

While older adults may have more time to be active once they have retired, they can often also experience financial limitations. Lower socioeconomic status can be a barrier to physical activity, as many activities require equipment and the use of facilities, which can cost money.

Family

Children often mimic the behaviours of their parents. If family members play a particular sport or physical activity, that behaviour is more likely to be adopted. Family members can help promote participation in physical activity in a variety of ways. They include providing access to resources (e.g. sports equipment, coaching), verbal encouragement and providing opportunities to be included in shared activities, such as a hike or bike ride together. This can help promote lifelong physical activity.

FIGURE 7.13 As a child, your parents and siblings have a great influence on how active you are.

TABLE 7.2 The main sociocultural enablers and barriers to physical activity

	Influence on physical activity	Description	Impact on children's physical activity
Enablers	Role models	Active family members (parents and siblings) modelling physical activity	Children are more likely to adopt physical activity behaviours modelled by their family.
	Resources	Providing access to sports equipment and coaching	Access to resources significantly influences the ability of children to participate in physical activities.
	Encouragement	Verbal encouragement and support for physical activities	Encouragement boosts motivation and interest in physical activities.
	Shared activities	Inclusion in shared physical activities, such as hikes or bike rides	Shared activities not only provide direct exposure to physical activity but also strengthen family bonds, promoting a healthy lifestyle.
	Opportunities	Creation of opportunities for physical activity through active family members	Active parents and siblings can create a variety of opportunities for physical activity, encouraging participation.
Barriers	Lack of role models	Absence of active role models in the family	A lack of role models and support from parents can be a barrier for children.
	Limited resources	Limited access to resources necessary for engaging in physical activities	Limited access to resources restricts children's ability to engage in and explore a variety of physical activities.

	Absence of encouragement	Lack of verbal encouragement and support	The absence of encouragement diminishes children's motivation and likelihood to engage in physical activities.
	Lack of shared activities	Absence of shared physical activities within the family	A lack of shared activities limits the exposure to physical activity and reduces opportunities for bonding and modelling healthy behaviours.
	Lack of opportunities	Lack of created opportunities due to inactive family lifestyle	A lack of opportunities reduces children's exposure to and participation in physical activities, limiting their ability to develop an active lifestyle.

Peers

The sports we choose and our engagement in physical activity are significantly influenced by our friends. The motivation to participate in certain sports often arises from the desire to be part of a friendship group, as illustrated in figure 7.14. Recognising the role of peers is crucial to understanding physical activity patterns.

FIGURE 7.14 The sports you play are heavily influenced by your peers.

Peers provide essential support and encouragement, which are vital for staying active. For instance, athletes recovering from injuries benefit from peer encouragement, helping them persist and maintain hope. Friends can also serve as gym buddies, fostering accountability for regular exercise. Competitive but friendly rivalries with peers can enhance performance, pushing individuals to excel. Moreover, friends often introduce us to new sports or activities. While not all these ventures might be appealing, many can lead to long-term commitments and enjoyment.

Peer dynamics can sometimes hinder physical activity. Social exclusion, particularly in skill-based sports where an individual may not match the proficiency levels of friends, can diminish motivation and lead to avoidance of physical activities. This, in turn, can contribute to a sedentary lifestyle. Additionally, if the peer group undervalues physical activity, favouring sedentary pastimes such as video gaming, individuals are likely to mirror these habits, reducing their overall physical activity levels.

TABLE 7.3 How peers can enable and be a barrier to physical activity

	Influence on physical activity	Description
Enablers	Motivation to participate	Participation in sports is often motivated by the desire to be part of a friendship group.
	Support and encouragement	Peers provide essential support and encouragement, which are vital for staying active, especially during recovery from injuries.
	Accountability and performance	Friends can serve as gym buddies, fostering accountability for regular exercise, and competitive but friendly rivalries can enhance performance.
	Introduction to new activities	Friends often introduce individuals to new sports or activities, leading to long-term commitments and enjoyment.
Barriers	Social exclusion	In skill-based sports, not matching the proficiency levels of friends can diminish motivation and lead to avoidance of physical activities.
	Undervaluing physical activity	If the peer group undervalues physical activity in favour of sedentary activities, such as video gaming, individuals are likely to mirror these habits, reducing their overall activity levels.

Socioeconomic status

Socioeconomic status (SES) is a term used to describe the social and economic situation of an individual. It incorporates three components: education, occupation and income. Opportunities and access to physical activity are often dictated by available money, time, facilities and equipment. As an example, if an individual has greater access to money and therefore sporting equipment, they are able to access a wider variety of physical activities.

socioeconomic status (SES) a term used to describe the social and economic situation of an individual. It incorporates three components: education, occupation and income.

FIGURE 7.15 People who have higher SES often have access to a wider variety of physical activity opportunities.

TABLE 7.4 How socioeconomic status can enable and be a barrier to physical activity

	Factor	Influence on physical activity	Examples
Enablers	Income	Higher incomes facilitate access to a diverse range of exercise facilities and equipment.	Affordability of gym memberships allows for regular use of specialised facilities, such as swimming pools, enhancing physical activity opportunities.
	Occupation and education	Higher levels of education and occupational status lead to a greater understanding of the benefits of physical activity.	Individuals with higher SES are more likely to engage in regular physical activity due to comprehensive awareness and better time-management skills.
	Access to equipment	Higher SES provides the ability to afford personal fitness equipment or gym memberships.	Higher-income individuals can access strength-training equipment and other resources, enhancing their ability to maintain an active lifestyle.
	Transportation	Higher SES provides better access to transportation, facilitating access to physical activity venues.	People from higher SES backgrounds have easier access to parks, gyms and sports facilities, which encourages regular physical activity.
Barriers	Income	Lower incomes may restrict access to exercise facilities and equipment.	Individuals with lower incomes face limitations in accessing specialised facilities, such as swimming pools, reducing physical activity options.
	Chronic diseases	Having a lower SES is associated with higher rates of chronic diseases, hindering physical activity.	Physical limitations from chronic conditions reduce activity levels in lower SES groups, exacerbating health disparities.
	Transportation	Having a lower SES may limit efficient transportation options to physical activity venues.	Reliance on public transportation with fewer direct routes and longer travel times makes accessing physical activity locations more challenging for those from a lower SES background.

Gender

Gender has an influence on physical activity levels across the lifespan. Girls and boys are often socialised into different sports. Some sports such as netball, softball and gymnastics may be inappropriately labelled as girls' sports, while sports such as Australian Rules football, rugby and boxing may be assumed to be more masculine and therefore more suitable for boys. In recent times, many gender stereotypes in regard to sports participation have been challenged, with an increasing number of women playing traditionally male-dominated sports.

Addressing these barriers requires concerted efforts to increase female representation in sports leadership, challenge gender stereotypes, ensure equitable access to sports facilities, and enhance media coverage and sponsorship opportunities for women's sports. By addressing these societal factors, we can create a more inclusive environment that encourages and supports women's participation in physical activity at all levels.

FIGURE 7.16 Gender stereotypes influence participation in sports.

TABLE 7.5 How gender can enable and be a barrier to physical activity

Barrier	Description	Impact on women's participation
Role models	Women are under-represented on sports club committees, leading to a lack of advocacy for women's needs.	Limited access to necessary facilities and programs, reducing participation
Gender stereotypes	Prevailing stereotypes deter women from participating in activities perceived as 'masculine'.	Self-imposed exclusion from a range of sports due to stigma
Limited opportunities	Societal norms constrict opportunities for women, such as men occupying women's playing areas.	Further limits access for female athletes, decreasing participation
Societal emphasis on male-dominated sports	Greater focus on male sports diminishes interest and participation among women.	Suggests women's sports are less important, reducing their appeal
Media coverage and sponsorship	Limited media coverage leads to fewer sponsorship opportunities.	Results in inadequate facilities due to under-investment, creating barriers to participation

Cultural norms

Cultural norms shape attitudes towards physical activity and therefore are a significant influence on the amount and type of physical activity an individual engages in. Some cultural norms act as barriers (e.g. racial discrimination); however, others can have a positive influence, including specific programs that are created to be inclusive, such as Netball Australia's One Netball program.

FIGURE 7.17 The AFL multicultural round celebrates diversity in sport.

FIGURE 7.18 Former Richmond player Bachar Houli successfully combined his faith with his passion for AFL.

TABLE 7.6 How cultural norms can enable and be a barrier to physical activity

Category	Factor	Description	Examples
Barriers	Racial discrimination	Can deter participation and access to physical activities	An individual being treated differently because of their ethnic or cultural background
	Limited opportunities	Fewer opportunities for sports that hold cultural significance	Traditional First Nations games do not get as much formal recognition as mainstream sports such as basketball.
Enablers	Multilingual information	Providing program details in multiple languages to improve accessibility	Providing information about sports in languages other than English
	Cultural accessibility	Adjusting programs to be culturally sensitive and inclusive	Netball Australia's One Netball program
	Flexibility in programs	Allowing adjustments for cultural practices within sports programs	Muslim former AFL player Bachar Houli being allowed to pray during training
	Role models and awareness	Promoting multicultural role models and awareness programs	AFL's multicultural round
	Prevalence of a particular sport	Some sports get more attention than others.	Swimming is considered to be a national sport. Factors such as Australia's extensive coastline influence this perception, and high-profile swimmers are role models for many.

Influence of cultural factors across the lifespan

The impact of culture can change across the lifespan. Generally, when a person is younger, they are strongly influenced by their parents' beliefs. As a person grows up and gains more independence, they may have more choice over how culture influences their lives. Regardless, a prevailing culture or preference for one type of physical activity is common.

FIGURE 7.19 Different cultures embrace different types of physical activity.

Community

The community significantly influences physical activity levels. Environmental factors such as availability to sports and safety, act as both enablers and barriers to physical activity. Many sports that we choose to take seriously are influenced by regional preferences; for example, in Victoria, Australian Rules football is preferred over rugby, whereas in other parts of Australia that is not the case.

FIGURE 7.20 AFL popularity is a catalyst for enhanced physical activity in Victoria.

TABLE 7.7 How community can enable and be a barrier to physical activity

Factor	Enabler	Barrier
Availability to sports	In certain regions, specific sports are more popular (e.g. rugby in Queensland and New South Wales, and AFL in Victoria). This regional preference can boost participation and interest in these sports.	In country towns, it can be challenging to find enough people to fill sporting teams, which reduces opportunities for physical activity participation.
Safety	Communities that are safe and cater to the needs of the public who want to exercise are more likely to see increased physical activity participation.	In some areas, high crime rates may deter people from engaging in outdoor activities such as running, walking, or bike riding, due to safety concerns.

on Resources

Weblink Piano stairs

7.4 Activity

7.4 Quick quiz on | **7.4 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 4, 5, 6	9, 11, 12	3, 7, 8, 10

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **List** four sociocultural influences that may act as barriers to physical activity.
2. Sociocultural factors can act as enablers and barriers to physical activity. **Outline** why.
3. Parents are an important influence on the physical activity patterns of their children during childhood and adolescence. **Explain** why.
4. **Describe** how income can act as a barrier to physical activity.
5. **Outline** two sociocultural factors that may act as enablers of physical activity for older adults.

APPLY your understanding

6. **Explain** how the family as a sociocultural factor can promote physical activity levels.
7. Draw a timeline of your life so far and clearly label all sociocultural enablers and barriers to physical activity. Now predict at least two possible barriers and enablers you may experience in your adult and older years.
8. Interview an older person (65+yrs) and **list** the different physical activities they have participated in across their lifespan. Investigate the factors that influenced these behaviours.
   Determine the most significant enablers and barriers to physical activity.
9. Pickleball combines elements of tennis, badminton and table tennis. It uses solid paddles and a perforated ball on a badminton-sized court for singles or doubles play. It caters to a wide range of skill levels, with a distinctive non-volley zone ('kitchen') to foster strategic exchanges.
   Describe how a sociocultural factor may influence adults' participation in pickleball.
10. **Explain** how peers as a sociocultural factor could act as a barrier for a group playing lawn bowls.
11. Research your local physical activity facility (e.g. gym, oval, swimming pool). What programs/strategies, if any, do they offer to encourage people from different cultures to be active?
12. Consider a non-English speaking mother of two. Devise a program to help encourage her to be more physically active. When devising your program, consider what could facilitate and discourage her involvement in physical activity.

7.4 Exam questions

Question 1 (1 mark)

Family and friends:

A. positively affect physical activity levels.
B. negatively affect physical activity levels.
C. can both positively and negatively affect physical activity levels.
D. generally do not affect physical activity levels.

Question 2 (3 marks)

Describe a program that aims to overcome the cultural barriers to physical activity.

Question 3 (4 marks)

Explain how peers could act as an enabler and barrier to participation in ten-pin bowling.

7.5 Physical activity and sedentary behaviour guidelines

Key knowledge	Key skill
• physical activity and sedentary behaviour guidelines for different age population groups	• describe the physical activity and sedentary behaviour guidelines for different age population groups

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

7.5.1 About the guidelines

The Australian Physical Activity and Sedentary Behaviour Guidelines were developed by the Australian government and are advertised widely, including on the Australian Department of Health and Aged Care website. This website provides a variety of resources to help people make informed decisions about their health.

The guidelines outline how much physical activity individuals should do, the importance of reducing the time spent sitting or lying down and recommendations for the amount of sleep required at each stage of life. Needs vary depending on an individual's age.

These guidelines outline:

- how much physical activity an individual should do each day
- strategies to incorporate increased physical activity into everyday routines
- the importance of reducing and breaking up sedentary time
- how much sedentary screen time is recommended
- how much sleep children and young people should get
- how children and young people can get good quality sleep.

These recommendations are mapped to the following population groups:

- children from birth to 5 years of age
- children and young people between the ages of 5 and 17
- adults aged 18 to 64 years
- older adults aged 65 years old and above.

7.5.2 How the guidelines were developed

There is a relationship between physical inactivity and sedentary behaviour. Generally, the greater the sedentary behaviour, the higher the levels of physical inactivity and vice versa. However, it is important we understand the difference between these two concepts.

Physical inactivity means not meeting the daily physical activity guidelines. You can do enough physical activity to meet the guidelines and still be sedentary if you spend a lot of time sitting or lying down. **Sedentary behaviour** includes time spent sitting or lying down for various activities over the last week. This includes waiting for transport, sitting while in transit, playing computer games, using the internet, watching television, talking or texting on a phone and leisure activities that are low in intensity. This includes playing chess, reading a book, going to the movies or having a barbecue.

physical inactivity a lack of involvement in physical activity during an individual's leisure time

sedentary behaviour behaviour associated with sitting or lying down, including activities such as watching television, working or playing on the computer, driving or sitting in a car, bus or train. It also includes homework, studying or reading.

For each of the population groups, the recommendations for physical activity and sedentary behaviour have been based on evidence that links the intensity, frequency, duration and type of physical activity to specific health outcomes, such as a reduction in obesity, cardiovascular disease, diabetes mellitus and other chronic diseases.

Similar evidence has linked increased sedentary behaviour with these same conditions. Following the Australian Physical Activity and Sedentary Behaviour Guidelines is strongly correlated with significantly improved health outcomes. The guidelines for each age group are listed in the sections that follow.

FIGURE 7.21 Over the course of our lives we will engage in many different types of physical activity.

Physical activity recommendations for children aged 0–5

Infants (birth to 1 year)

All babies and young children benefit from a mix of physical activity, inactivity and sleep in each 24-hour period. Physical activity for young children mainly happens through unstructured, active play, including:

- supervised interactive floor-based play — the more the better
- at least 30 minutes of 'tummy time' over the course of the day while awake, including moving their arms and legs
- reaching and grasping for objects.

Once they are mobile, it can be through:

- crawling
- pulling up to a standing position and moving while holding onto things
- walking — in some cases.

FIGURE 7.22 Once infants are mobile, they can engage in many unstructured activities, such as crawling.

on Resources

Weblink Physical activity and exercise guidelines for all Australians

Toddlers and children (1 to 5 years)

Toddlers love to run around. The more active play toddlers take part in, the better.

Toddlers should get at least three hours of various physical activities each day, including energetic play. This could be through:

- running — playing tips, ball games or races at the park
- twirling and jumping — at the park or by creating fun obstacle courses at home
- dancing
- skipping.

This should take place throughout the day, not all at once. Physical activity for toddlers should be fun and encourage exploration and discovery.

FIGURE 7.23 Dancing is a good way for toddlers to be active.

Sedentary behaviour and screen-time recommendations for children aged 0–5

Sedentary screen time during early childhood can have long-term impacts on a child's development. It is recommended that there is no screen time for children under 2 years, and no more than 1 hour per day for those aged 2 to 5 years. In addition:

- toddlers should not be restrained for more than one hour at a time (such as in a stroller, car seat or high chair)
- while being inactive toddlers should be doing educational activities, such as reading, telling a story, singing, painting or doing craft.

Physical activity recommendations for children and young people aged 5–17

Being active is important for children and young people to maintain health and set good habits for life. All children and young people should get the right mix of physical activity, inactivity and sleep in each 24-hour period.

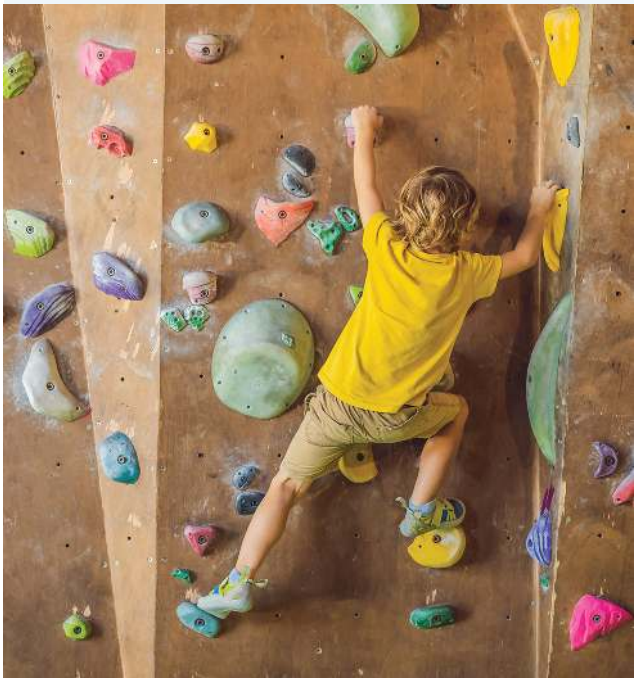
Children and young people should do at least 60 minutes each day of moderate to vigorous physical activity that makes the heart beat faster. More is better. It doesn't have to be a full 60 minutes at once — several shorter sessions throughout the day work too.

At least three days per week, children and young people should incorporate vigorous activities and activities that strengthen muscle and bone in the 60 minutes.

These activities don't have to be organised or formal, and can include:

- football
- basketball
- netball
- bike riding
- swimming
- dancing.

FIGURE 7.24 Children and young people should engage in strength-based activities three times per week.



As part of the 60 minutes of daily activity, children and young people should include muscle and bone-strengthening activities three days per week, such as:

- running
- climbing
- swinging on monkey bars
- push-ups
- sit-ups
- lifting weights
- yoga.

FIGURE 7.25 Vigorous activities provide additional health benefits.

Sedentary behaviour and screen-time recommendations for children and young people aged 5–17

Screen time during childhood can have long-term impacts on a child's development. Children and young people should have no more than 2 hours of sedentary recreational screen time per day. This does not include screen time needed for schoolwork.

Long periods of sitting can lessen the benefits of being physically active. So, it's important to break these up as often as possible.

Getting enough good-quality sleep is essential for healthy growth. It is recommended that each night:

- children aged 5 to 13 years get 9 to 11 hours of uninterrupted sleep
- young people aged 14 to 17 years get 8 to 10 hours of uninterrupted sleep.

To establish and maintain healthy sleep patterns, children and young people should:

- have a consistent bedtime and wake-up time
- avoid screen time 1 hour before sleep
- keep screens out of the bedroom.

FIGURE 7.26 Too much screen times is associated with poor health outcomes.

Physical activity recommendations for adults aged 18–64 years

Adults should be active most days, preferably every day. Each week, adults should do either:

- 2.5 to 5 hours of moderate intensity physical activity, such as a brisk walk, golf, mowing the lawn or swimming
- 1.25 to 2.5 hours of vigorous intensity physical activity, such as jogging, aerobics, fast cycling, soccer or netball
- an equivalent combination of moderate and vigorous activities.

Adults should include muscle-strengthening activities as part of their daily physical activity on at least 2 days each week. This can be:

- push-ups
- pull-ups
- squats or lunges
- lifting weights
- household tasks that involve lifting, carrying or digging.

FIGURE 7.27 Riding your bike to work is a great way to help work towards meeting the guidelines.

Sedentary behaviour and screen-time recommendations for adults aged 18–64 years

Long periods of sitting can offset the benefits of being physically active, so it's important to:

- reduce the time you spend sitting — for example, by organising walking meetings, using a standing desk or enjoying a walk during a lunch break
- break up long periods of sitting — for example, by doing lunges or star jumps or walking around when on the phone.

FIGURE 7.28 Standing desks help reduce time sitting.

Physical activity recommendations for older adults aged 65+ years

As you get older, it's important to do some form of physical activity every day.

Older adults often have health problems. Fortunately, there are many ways to engage in physical activity. It's a matter of finding what works for each individual. Older adults with health issues should talk to their doctor about what activity suits them. For example, if they are diagnosed with:

- heart problems, diabetes or asthma — they can start moderate walking or swimming
- arthritis — they can try hydrotherapy or swimming in a warm pool
- osteoporosis — they can try weight-bearing and strength activities.

People aged 65 years and over should engage in at least 30 minutes of moderate intensity physical activity on most, preferably all, days. If they find 30 minutes difficult right now, they can start with just 10 minutes once or twice a day. After 2 weeks, they can increase to 15 minutes twice a day. If they can do more than 30 minutes, they will get extra benefits. Over the course of the week, older adults should try to incorporate different types of activities.

Sedentary behaviour and screen-time recommendations for older adults aged 65+ years

Older adults should try to reduce the time they spend sitting down, breaking that time up as often as they can.

FIGURE 7.29 There are many opportunities for older Australians to engage in low-impact activities that promote health, such as water aerobics.

TABLE 7.8 Summary of Australian Physical Activity and Sedentary Behaviour Guidelines

	Ages 1–2	Ages 3–5[a]	Ages 5–17[b]	Ages 18–64	Ages 65 and over
Physical activity	At least 180 minutes of energetic play per day	At least 180 minutes per day with at least 60 minutes of energetic play	At least 60 minutes of moderate to vigorous activity involving mainly aerobic activities per day	Be active on most, preferably all days, with at least 150 minutes of moderate to vigorous activity per week	Be active on most, preferably all days with at least 30 minutes of moderate activity per day
Strength	N/A	N/A	At least 3 days a week	Muscle strengthening activities 2 times a week	Incorporate muscle strengthening activities
Sedentary or screen-based activity[c]	Do not restrain for more than 1 hour at a time. Under 2 years should have no sedentary screen time. For 2 years, no more than 60 minutes of sedentary screen time per day.	Should not be restrained for more than 60 minutes at a time[d]. No more than 60 minutes of sedentary screen time per day.	No more than 120 minutes of screen use. Break up long periods of sitting.	Minimise and break up prolonged periods of sitting.	Be as active as possible.

Source: Australian Institute of Health and Welfare, 19 May 2023, https://www.aihw.gov.au/reports/physical-activity/physical-activity.

Notes:

a. This group includes those aged 5 who are not yet in full-time schooling (for example, preschoolers).
b. This group includes those aged 5 who are in full-time schooling.
c. Does not include screen time needed for school work.
d. Examples include being restrained in a stroller, car seat or high-chair.

7.5 Activity

7.5 Quick quiz on | **7.5 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 4	3, 5, 7	6, 8

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **List** the types of activities that are recommended for older Australians as described in the physical activity guidelines.
2. **Identify** the type of activities that are recommended for older Australians as described in the physical activity guidelines.
3. Provide advice to a 15-year-old about the Australian Physical Activity and Sedentary Behaviour Guidelines they should be following.
4. **Explain** the association between sedentary behaviour and health outcomes.

APPLY your understanding

5. A 9-year-old child swims for at least an hour per day at the appropriate intensity for health gains. They do no other type of activity. Recommend another activity for this child to add to their weekly schedule. **Justify** your selection with reference to the Australian Physical Activity and Sedentary Behaviour Guidelines for children.

Source: *Adapted from ACHPER 2022, Trial Exam Unit 2, Section B, Q.10.c, Q.10.d;* © ACHPER

6. Jessica is in Year 11. She gets up around 8 am and is driven to school each morning. Most of the day is spent sitting in the classroom and Jessica chooses to use lunchtime to sit around and catch up with friends, or study in the library.
   Jessica uses public transport to get home and walks 10 minutes to the bus stop, then a further 10 minutes to get home after getting off the bus. In the afternoon, she spends at least 2 hours revising and studying, and then 2 to 3 hours of TV and movies or social media before bed.
   Jessica trains for netball for 1 hour on a Tuesday night and then plays in an hour-long competitive match on a Saturday afternoon.
   a. Using the information provided in this case study, **discuss** whether Jessica is meeting the Australian Physical Activity and Sedentary Behaviour Guidelines for people of this age.
   b. Based on your response in **part a**, **explain** two changes Jessica could make to her current physical activity levels to ensure the guidelines are met.
7. **Compare** the types of physical activities recommended for adults versus older adults (over 65 years of age).
8. **Suggest** two ways in which a school could help young people meet the Australian Physical Activity and Sedentary Behaviour Guidelines.

7.5 Exam questions

Question 1 (1 mark)

Children aged 5 to 12 are recommended to be active every day for how long?

A. 30 minutes
B. 30–60 minutes
C. 60 minutes only
D. 60+ minutes

Question 2 (2 marks)

Ashley, a 19-year-old nursing student, created a physical activity plan to help himself meet the Australian Physical Activity and Sedentary Behaviour Guidelines. He is time-poor and trying to be healthier.

Day	Activity	Duration
Monday	Strength training (bodyweight exercises)	30 minutes
Tuesday	Jogging or brisk walking	90 minutes
Wednesday	High-intensity interval training (running)	20 minutes
Thursday	Yoga and stretching exercises	100 minutes
Friday	Leisurely walk	60 minutes
Saturday	Yoga and stretching exercises	90 minutes
Sunday	Leisurely walk	60 minutes

Justify whether Ashley's physical activity plan has allowed him to meet the Australian Physical Activity and Sedentary Behaviour Guidelines.

Question 3 (3 marks)

List the three sedentary behaviour guidelines for children aged 5 to 12 years old and 5 to 17 years old.

7.6 Prevalence and trends in physical activity, physical inactivity and sedentary behaviour

Key knowledge	Key skill
• prevalence and trends of physical activity, physical inactivity and sedentary behaviour	• analyse and interpret secondary data related to physical activity behaviour to explain outcomes of physical activity and sedentary behaviour

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

7.6.1 Understanding physical activity and sedentary behaviour levels

We have often depicted physical activity and sedentary behaviour as being at opposite ends of the continuum of activity, implying that a person cannot be active and sedentary. More recent research has found that, on the contrary, a person may be both physically active and engage in sedentary behaviour. For example, consider an office worker who sits at work all day, jogs 30 minutes to and from work and then relaxes in front of the television for the rest of the evening at home. Is this person active because they spend an hour each day jogging? Or are they sedentary because they spend the majority of their day sitting down?

FIGURE 7.30 Social media use contributes to many people not meeting the guidelines.

Researchers are now beginning to acknowledge that being active does not necessarily displace sedentary behaviour. People may engage in both types of behaviour at different times of the day. This has led to the recent modification of the national physical activity guidelines to also include sedentary behaviour guidelines. They have now become the Australian Physical Activity and Sedentary Behaviour Guidelines. For maximal health benefits, including maintaining a healthy weight, we need to ensure we are seeking to be physically active and limiting sedentary behaviour.

METs (metabolic equivalents) commonly used to express the intensity of physical activities. A MET is the ratio of a person's working metabolic rate relative to the resting metabolic rate. Your MET level would be 1 if you were generally sedentary (e.g. lying down, reading or sitting and talking). Participation in an activity of moderate intensity would result in a MET level of 3–6.

METs (metabolic equivalents) play a crucial role in measuring these behaviours. METs are commonly used to express the intensity of physical activities. A MET is the ratio of a person's working metabolic rate relative to the resting metabolic rate. Your MET level would be 1 if you were generally sedentary (e.g. lying down, reading or sitting and talking). Participation in an activity of moderate intensity would result in a MET level of 3–6. Knowing these MET values helps quantify the spectrum of physical activity and its impact on health.

7.6.2 The importance of data on physical activity, physical inactivity and sedentary behaviour levels

Secondary data on physical activity, physical inactivity and sedentary behaviour is used as evidence to shape Australian health initiatives, fostering many health benefits that were discussed subtopic 7.3. Additionally, it assists policymakers in targeting specific population groups, assessing the effectiveness of current interventions and optimising resource allocation to address the challenges associated with unhealthy lifestyle choices.

According to Pedersen and Saltin (2015):

> Low levels of physical activity are a major risk factor for chronic conditions. People who are not active enough have a greater risk of developing cardiovascular disease, type 2 diabetes, osteoporosis and dementia. Being physically active improves mental and musculoskeletal health and reduces other risk factors such as overweight and obesity, high blood pressure and high blood cholesterol. Physical activity can also improve symptoms, delay, or halt the progression of a number of conditions, or the onset of associated disease and complications.

The federal government periodically commissions surveys of the population to identify current trends in Australian society. In 2022, it conducted the National Health Survey. The survey is designed to collect a wide range of information about the health of Australians, including the prevalence of health conditions and health risk factors, including physical activity levels, demographic and socioeconomic characteristics.

These surveys were conducted on behalf of the federal government by the Australian Bureau of Statistics (ABS) (see figure 7.33). This data is helpful for healthcare professionals because it not only identifies current trends in health status, but it also highlights potentially disadvantaged groups and individuals.

FIGURE 7.31 Coronary heart disease is a disease closely linked to physical inactivity.

FIGURE 7.32 Achieving the guidelines requires incorporating different types of movement in your life, as it helps prevent a range of conditions.

7.6.3 Physical activity, physical inactivity and sedentary behaviour trends

Unfortunately, according to the 2022 survey, most Australians did not meet the physical activity and sedentary behaviour guidelines. Below are some key statistics and trends over time relating to Australia's physical activity, inactivity, and sedentary behaviour levels.

Key statistics:

- Almost one in four (23.9 per cent) people aged 15 years and over met the physical activity guidelines.
- Nearly half (46.9 per cent) of employed adults aged 18–64 years described their day at work as mostly sitting.

Physical activity, physical inactivity and sedentary behaviour data in children aged 2–5

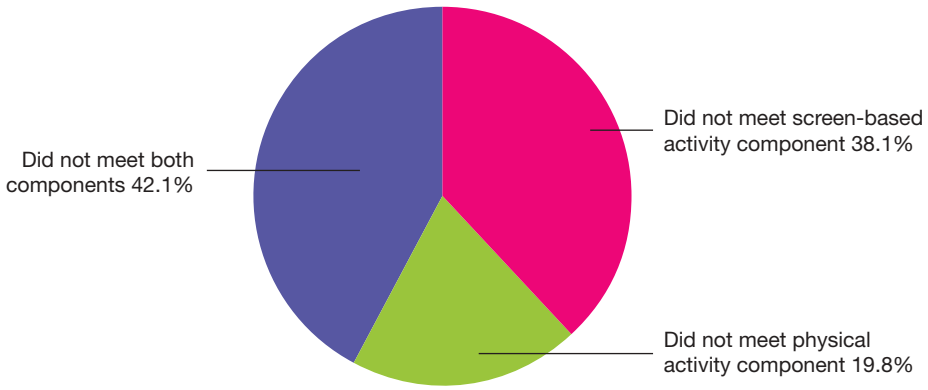
Children aged 2–5 were not included in the 2022 survey, but based on 2018 data from the Australian Institute of Health and Welfare, the majority of children in this age group did not meet the guidelines:

- Over 8 in 10 (83 per cent) of children aged 2–5 did not meet both the physical activity component and the screen-based activity component.
- Thirty-nine per cent did not meet the physical activity component and 75 per cent did not meet the screen-based activity component. (Children aged between 2 and 5 should no have more than one hour of sedentary recreational screen time per day.)

As a result of current physical inactivity levels, many children are at a higher risk of poorer health outcomes, which include type 2 diabetes and heart disease.

Too much screen time among this age group is also a big concern. According to the Australian Institute of Family Studies (2024), for children under 5 years there is evidence that screen time has negative effects on weight, motor and cognitive development, and social and psychological wellbeing.

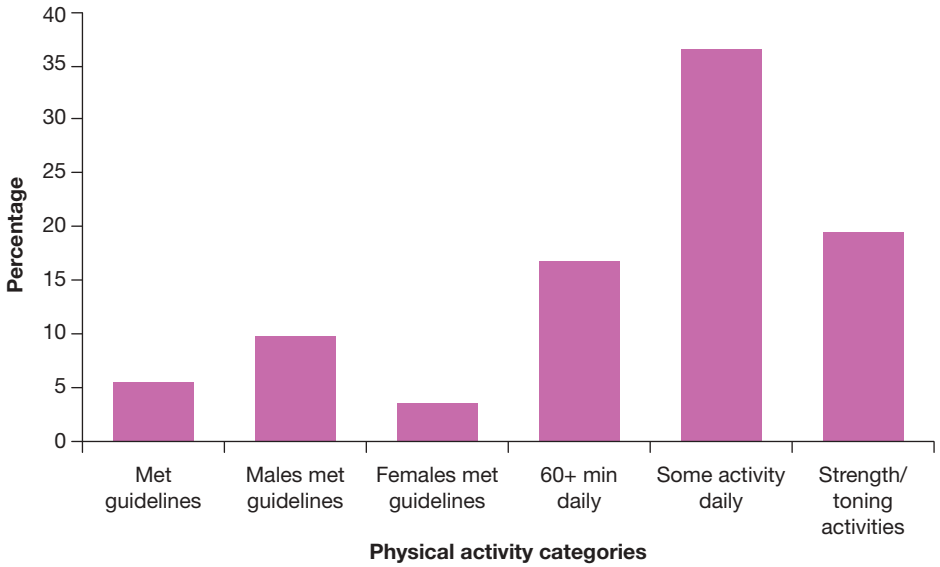
FIGURE 7.33 Physical activity and screen-based activity compliance for children aged 2–5



Physical activity, physical inactivity and sedentary behaviour data in young people aged 5–17

- One in twenty (5.6 per cent) young people met the physical activity guidelines in 2022. This has more than doubled since 2017–18 (1.9 per cent).
- Young males aged 15–17 years were more likely to meet the physical activity guidelines than young females (9.9 per cent compared to 3.7 per cent).
- One in six (16.8 per cent) young people did at least 60 minutes of physical activity every day in the last week, but it was not always moderate to vigorous activity. One in three (36.4 per cent) young people undertook some physical activity every day in the last week.
- One in five (19.5 per cent) did three or more days of strength or toning activities in the last week (see figure 7.34).

FIGURE 7.34 Physical activity trends in young people aged 5–17



Source: Australian Bureau of Statistics, *Physical activity 2022,* released 2023.

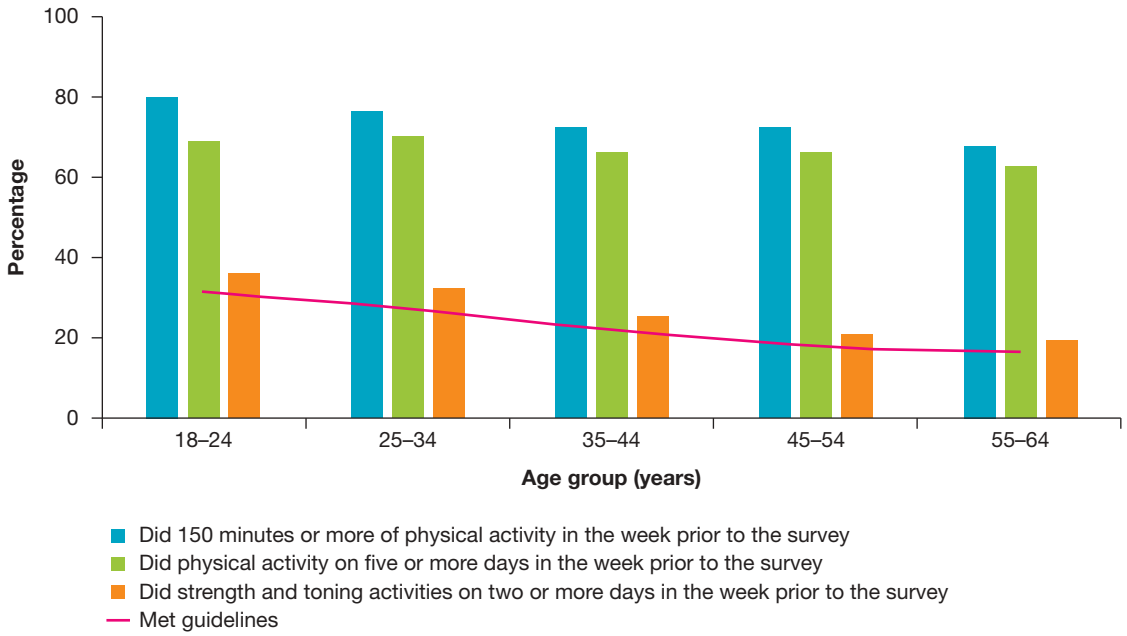
EXAM TIP

When analysing data trends, ensure to clearly describe the overall pattern of the data and specify the relevant population groups, such as young people aged 5–17, to provide context and clarity.

Physical activity, physical inactivity and sedentary behaviour in adults aged 18–64

One in five (22.4 per cent) adults aged 18–64 years met the physical activity guidelines in 2022, an increase from one in six (17.0 per cent) in 2017–18. More than half (56.4 per cent) completed 30 minutes of activity on five or more days.

FIGURE 7.35 Proportion of adults aged 18–64 years by whether they met physical activity guidelines and age, 2022



Source: Australian Bureau of Statistics, *Physical activity 2022,* released 2023.

One in four (26.6 per cent) undertook strength or toning exercises on two or more days in the last week (see figure 7.35). Overall, males were more likely to meet the physical activity guidelines than females (24.9 per cent compared to 19.9 per cent).

Although three-quarters (77.6 per cent) of people aged 18–64 years did not meet the guidelines, the majority were active in the week prior to interview.

- Two in three (67.4 per cent) undertook at least some physical activity on five or more days.
- Three quarters (74.2 per cent) did at least 150 minutes of physical activity in the week.

According to the ABS:

> Among those who did not meet the muscle strengthening guideline (at least two days of muscle strengthening activities per week), fewer than 11 per cent of men or women, across all age subgroups, except for women aged 18–34 (14 per cent), did muscle-strengthening activities on one day in the last week. The proportion of people who did muscle strengthening activity on one day in the last week generally decreased as age increased (ABS 2022b).

FIGURE 7.36 Gymnastics incorporates weight-bearing activities that are great for strengthening bones and muscles.

The 74.2 per cent of adults not meeting the muscle-strengthening component of the guidelines are at a higher risk of developing osteoporosis. Osteoporosis is a condition suffered by many Australians. Older people are at most risk of suffering from osteoporosis.

type 2 diabetes a condition that affects how the body uses sugar (glucose) for energy and stops the body from using insulin properly

Osteoporosis is characterised by a reduction in bone density. Healthy bone tissue is constantly being broken down and replaced, but for people with osteoporosis, this process of repair does not keep up with the deterioration of the bone tissue, causing bones to become weak and brittle. This thinning of the bones leads to a higher risk of bone fractures. There is a range of risk factors associated with osteoporosis, the most significant being the inadequate consumption of calcium, a lack of vitamin D absorption and physical inactivity.

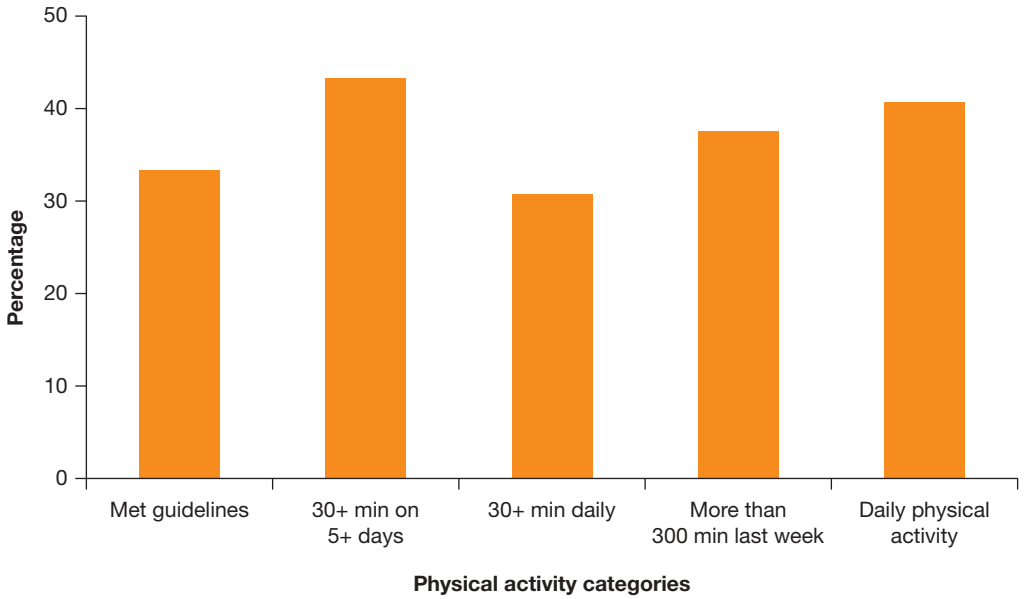
Type 2 diabetes is a growing health concern in many countries, including Australia, with close to 1 million adults diagnosed with the condition. It is a disease characterised by the inability of the pancreas to properly control blood sugar levels in the body. It usually develops in people over the age of 45, but due to poor lifestyle habits there are increasing numbers of younger people and children at risk of developing type 2 diabetes. To combat the increasing prevalence of this condition within the Australian community, there are lifestyle choices that people can make, including eating more nutritious foods, reducing kilojoule intake and engaging in more physical activity.

FIGURE 7.37 Many Australians will have to regularly monitor their glucose levels due their lifestyle choices.

Physical activity, physical inactivity and sedentary behaviour of older adults aged 65+

- One in three (33.4 per cent) people aged 65 years or over met the physical activity guidelines in 2022.
- Four in ten (43.4 per cent) did at least 30 minutes of physical activity on five or more days and three in ten (30.8 per cent) completed at least 30 minutes of physical activity daily.
- One in three (37.6 per cent) did more than 300 minutes of physical activity in the last week and 40.7 per cent engaged in daily physical activity.

FIGURE 7.38 Physical activity guidelines data for people aged 65+



Source: Australian Bureau of Statistics, *Physical activity 2022,* released 2023.

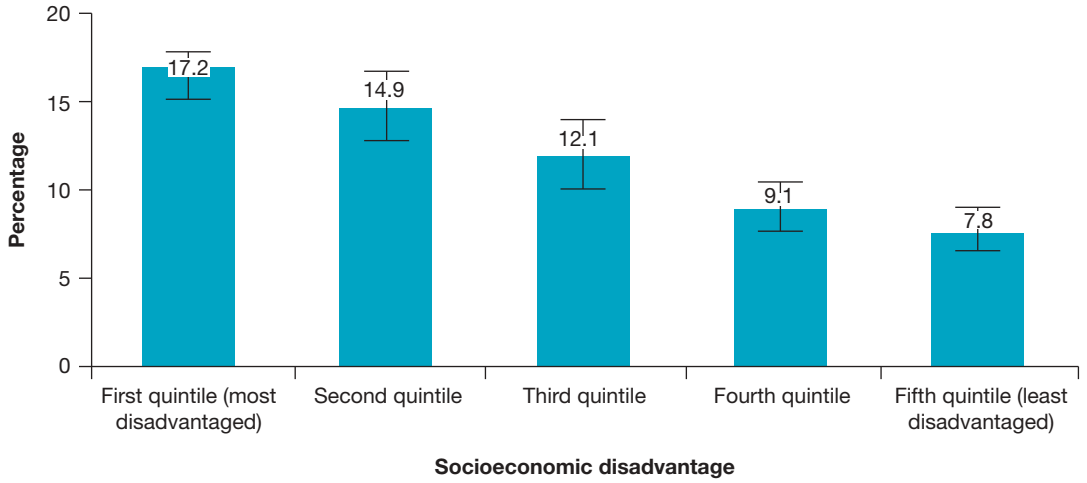
Socioeconomic status and physical activity levels

Adults aged 18 years and over living in areas of *most* disadvantage were less likely than those living in areas of the *least* disadvantage to have:

- engaged in some type of physical activity in the last week (83.1 per cent compared to 92.2 per cent)
- met physical activity guidelines (21.5 per cent compared to 29.5 per cent).

Adults living in areas of most disadvantage were more likely to have completed zero minutes of physical activity in the last week than those living in areas of least disadvantage (17.2 per cent compared to 7.8 per cent).

FIGURE 7.39 The relationship between SES and no physical activity in 2022



Note: A lower Index of Disadvantage quintile (e.g. the first quintile) indicates relatively greater disadvantage and a lack of advantage in general. A higher Index of Disadvantage (e.g. the fifth quintile) indicates a relative lack of disadvantage and greater advantage in general. See Socio-Economic Indexes for Areas (SEIFA), Australia, 2016 (abs.gov.au).

Source: Australian Bureau of Statistics, *Physical activity 2022,* released 2023.

7.6.4 How can I be more physically active?

Making time for physical activity can be challenging, but it's crucial for our wellbeing. Here are some practical tips to help you and others prioritise exercise and lead a healthier life:

- Develop a realistic plan that fits your lifestyle and routine.
- Choose activities that you enjoy and find appealing.
- Keep track of your progress over time to see your improvements.
- Whenever possible, incorporate incidental physical activity into your daily routines, such as walking or cycling to work.
- Take the stairs instead of using elevators and consider standing while using public transport.
- Find a workout buddy. This can help provide mutual accountability.
- Take the opportunity to walk part of your commute by getting off the train or bus a few stops earlier.
- Set up a reward system to help celebrate your achievements and milestones along the way.

FIGURE 7.40 Having a workout buddy can hold you accountable and help you achieve the recommended activity levels in the Australian Physical Activity and Sedentary Behaviour Guidelines.

By following these suggestions, you can take positive steps toward better health and longevity.

7.6 Activity

7.6 Quick quiz on | **7.6 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 3	4, 7	5, 6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

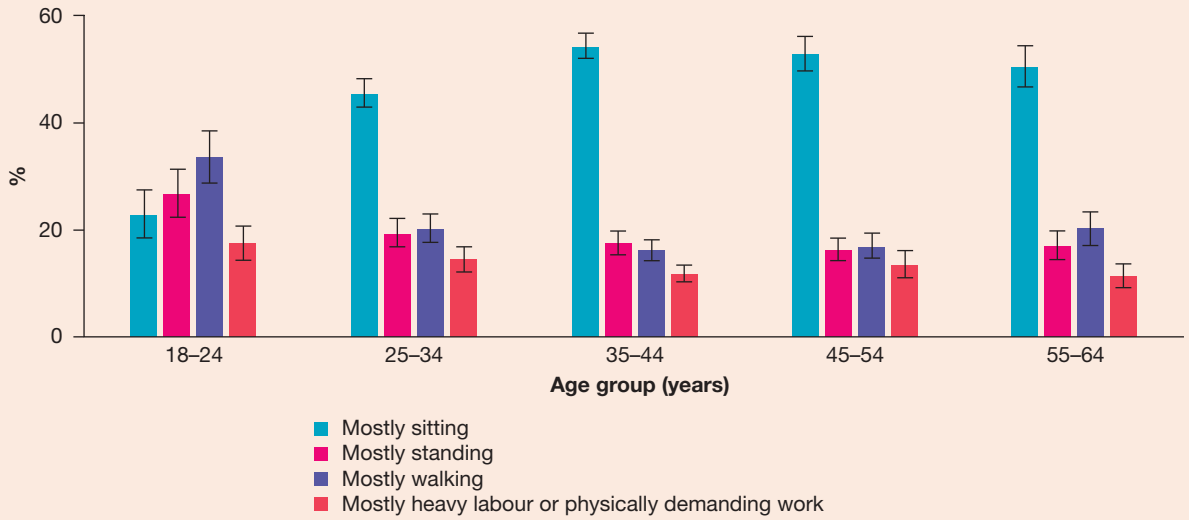
TEST your understanding

1. **Outline** why the government collects data on physical activity levels from surveys.
2. Provide four examples of sedentary behaviour.
3. Referring to figure 7.34, **identify** the percentage of Australian children aged between 5 and 17 who met both the physical activity and screen-based activity recommendations.
4. Using data from figure 7.34, **outline** whether most people aged 5–17 met the strength-based activity guideline.
5. A friend of yours is looking at the relationship between income and level of physical activity. Your friend says that the least disadvantaged group according to income has the highest level of physical activity, while the most disadvantaged group has the lowest level of physical activity. Your friend asks you to clarify this statement to help them understand what this means.

APPLY your understanding

6. Using data from figure 7.39, **explain** the relationship between SES and proportion of adults by whether they did zero minutes of physical activity in the last week.
7. a. **Outline** two trends in the following graph that represent a typical work day for adults.
   b. Using the data from the following graph, **identify** the group with the highest proportion of 'mostly sitting', and suggest two ways individuals could reduce sitting at work.

Proportion of adults aged 18–64 years by type of activity at work on a typical work day in the last week and age, 2022



Source: Australian Bureau of Statistics, *Physical activity 2022,* released 2023.

7.6 Exam questions

Question 1 (1 mark)

Outline the relationship between age and high-intensity physical activity levels, as found by the 2022 Australian Health Survey.

Question 2 (2 marks)

Using data, **outline** how popular football or soccer is for 15- to 17-year-olds compared to 18- to 24-year-olds.

Question 3 (2 marks)

Identify and **justify** who is more likely to be sufficiently active: someone who lives in a major city or someone who lives in a regional area.

7.7 Methods of assessing physical activity and sedentary behaviour

Key knowledge	Key skill
• subjective and objective methods of assessing physical activity and sedentary behaviour such as recall surveys or diaries, pedometry, observation tools, digital tools and wearable technology	• justify and use appropriate methods to measure and analyse physical activity and sedentary behaviour at the individual and population level

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

7.7.1 Assessing physical activity and sedentary behaviour

There are many reasons why governments assess physical activity and sedentary behaviour at the population level. These include the following:

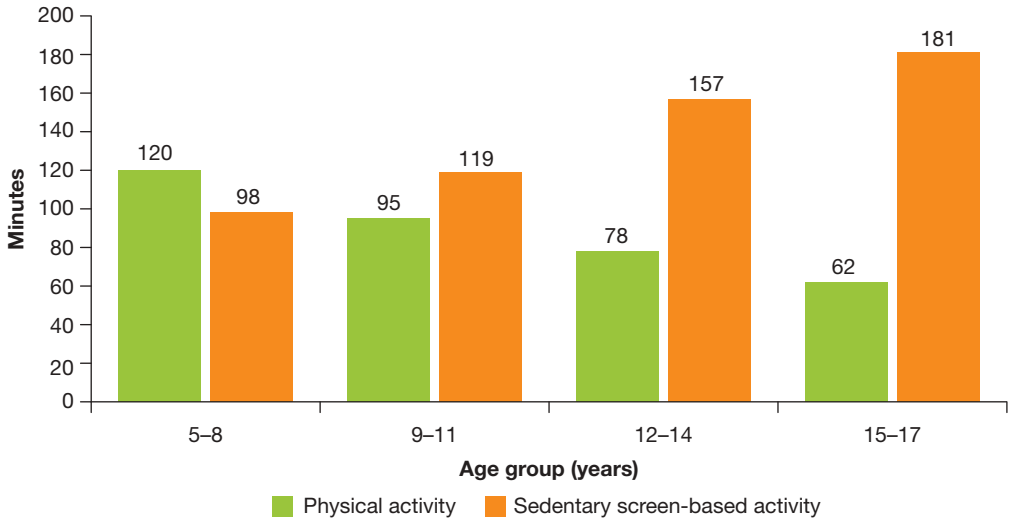
- to provide an evidence base for the behavioural determinants of health
- to help understand the key issues relating to physical activity and inactivity
- to track progress or lack of progress over time at a population level
- to highlight disadvantaged groups so that specific interventions can be developed to ensure appropriate interventions can be designed, implemented and assessed.

Figure 7.41 illustrates the vital role of population assessments, showcasing data from the Australian Health Survey that reveals key insights into the physical activity and sedentary patterns of various groups. This valuable information enables policy-makers to address the increasing trend in sedentary behaviours and the reduction in physical activity among all age groups.

In addition to assessing physical activity and inactivity for populations, there is value in assessing them at an individual level. Some benefits of assessing an individual's physical activity and sedentary behaviour include the following:

- to gather specific information about an individual
- to provide more accurate data for an individual, so appropriate strategies can be tailored to that person
- to provide information to enable an individual to highlight the strengths and weaknesses in their daily movement patterns
- to use the information as a motivational tool to encourage increased physical activity
- to use the information as a motivational tool to discourage sedentary behaviour
- to track an individual's level of activity over time to highlight patterns of behaviour (e.g. increased levels of sedentary behaviour over winter) so that trends can be identified and appropriate interventions put in place.

FIGURE 7.41 Evaluating physical activity in populations can initiate targeted interventions



Source: Australian Bureau of Statistics, *Australian Health Survey: Physical Activity*, 2013.

Do you keep track of your physical activity? By monitoring how active you are, you or your trainer can establish SMART goals. SMART goals are **s**pecific, **m**easurable, **a**ttainable, **r**elevant and **t**ime-bound. This not only offers valuable feedback and accountability but also gives you reasons to celebrate your achievements! Using fitness trackers or apps can simplify this process, making it more enjoyable and ensuring your exercise plan is tailored to your personal needs. Regularly reviewing and adjusting your goals based on your progress can lead to lasting health benefits, including improved overall wellbeing and a reduced risk of chronic diseases.

FIGURE 7.42 A personal trainer can record and track a client's level of physical activity and tailor a program to suit their needs.

There are a range of assessment tools. These are often categorised as either **subjective** or **objective**.

Subjective measures of physical activity rely on a person's perception, understanding and interpretation of an event (e.g. how hard you ran on Monday). These are often used for large populations (see figure 7.43). In contrast, objective measures are obtained via measurable or observable means and are often used for individuals (e.g. wearable technology).

7.7.2 Subjective measures of physical activity

Using recall surveys as an assessment tool

Recall surveys are a commonly used subjective measurement tool for assessing the physical activity and sedentary behaviour levels of a population, due to their ease of administration and cost-effectiveness. Depending on the purposes of the survey, there are a variety of types of recall surveys, ranging from brief to significantly more detailed versions.

As a subjective method, recall surveys typically ask an individual to recall their levels of physical activity or sedentary behaviour over a given time frame.

subjective judgement made by an observer with a set criteria

objective judgement that is based on something that can be measured by units of time, distance or some other measurement/units

FIGURE 7.43 Methods of measuring physical activity

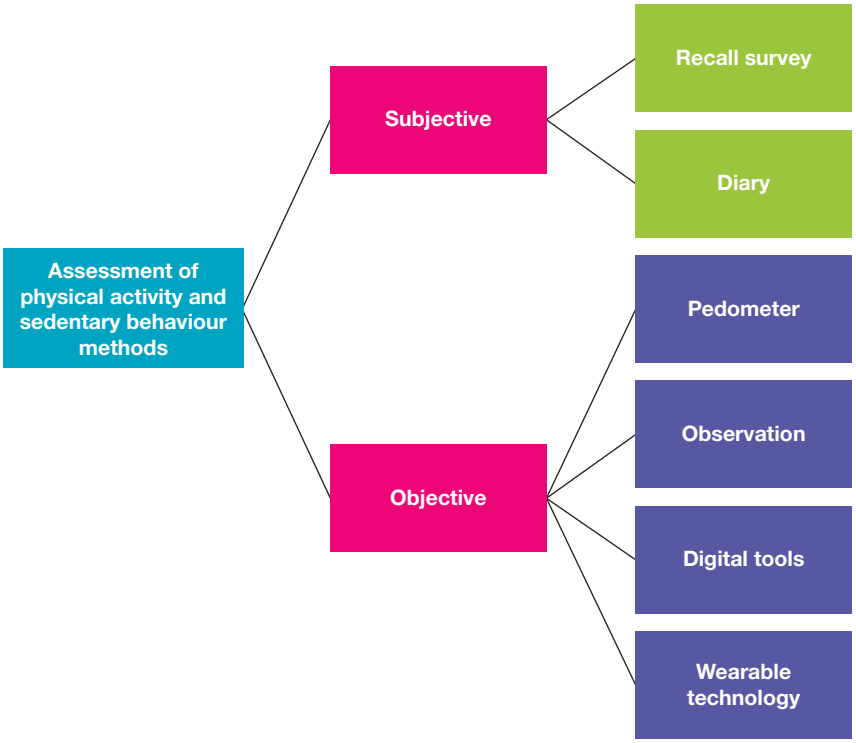


TABLE 7.9 Assessment tools as a measure of physical activity

	Frequency	Intensity	Type	Time	Sedentary behaviour
Recall survey	✓	✓	✓	✓	✓
Diaries	✓	✓	✓	✓	✓
Pedometer	✗	✗	✗	✗	✗
Observational tools	✓	✓	✓	✓	✓
Digital tools	✓	✓	✓	✓	✗
Wearable technology	✓	✓	✓	✓	✓

Short recall surveys are the quickest and easiest to undertake. This type of survey provides a swift assessment of both the domains and dimensions of physical activity, providing a basic overview of the physical activity and inactivity levels of population groups. Surveys like this would typically use a smaller number of questions and either be completed by an individual (known as a self-administered survey) or by an interviewer.

Longer self-recall surveys can be used and generally capture broad information. For example, a survey of an adult who is asked to recall the amount of sport and exercise they did as a child will have limited scope to record accurately the dimensions of health. An estimation of the type and frequency of sport might be all the researcher asks in such a survey.

TABLE 7.10 Advantages and disadvantages of recall surveys as an assessment tool

Advantages	Disadvantages
A cost-effective way of collecting large quantities of data	An increased likelihood of lower accuracy of data due to poor recall and a lack of understanding of the survey's requirements
Easy to administer and complete, often making it useful for large populations	Social desirability bias, when respondents exaggerate their physical activity levels and underestimate their level of sedentary behaviour
Can be used in a variety of formats including digital and print	The difficulty of accurately recalling details of past events, particularly over a longer period of time
Can be used to collect a broad range of data, including those often difficult to measure with devices	Not suitable for children under 10 years of age and older adults due to the cognitive limitations of these respondents
Take into consideration the context of physical activity and sedentary behaviour	Does not offer real-time monitoring of physical activity

Diaries as an assessment tool

Diaries are another subjective method of assessing levels of physical activity and sedentary behaviour. They share similar advantages to those of recall surveys.

Despite requiring diligent record-keeping, diaries capture rich information about the individual's activities, including how often, how hard and how long they exercise for, along with the exercises they tend to do. Information found in the diary is not limited to the dimension of physical activity. Diaries help us understand other underlying patterns — for example, how less likely it is that someone is going to exercise in the cold weather. Due to their limitations, diaries are best used in conjunction with other methods, such as wearable activity trackers, to increase their effectiveness and reliability, and supplement incomplete data.

TABLE 7.11 Advantages and disadvantages of diaries as an assessment tool

Advantages	Disadvantages
Can be used to record information whenever it is desired by those administering the test	The diary may become a burden to the person as they have to input information regularly.
The person filling out the diary doesn't have to recall information over a prolonged period, improving accuracy	Respondents become reactive to the presence of the assessment tool and therefore temporarily increase their physical activity levels.
Ease of administration	Diaries are prone to social desirability bias.
Low cost	Compared with surveys, diaries tend to have less prescriptive questions, and it is therefore harder to compare responses from different people.

For both recall surveys and diaries, there is an option to have an adult take a survey or fill in a diary on behalf of somebody else. Known as a proxy survey or proxy diary, these are used to collect data on behalf of those with limited cognitive ability, including children under 10, people aged over 80 and those with mental disabilities. A proxy report would typically be carried out by a parent, guardian, primary carer or a teacher.

FIGURE 7.44 Children under 10 have limited capacity to accurately recall their levels of physical activity and inactivity.

7.7.3 Objective measures of physical activity

Pedometer as an assessment tool

A pedometer is a device used to count the number of steps a person accumulates, typically over the course of a day. Traditionally, pedometers were worn on the hips, but modern advancements have incorporated pedometer functions into wrist-worn devices, such as smart watches (see figure 7.45). Traditional pedometers will count steps based on the motion of the hips, whereas smart watches worn on the wrist use advanced technology to detect movement.

Pedometers collect data and, depending on the type of model, can estimate the total distance covered during a day as well as the energy expenditure as a result of those steps. The pedometer's capacity to collect data means it is categorised as an objective assessment tool when collecting information regarding physical activity levels.

The recommendation to achieve 10 000 steps daily has gained recognition because of the considerable benefits to both physical and mental wellbeing. While pedometers may not precisely measure adherence to specific Australian Physical Activity and Sedentary Behaviour Guidelines, they can effectively serve as motivational tools, encouraging individuals to maintain an active lifestyle every day.

FIGURE 7.45 Pedometer functions can be seen and used in different ways.

TABLE 7.12 Advantages and disadvantages of pedometers as an assessment tool

Advantages	Disadvantages
A cheap tool (can be purchased from as little as a few dollars)	The limited dimensions that they can record; there is no scope to measure intensity and context.
A range of types available, with different functions including steps taken, distance covered and energy expended	They have no capacity to record upper body movement, nor can they measure swimming, cycling or gymnasium activity.
Some can be synced to other digital devices for data collection	They can be quite inaccurate for distance covered, particularly if users alter their usual stride length; this includes going up and down hills and stairs, or engaging in physical activity such as running or playing sport.
Easy to use	Users often experience reactivity when wearing a pedometer; this reduces the accuracy of data collected if used to measure the activity levels of an individual for the purposes of a population assessment of physical activity and sedentary behaviour.
Can record incidental exercise that occurs as a normal part of a person's day — activity that is often overlooked in surveys or diaries	They do not record sedentary behaviour.

Applying observational tools and a method of assessment

The aim of direct observation is to collect data that measures a participant's physical activity by type, duration and intensity, and the context of physical activity and inactivity. It offers an advantage over many other subjective and objective methods, such as decreasing the burden on people being assessed and improved accuracy. A trained observer is used to describe what the participant does in a particular setting. The trained observer would typically use a computer software program or application to record the information. Two common examples are SOFIT and SOPLAY; however, there are other digital direct observation tools which are increasingly being used.

FIGURE 7.46 Direct observation can occur in a PE class, where the student, teacher and lesson content are observed.

SOFIT

SOFIT (System for Observing Fitness Instruction Time) is designed to measure student physical activity, lesson context and teacher behaviour during PE classes (table 7.13). It will generally assess four students' levels of physical activity per class.

TABLE 7.13 What SOFIT measures

Measures	Examples
Student activity levels	Lying, sitting, standing, moderate (including walking) or vigorous activity
Lesson context	Analyses time spent in general content time (where students are not intended to be active during a PE class), knowledge content time (where the prime focus is on student acquisition of knowledge) and PE motor content (including fitness, skill practice, game play and other free play)
Teacher behaviour	Collects information about whether the teacher's behaviour or involvement promotes student physical activity

SOPLAY

SOPLAY (System for Observing Play and Leisure Activity in Youth) is used to directly assess physical activity in school students in free-play settings, such as during recess and lunch. A trained observer collects data either manually or digitally on the behaviour of groups of people in particular settings. This is done via a series of regular scans within the targeted setting. This includes:

- the number of students being active
- the type of activity
- the frequency of activity
- context, such as time of day, environmental conditions, temperature, presence of supervisors, area usability and availability of equipment
- behaviour comparisons of males versus females
- intensity of activity (either sedentary, walking or very active).

A similar program called SOPARC (System for Observing Play and Recreation Activity in Communities) is used in other community settings.

FIGURE 7.47 Recess and lunch are ideal times for physical activity to be observed in a free-play setting

TABLE 7.14 Advantages and disadvantages of observational tools for assessment

Advantages	Disadvantages
It is useful for assessing the activity levels of children in a range of settings.	It can be time-consuming to collect and analyse data.
The use of trained observers increases the accuracy of data collected.	It can be costly if trained professionals need to be used to increase accuracy.
There are free online guides for teachers and other data collectors who are interested in using assessment tools such as SOFIT and SOPLAY.	An awareness of the observer may increase reactivity.
It has the capacity to be used in conjunction with other methods, such as accelerometry, to provide a more accurate description of physical activity levels.	There is decreased accuracy when group size increases.

Using wearable devices as an assessment tool

Wearable technologies are devices equipped with sensors, screens, processors, memory and software with algorithms to filter, interpret, organise and store the raw data collected. They can connect to the internet and present data to users in real-time or as retrospective reports (Sousa et al., 2023). The devices available today help users understand their movement patterns over time and improve their daily lives, which includes preventing injuries from excessive overload.

FIGURE 7.48 Wearable devices are highly individualised and provide a lot of information for the user.

Wearable devices often feature in-built **accelerometers** and, in some instances, incorporate **inclinometry** to record more accurate data, particularly regarding sedentary behaviour. Inclinometers are mechanical or electronic devices used for objective data collection, measuring the angle of slope of an object, including the angle of incline of a human body. Hence, they can determine whether a person is lying, sitting or standing.

accelerometer a device that measures the acceleration or vibration of an object

inclinometry the measurement of angles, slope and tilt as well as elevation and/or depression

Wearable devices are increasingly personalised, allowing users to input personal information that enhances the accuracy of data collected. Moreover, there is a growing market for wearable technology used to measure physical activity, including watches and wristbands.

There is a variety of types available for use. They can measure a range of dimensions in any of the following combinations:

- steps taken
- distance travelled
- speed of movement
- sedentary behaviour, including sleep time
- energy expenditure (using algorithms to estimate this dimension based on body
- weight, duration and intensity of movement
- intensity via heart rate (through the skin via watch or bracelet)
- different modes of activity such as running, walking or cycling.

FIGURE 7.49 The popularity of wearable tech is rapidly increasing, with a growing number of people using this technology while exercising.

TABLE 7.15 Advantages and disadvantages of wearable devices as assessment tools

Advantages	Disadvantages
Can provide rich real-time data for the individual	Can be expensive (especially those with advanced features)
Have the capacity to measure physical activity and sedentary behaviour	Can still cause some reactivity (although less than other tools such as pedometers)
Has the capacity to measure any dimension	Individual differences in physiology may lead to inaccurate results.
Can be used in many different contexts (e.g. outdoor, water, remote locations and inside)	Some people may find it challenging to use the technology in a meaningful way.

Digital tools to measure physical activity levels

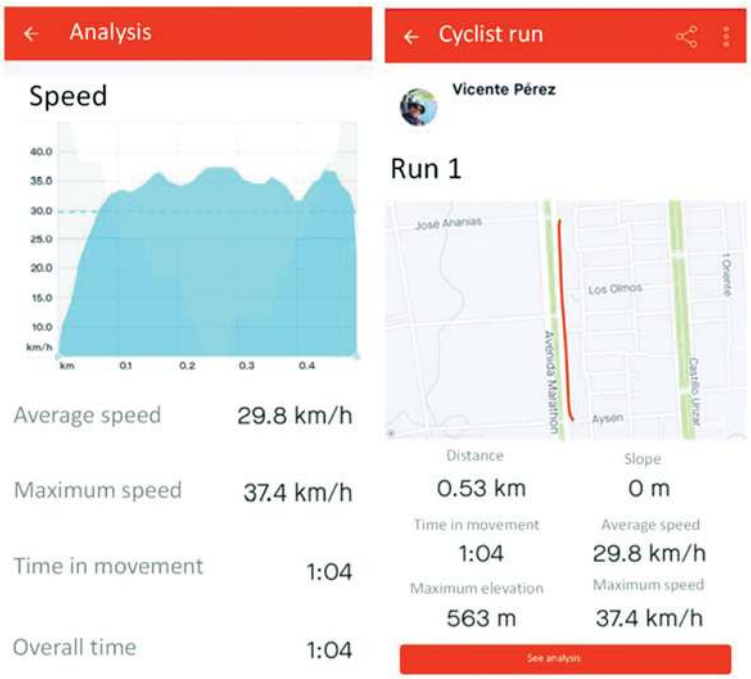
Digital tools, which encompass a wide range of devices such as tablets, computers and smartphones, use applications and software programs to track physical activity and sedentary behaviour levels. Today, many digital tools are available as smartphone and/or tablet apps.

Strava, for example, is an app that many athletes use to measure their progress over time. With capabilities to analyse progress and performance at the user's fingertips, Strava provides valuable insights for athletes and fitness enthusiasts alike.

TABLE 7.16 Advantages and disadvantages of digital tools for assessment

Advantages	Disadvantages
Has the capacity to measure physical activity and sedentary behaviour	Can be expensive (especially those with advanced features)
Has the capacity to measure physical activity and sedentary behaviour	Some people may find it challenging to use the technology in a meaningful way.
Allows individuals or coaches to review in-depth data to make future decisions about physical activity	Requires continual internet access, which may be difficult in some locations

FIGURE 7.50 Strava is an app that many exercise enthusiasts use to monitor their progress.



Selecting an assessment tool

Selecting an assessment tool depends on a range of factors. There is generally an inverse relationship between accuracy and practicality in the collection of physical activity and sedentary behaviour data. In other words, the higher the accuracy, the lower the practicality and the lower the accuracy, the higher the practicality.

7.7 Activity

7.7 Quick quiz on

7.7 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 4	5, 7	3, 6, 8

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **List** three reasons why assessment of physical activity and sedentary behaviour at the population level is necessary.
2. **List** three reasons why assessment of physical activity and sedentary behaviour at the individual level is necessary.
3. **Explain** the difference between a recall survey and a recall survey by proxy. In what circumstances should a proxy recall survey be used as a physical activity assessment tool?
4. **Outline** the difference between wearable technology and digital tools in measuring physical activity.
5. **Describe** why direct observation offers an advantage over other subjective and objective physical activity and sedentary behaviour assessment tools.

APPLY your understanding

6. You are a primary school PE teacher. You are trying to encourage students to increase their level of movement during the school day. You have heard that pedometers cause reactivity. **Explain** what the term *reactivity* means. **Outline** two advantages and disadvantages of using pedometers in a school context.
7. Research the latest wearable technologies. Select one that would suit your lifestyle and **describe** what this tool can measure.
8. Using an example of a marathon runner, **justify** the use of a wearable device during training.

7.7 Exam questions

Question 1 (2 marks)

Outline two situations in which you would avoid using recall surveys.

Question 2 (2 marks)

Outline a similarity and a difference between recall surveys and diaries.

Question 3 (3 marks)

List three advantages of subjective measures of physical activity such as recall surveys and diaries.

7.8 Key skills

Key skills

- participate in and explain different types of movement experiences including a variety of culturally diverse and inclusive physical activities
- participate in a variety of movement experiences to reflect on and record information related to the physical, social, mental, emotional and spiritual benefits of physical activity
- investigate, through participation, the sociocultural influences on physical activity behaviour across the lifespan
- analyse patterns and influences on physical activity participation across the lifespan
- analyse and interpret secondary data related to physical activity behaviour to explain outcomes of physical activity and sedentary behaviour
- justify and use appropriate methods to collect and analyse data related to physical activity and sedentary behaviour at the individual and population levels

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

7.8.1 Tell me

To address these key skills for this topic, it is important to remember the following:

- it is important to be involved in movement experiences and be able to analyse a variety of different movement experiences
- link movement experiences to the benefits for all the dimensions of health and wellbeing
- the Australian Physical Activity and Sedentary Behaviour Guidelines need to be mapped to the appropriate age classification
- select appropriate assessment methods when asked to measure and analyse both physical activity and sedentary behaviour levels, for either an individual or for a large population group
- there are trends and factors that affect engagement in physical activity throughout life
- during the data collection period, you may need to collect your own data (primary data) or work with data collected from other people or researchers (secondary data)
- when selecting the appropriate method, you will need to explain the advantages and disadvantages of the assessment methods in order to justify your selection.

7.8.2 Show me

Practice question (11 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

Below is a completed diary for a 17-year-old female named Alex.

Day	Time	Type	Intensity	Others
Monday	45 minutes	Strength	Moderate	Video games: 3 hours
Tuesday	30 minutes	Cycling (aerobic)	High	
Wednesday	Rest day	Rest	N/A	Movies: 3 hours
Thursday	60 minutes	Strength	High	
Friday	45 minutes	Running (aerobic)	Moderate	
Saturday	30 minutes	Running (aerobic) Dancing	High Moderate	
Sunday	Rest day	Rest	N/A	Movies: 2 hours

a. **Outline** two potential mental health *benefits* of Alex completing her physical activity plan. (2 marks)

b. **Identify** a *potential negative* health outcome for Alex sustaining her sedentary behaviour (1 mark)

c. **Explain** how two sociocultural factors could influence Alex's sedentary behaviour. (4 marks)

d. **Discuss** one *advantage and one disadvantage* of Alex using a diary to measure her physical activity levels. (2 marks)

e. **Justify** whether Alex's physical activity plan would allow her to meet both the physical activity and sedentary behaviour guidelines for her age group. (2 marks)

Decode the question

Strategies to decode the question

- **Identify the action word:**
  Identify — determine the key characteristics or features
  List — enter in a list with others
  Outline — general description but not in detail
  Explain — provide detail to show the relationship between concepts
  Justify — prove with reasoning why an option chosen is the best
- **Key terminology —** *benefits, potential negative, advantage and disadvantage*
- **Key concept/s —** Physical activity and sedentary behaviour guidelines, mental health, sedentary behaviour, physical activity
- **Marking scheme —** 11 marks — always check marking scheme for depth of response required, linking to key information highlighted in the question

Sample response and marking scheme

a.
- Improved self-confidence from accomplishing the task
- Decreased stress levels as Alex now knows that she can complete the activity plan

Award 1 mark for each mental health benefit.

b.
- Cardiovascular disease
- Type 2 diabetes
- Cancer
- Obesity
- Mental health issues, such as depression

Award 1 mark for listing any of the above.

c. **Income:** *high-income households may have more disposable income* to provide technological gadgets (e.g. gaming consoles to play video games) that encourage Alex's sedentary behaviour.
Families: *may not set boundaries* around screen time and encourage other forms of entertainment which could have *contributed* to Alex's sedentary behaviour on Wednesday and Sunday
Award 1 mark for each sociocultural factor.
Award 1 mark for a meaningful link from a sociocultural factor to sedentary behaviour.

d.
- Alex's diary is likely to be an *accurate and reliable* source of her physical activity behaviour activities because she can record them in real-time shortly after they occur.
- Alex might find the diary *burdensome* since she must consistently record her activities over time. This could lead to her using the diary less frequently over an extended period, ultimately compromising its accuracy.

Award 1 mark for discussing one advantage of using a diary.
Award 1 mark for discussing one disadvantage of using a diary.

e.
- Alex needs to be active every day, in as many ways as possible, Alex was not active on Wednesday or Sunday, not adhering to this guideline.
- Alex needs to ensure she is *not engaged in screen-based activity* for any longer than 2 hours per day. On Monday and Wednesday, she exceeded this time, and therefore *did not adhere* to this guideline.

Award 1 mark for justifying why Alex has not met the physical activity guidelines and one mark for justifying why she hasn't met the sedentary behaviour guidelines.

7.8.3 Let me do it

Question 1 (5 marks)

Sally, a 15-year-old secondary-school student, engaged in the following physical activity during one week.

Frequency of activity = 7 days

Intensity of activity = moderate

Total duration over the week = 120 minutes

Type = aerobic activities, including running and swimming

a. Using the information above, **explain** the area of weakness for Sally, an adolescent, in relation to one of the four dimensions of the Australian Physical Activity and Sedentary Behaviour Guidelines. **(2 marks)**

b. Using your knowledge of the guidelines, **justify** to Sally what she needs to do to meet all four of the dimensions listed above. **(2 marks)**

c. Identify a physical health benefit for Sally if she were able to meet the physical activity guidelines on a regular basis. **(1 mark)**

7.9 Review

Hey students! Now that it's time to revise this topic, go online to:

Review your results

Watch teacher-led videos

Practise exam questions

Find all this and MORE in jacPLUS

7.9.1 Summary

Physical activity and its influences

- Physical activity is any activity that involves or requires some form of physical exertion.
- There are many types of physical activity, such as play, games, sports (informal and formal), chores, exercise and recreational activities.
- The type of physical activity generally engaged in changes across the lifespan.
- Engaging in regular movement has physical, emotional, mental, social and spiritual benefits.
- Sociocultural factors can act as both enablers and barriers to individual physical activity. They include:
  - gender
  - family
  - socioeconomic status (SES)
  - community
  - cultural norms
  - peers.
- The barriers and enablers of physical activity and sedentary behaviour can differ greatly from person to person and across the lifespan.
- Sedentary behaviour involves activities requiring little to no movement.
- The Australian Physical Activity and Sedentary Behaviour Guidelines have been developed to educate people about the benefits of being active and the dangers of being inactive.
- The Australian Physical Activity and Sedentary Behaviour Guidelines have been developed for children, adolescents, adults and older Australians.

Assessing physical activity levels

- Poor health outcomes associated with physical inactivity and sedentary behaviour include chronic health conditions such as diabetes mellitus, some cancers, obesity, cardiovascular disease and osteoporosis.
- Unfortunately, most Australians do not meet the Australian Physical Activity and Sedentary Behaviour Guidelines.
- Data collected by government and non-government agencies helps identify at-risk groups of the population.
- On average, children in Australia spend too much time in front of a screen, not being active.
- There is a clear relationship between SES and increased physical activity.
- There are trends that can be identified via collection of data; for example, males are more active than females, and, as adults get older, they are less likely to engage in vigorous physical activity.
- Most Australians do not engage in strength-based activities.
- Assessment of the physical activity and sedentary behaviours of individuals and population groups can be done by using assessment tools, which are categorised as either objective or subjective.
- Subjective assessment tools include recall surveys and diaries.
- Objective assessment tools include pedometers, wearable technologies and other digital tools.
- There are advantages and disadvantages of each assessment tool.
- Often two or more assessment tools are used to increase the accuracy of the information collected.
- Assessment tools are becoming more accurate due to advances in information communications technology.
- Generally, the higher the accuracy of an assessment tool, the lower the practicality (and vice versa).

Resources

Interactivity Physical activity and sedentary behaviour: sociocultural influences, enablers and barriers quiz (int-6652)

7.9.2 Key terms

accelerometer a device that measures the acceleration or vibration of an object
barrier something that prevents progress or makes it difficult for an individual to achieve something
demographics the physical characteristics of a population, such as age, gender, ethnicity, family size, job status and education.
enabler something that makes it possible for a particular thing to be done
inclinometry the measurement of angles, slope and tilt as well as elevation and/or depression
METs (metabolic equivalents) commonly used to express the intensity of physical activities. A MET is the ratio of a person's working metabolic rate relative to the resting metabolic rate. Your MET level would be 1 if you were generally sedentary (e.g. lying down, reading or sitting and talking). Participation in an activity of moderate intensity would result in a MET level of 3–6.
objective judgement that is based on something that can be measured by units of time, distance or some other measurement/units
physical activity any movement of the body produced by skeletal muscles, resulting in energy expenditure
physical inactivity a lack of involvement in physical activity during an individual's leisure time
sedentary behaviour behaviour associated with sitting or lying down, including activities such as watching television, working or playing on the computer, driving or sitting in a car, bus or train. It also includes homework, studying or reading.
socioeconomic status (SES) a term used to describe the social and economic situation of an individual. It incorporates three components: education, occupation and income.
subjective judgement made by an observer with a set criteria
type 2 diabetes a condition that affects how the body uses sugar (glucose) for energy and stops the body from using insulin properly

7.9 Exam questions

7.9 Section A — Multiple choice questions

Question 1 (1 mark)

Physical activity has been shown to:

A. increase the chance of illness.
B. promote mental illness.
C. increase the chance of diabetes mellitus.
D. decrease the risk of osteoporosis.

Question 2 (1 mark)

Being active improves mental health and reduces the chance of mental illnesses such as:

A. stress, diabetes mellitus and anxiety.
B. anxiety, depression and stress.
C. cardiovascular disease and obesity.
D. obesity, stress and depression.

Question 3 (1 mark)

Which of the following is the correct definition of social health?

A. The ability to be happy
B. The capacity to get on well with others
C. The ability to run a marathon
D. The ability to communicate effectively

Question 4 (1 mark)

The recommendations for Australians about appropriate levels of activity and sedentary behaviour are called the:

A. Australian Physical Activity Guidelines.
B. National Guidelines.
C. Australian Physical Activity and Sedentary Behaviour Guidelines.
D. Australian Sedentary Behaviour Guidelines.

Question 5 (1 mark)

Which of the following statements is correct?

A. Subjective assessment refers to information obtained from a stopwatch or other measuring device.
B. Objective assessment refers to information obtained from a person's ideas.
C. Objective assessment refers to information obtained from a person's perception, understanding and interpretation of an event.
D. Subjective assessment refers to information obtained from a person's perception, understanding and interpretation of an event.

Question 6 (1 mark)

Respondents to surveys exaggerate their physical activity levels and underestimate their level of sedentary behaviour. This is known as:

A. reactivity.
B. social desirability bias.
C. cognitive limitations.
D. reflexivity.

Question 7 (1 mark)

Devices that measure steps taken during a day are called:

A. inclinometers.
B. heart-rate monitors.
C. accelerometers.
D. pedometers.

Question 8 (1 mark)

SOFIT, a software program used to assess physical activity, is used in conjunction with which of the following methods?

A. Direct observation
B. Recall survey
C. Proxy report
D. Diary

Question 9 (1 mark)

The following is a common trend in Australia.

A. As adults age, their levels of vigorous activity decrease.
B. Females become more active as they get older.
C. The older you get, the more active you become.
D. The less you work, the more physical activity is done.

Question 10 (1 mark)

SES is a significant indicator of healthy behaviour. SES is an acronym for:

A. social and economic standards.
B. student education services.
C. socioeconomic status.
D. stable economic situation.

7.9 Section B — Short answer questions

Question 1 (4 marks)

Source: Adapted from *2018 ACHPER Exam Unit 2, Section B, Q1; © ACHPER*

Andre is a 17-year-old student at Cambrook Secondary College and his weekly activity plan is outlined below.

School day	Before school	During school	After school
Monday	Walk to school 15 minutes		
Tuesday		PE class (Netball) 45 minutes	Football training 90 minutes
Wednesday	Walk to school 15 minutes		
Thursday		Lunchtime cricket with friends 30 minutes	Football training 90 minutes
Friday	Walk to school 15 minutes	PE class (Soccer) 45 minutes	
Weekend	**7am – 9am**	**9am – 4pm**	**4pm – 9pm**
Saturday	Walk the dog 35 minutes		
Sunday	Football game 120 minutes		

Refer to frequency, type, time and intensity, to **justify** whether Andre has met the Australian National Physical Activity Guidelines.

Question 2 (3 marks)

Source: Adapted from *2018 ACHPER Exam Unit 2, Section B, Q2; © ACHPER*

Outline what is meant by MET, and provide two examples of leisure or sports activities that involve moderate physical activity.

Question 3 (2 marks)

Outline two limitations of pedometers as a measure of physical activity levels.

Question 4 (3 marks)

Source: *2022 ACHPER Exam Unit 2, Section B, Q.12; © ACHPER*

The managers of Ageing Well nursing homes have developed a new procedure to promote healthy ageing among their residents. The updated procedures are for staff who work and care for residents such as nurses, personal care workers and activities coordinators. They focus on professional development, enabling staff to expand their knowledge, skills and advice when promoting physical activity.

The training includes support for the elderly when considering their readiness to be physically active, existing medical conditions via screening and an emphasis on incidental and leisure activities within the grounds of the nursing home. Ageing Well strives to provide access to specialists, such as physiotherapists, exercise physiologists and fitness instructors, and include regular scheduled opportunities for residents to become involved in physical activity. Residents are supported by specialists to use their surrounding gardens, parks and footpaths in their activity schedules.

Discuss whether a subjective or objective method would be suitable for this population group. Ensure you include an example of your chosen method.

Question 5 (3 marks)

Using active transport is a common way in which people can increase their physical activity. **Define** and give two examples of active transport.

Continue to build your exam skills

Access the Unit 2 Area of Study 1 Review at the end of Topic 9. This includes:

- Practice extended response
- Practice examination
- Practice school-assessed coursework

8 Strategies to increase physical activity and reduce sedentary behaviour

8.1 Overview

Hey students! Bring these pages to life online

Watch videos

Engage with interactivities

Answer questions and check results

Find all this and MORE in jacPLUS

LEARNING SEQUENCE

8.1 Overview
8.2 The social-ecological model
8.3 Population-based initiatives that promote physical activity
8.4 Key skills
8.5 Review

8.1.1 Introduction

What influences your decision to engage in physical activity? Are there uncontrollable factors contributing to a **sedentary lifestyle**? The challenge of promoting physical activity extends beyond simple encouragement, requiring interventions that navigate complex layers of influence.

In Victorian government schools, students in Years 7–10 must receive 100 minutes of physical education each week. However, the success of such policies hinges not only on compulsory participation but also on the individual's readiness to engage and the availability of a supportive physical and social environment. This topic delves into the effectiveness of population-based initiatives aimed at promoting physical activity and equips you with the tools to critically assess their impact.

FIGURE 8.1 Encouraging regular and consistent physical activity from a young age can set up positive habits for life.

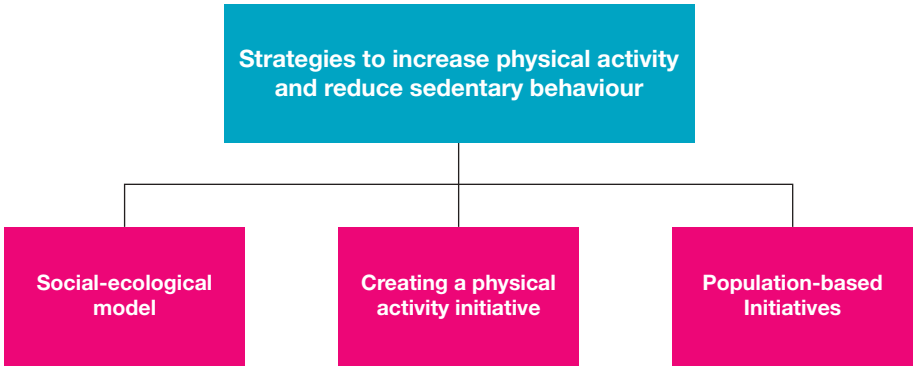
sedentary lifestyle when an individual spends six or more hours a day sitting or lying down, without any significant physical movement in their daily life

8.1.2 Key knowledge and Key skill

Key knowledge	Key skill	Subtopic
• components of the social-ecological model (individual, social environment, physical environment and policy)	• apply the social-ecological model to critique and create physical activity initiatives and strategies aimed at increasing physical activity and/or reducing sedentary behaviour	**8.2**
• a range of population-based initiatives that target enablers of and barriers to physical activity		**8.3**

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

8.1.3 Topic overview



8.2 The social-ecological model

Key knowledge	Key skill
• components of the social-ecological model (individual, social environment, physical environment and policy)	• apply the social-ecological model to critique and create physical activity initiatives and strategies aimed at increasing physical activity and/or reducing sedentary behaviour

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

8.2.1 The social-ecological model

Physical activity and sedentary behaviour are influenced by many factors. A **systems-thinking** approach is often used by experts to explain the complex nature of human behaviour. A system can be described as something that consists of elements that:

- interact with each other
- are interrelated, meaning all factors influence each other
- are interdependent, meaning each factor depends on each other.

Your environment affects your decisions to engage in physical activity, and your individual choices affect your environment. For example, the decision to ride your bike to school is often motivated by a desire for physical activity and supported by a community culture that values active lifestyles, in which individuals and families encourage each other to engage in such behaviours.

This choice is enabled by a physical environment equipped with safe, dedicated bike lanes that have been created as a result of policies aimed at promoting active transport. These policies, often influenced by community advocacy for safer, more accessible and attractive routes, illustrate how the built environment shapes our daily activities. Therefore, the choice to ride to school is not only a personal one but also deeply influenced by the social environment, the physical infrastructure and supportive policies. Together, these factors interact and depend on each other, collectively shaping the physical activity levels in our community.

Understanding the interactions, interrelationships and interdependence of the factors that influence physical activity and sedentary behaviour provides many challenges to promoting physical activity, but provides opportunities for innovative solutions.

By considering various factors, we can critique the likely effectiveness of programs and create our own programs to help make communities healthier.

This topic will use the social-ecological model as it applies to physical activity. This approach attempts to explain the interrelationships between people and their environment. Models such as the social-ecological model have evolved and been adapted in line with an understanding of the multiple factors that influence behaviour.

8.2.2 Components of the social-ecological model

The **social-ecological model** is a framework used to develop, implement and critique health-promotion strategies aimed at improving people's health by promoting physical activity and limiting sedentary behaviour.

There are four components of the social-ecological model. The individual is at the centre, followed by the social environment, the physical environment and policy. The social-ecological model is seen as a series of circles that overlap and interrelate, with each circle representing a different component or layer of the model.

systems thinking a framework for understanding the world by the ways that different entities within a system influence one another

social-ecological model a framework used to develop, implement and critique health-promotion strategies aimed at improving health by promoting physical activity and limiting sedentary behaviour

FIGURE 8.2 The socio-ecological model aims to develop, implement, and evaluate health-promotion strategies to encourage increased physical activity and reduced sedentary behavior. This example considers riding your bike to school.

FIGURE 8.3 The social-ecological model is used to design, implement and critique strategies and programs aimed at promoting physical activity and discouraging sedentary behaviour.

8.2.3 The individual

At the centre of the social-ecological model is the individual component. It incorporates all the personal factors that influence physical activity and sedentary behaviour. Some of the factors in the individual layer that affect how people think and behave are described in table 8.1. Table 8.1 describes how these factors impact our physical activity and our sedentary activity.

TABLE 8.1 Individual factors that influence physical activity and sedentary behaviour

Individual factor	Description	Impact on physical activity	Influence on sedentary behaviour
Knowledge and education	Understanding the benefits and consequences of physical inactivity	Knowledge and education about physical activity promote a greater understanding of the benefits of physical activity, leading to increased participation, improved physical health and commitment to regular exercise routines.	Inadequate knowledge of the consequences of physical inactivity may lead to increased sedentary behaviour
Attitudes and beliefs	An individual's view on the importance of physical activity for their health	Positive attitudes towards physical activity promote increased participation in exercise, enhanced physical health and sustained motivation for regular physical activity.	A poor attitude towards physical activity can decrease the amount of movement an individual engages in each day (e.g. choosing to drive to school when it takes a short time to walk).
Perceived barriers	Obstacles that a person believes stop them from engagement in physical activity (e.g. lack of time).	A person who recognises the barriers can find creative solutions to stay active (e.g. someone short of time can find a way to do at-home exercises with minimal equipment).	People find it easier to make excuses for their sedentary behaviour when they encounter barriers to physical activity.
Motor skills	The ability to perform physical tasks that require voluntary movement from the muscles	People with good motor skills are more likely to have increased confidence in all physical activities, and especially ones that require complex movement.	Poor motor skills can lower self-esteem and increase the likelihood of a person withdrawing from physical activity.
Motivation and enjoyment	The internal drive to be physically active. This internal drive is also known as **intrinsic motivation**, which is a desire to do something for its internal rewards such as learning and exploring, rather than a desire to do something due to an external reward or to please another person.	Intrinsic motivation to be active is strongly associated with higher levels of activity over a person's lifetime.	A lack of motivation or enjoyment in physical activities can lead to an individual adopting a sedentary lifestyle.

FIGURE 8.4 The development of motor skills builds the confidence that allows many opportunities for lifelong physical activity.

intrinsic motivation an individual's inner drive to perform a certain action or behave in a specific way. Examples include doing something for pleasure or believing a specific action is the correct thing to do.

TABLE 8.1 Individual factors that influence physical activity and sedentary behaviour *(continued)*

Individual factor	Description	Impact on physical activity	Influence on sedentary behaviour
Age and gender	How old a person is and their gender (e.g. male, female, non-binary) can influence a person's physical activity levels.	A culture that promotes physical activity for people of all ages and genders has a positive impact on the participation rates of the community.	Older people may find it more difficult to exercise due to decreased physical capacity.
Socioeconomic status (SES) of the individual	Socioeconomic status (SES) is a term used to describe the social and economic situation of an individual. It incorporates level of education, occupation and income.	The higher the SES of a person, the more likely they are able to have access to the resources needed for physical activity, promotion participation.	Lower SES may increase sedentary behaviour due to inability to afford equipment or fees associated with physical activity.
Self-efficacy	**Self-efficacy** is a term used to describe an individual's belief that they can perform at a level where specific tasks can be achieved and goals attained	Individuals with high degrees of self-efficacy are likely to show more resilience when completing a task, particularly when overcoming barriers, leading to persistence and success.	Low self-efficacy can make sedentary options more appealing, as individuals may doubt their ability to engage in physical activities.
Injuries and disabilities	Physical conditions that affect the types and intensity of physical activity that is possible.	Injuries restrict the types of activity possible for an individual and can make it more difficult to engage in sufficient activity	Physical limitations can lead to increased time spent being sedentary, especially if the condition or disability is severe.

FIGURE 8.5 There are many individual factors that influence whether an individual engages in physical activity.

self-efficacy an individual's belief that they can execute behaviours that can achieve a certain level of success

8.2.4 Social environment

The next layer in the social-ecological model is the social environment, which has a significant influence on the individual. Many of the social environment factors that influence an individual's level of physical activity are discussed in table 8.2.

TABLE 8.2 Social factors that influence physical activity and sedentary behaviour

Social environmental factor	Description	Impact on physical activity	Influence on sedentary behaviour
Family	The activity levels of parents and siblings serve as models for children, influencing their physical activity habits. Family support through funding and transportation is also significant.	Parents who pay membership fees, provide sports equipment and uniforms, and transport their children to these sporting and leisure-time commitments are demonstrating high levels of support for physical activity.	An inactive family environment can limit exposure to activity opportunities, promoting sedentary habits.
Spouse or partner	An individual's romantic partner can serve as a source of motivation for their physical activity choices.	Couples who enjoy being active together can encourage each other's fitness and health, often participating in activities like walking, riding or gym sessions together.	A partner's preference for sedentary leisure time can influence the other to engage in less physical activity (e.g. watching movies).
Peers	Peers of similar age can positively or negatively influence an individual's activity levels, through encouragement or the lack of it.	Examples include an individual deciding to take on a new sport because their friends have encouraged them to join, and another who drops out of a sport because their friends have left.	Negative peer pressure or lack of interest can lead to dropping out of sports, increasing sedentary behaviour.
Institutions and organisations	Schools, workplaces and community organisations can play pivotal roles in promoting or inhibiting physical activity through their policies and the opportunities they provide.	Supportive environments can significantly increase regular physical activity among their members. Local sports clubs provide an environment that makes it easier to be physically active.	Lack of institutional support or programs can reduce opportunities for physical activity and promote sedentary behaviour.
Social support	Living in a community with strong social support networks can encourage greater levels of physical activity.	Strong social support is linked to higher physical activity levels, as communal encouragement can motivate individuals.	Isolation or lack of social support can make an individual withdraw from physical activity.
Healthcare professionals and educators	Professionals such as doctors, coaches and teachers can influence individual behaviours towards more active lifestyles through advice and encouragement.	Recommendations and encouragement from trusted authorities (e.g. teacher, coach) can significantly motivate individuals to be more active.	Lack of guidance or encouragement can contribute to sedentary choices.
Community norms and cultural background	The prevailing behaviours and views within a community, as well as cultural attitudes towards physical activity, can heavily influence individual behaviours.	Communities that value physical activity can foster high levels of participation among their members.	Cultural discouragements or norms against physical activity can hinder participation, especially among women.
Socioeconomic status of the community	A community's income, education and employment levels can affect its overall activity levels, similar to the SES of individuals.	Higher SES communities tend to have more resources and opportunities for physical activity, leading to higher participation rates.	Lower SES communities may face barriers to access, leading to increased sedentary lifestyles.

FIGURE 8.6 Couples who enjoy being active together can encourage each other to be fit and healthy.

FIGURE 8.7 Local sporting clubs and institutions can provide opportunities to increase physical activity.

8.2.5 Physical environment

The physical environment is the natural and human-made environment in which physical activity can take place. Like other factors, it can have either a negative or positive impact on an individual's physical activity levels. The physical environment can determine the type and duration of activities that an individual undertakes. The factors in the physical environment that influence physical activity are listed in table 8.3.

FIGURE 8.8 A physically appealing environment, such as Australia's coast, can promote physical activity levels

TABLE 8.3 Physical environmental factors that influence physical activity and sedentary behaviour

Physical environmental factor	Description	Impact on physical activity	Influence on sedentary behaviour
Natural factors	Weather and geography significantly influence the types of physical activities that are feasible and appealing. Warmer, sunnier climates tend to encourage more outdoor activity, while colder, less favourable weather conditions can decrease activity levels.	Increased sunlight and warmer temperatures correlate with higher physical activity levels due to greater opportunity and accessibility. Proximity to different geographical features (e.g. beaches or mountains) also dictates the kinds of sports and activities that are readily accessible.	Colder, windier conditions with less daylight can lead to decreased physical activity, promoting more sedentary behaviours.
Availability and access to sport and recreational facilities	The presence of parks, playgrounds, tracks, gymnasiums, and sports fields can encourage physical activity by providing the necessary infrastructure for a variety of sports and exercises.	Greater access to diverse facilities in urban areas promotes increased physical activity among community members.	Limited facilities in rural areas can decrease opportunities for physical activity, potentially increasing sedentary time.
Aesthetics	Aesthetics refers to the perceived qualities of a particular facility or environment. The visual and physical appeal of an environment or facility can enhance or diminish the desire to engage in physical activities in that space.	Aesthetically pleasing environments encourage more outdoor physical activity by making it enjoyable. A flat walking track surrounded by flowers and trees that provide shelter from sun and wind is likely to increase physical activity levels.	Unattractive or poorly maintained environments may deter people from engaging in outdoor activities, promoting sedentary behaviour.
Weather	Weather refers to the atmospheric conditions present in a specific place at a particular time, including temperature, precipitation, humidity, wind, and atmospheric pressure.	Good weather (e.g. sunny) encourages outdoor activities, such as surfing, running and cycling.	Extreme weather conditions can lead to increased time indoors doing sedentary activities (e.g. watching TV).

TABLE 8.3 Physical environmental factors that influence physical activity and sedentary behaviour *(continued)*

Physical environmental factor	Description	Impact on physical activity	Influence on sedentary behaviour
Geography	Geography refers to Earth's landscapes, environments, and the relationships between people and their surroundings.	Natural landscapes such as parks and trails promote walking and hiking. Coastal areas promote engagement in beach activities such as swimming and surfing	Coastal areas are often sites for sunbathing, which can increase sedentary behaviour.
Safety	Safety encompasses a range of factors such as crime rates, traffic and terrain. Safety concerns, such as high crime rates, traffic density, and unsafe terrain, can significantly affect a person's willingness to engage in physical activities, especially in outdoor or public spaces.	Implementing safety measures and reducing traffic can encourage physical activities like walking and cycling.	People are discouraged to be active in areas deemed to be unsafe, such as dark and unlit areas. The volume and speed of traffic can be a barrier to people engaging in physical activity, particularly active transport such as riding or walking to work or school.
Community design and public transport	The layout and infrastructure of a community, including the availability of public transport and the design of urban spaces, can either facilitate or hinder physical activity.	When there is easy access to shops, public transport and sports facilities, people can find it easier to incorporate walking and riding into their everyday life instead of using their cars. Designing urban spaces with physical activity in mind can enable and motivate individuals and enhance the likelihood of participation	Poorly designed communities can discourage walking or cycling, leading to increased reliance on cars and sedentary habits.

FIGURE 8.9 A community's urban design can make physical activity choices easier.

8.2.6 Policy

This layer of the social-ecological model includes all recommendations, procedures, regulations and legislation that have the potential to affect physical activity (see table 8.4). These can include informal local policies or rules, or formal legislation and policies developed by governments (local, state or federal).

TABLE 8.4 Policy factors that influence physical activity and sedentary behaviour

Policy factor	Description	Impact on physical activity	Influence on sedentary behaviour
Urban planning policies	Policies mandating land reservation for parks and gardens, and the inclusion of footpaths and bike paths in urban design influence physical activity levels.	Urban planning schemes include providing footpaths for pedestrians, bike paths for cyclists and designing built environments that encourage physical activity.	Reduced sedentary behaviour by providing infrastructure that encourages walking, cycling and outdoor activities.
Education policies	Rules enforced by schools can either promote or deter physical activity, including compulsory PE classes, sports equipment provision and bike rack access. Conversely, restrictions on sports uniforms, certain grounds and access to equipment for safety reasons can deter activity.	Mandating PE and sport in Victorian schools provides more opportunities for young people to be physically active.	Restrictive policies may lead to increased sedentary time among students during school hours.
Workplace policies	Policies in the workplace that encourage physical activity, such as walk and talk meetings, discouragement of elevator use and provision of standing desks.	Encourages employees to be less sedentary at work through active meetings and alternatives to sitting.	Policies that promote sedentary options can lead to increased sitting time and less overall physical activity.
Funding policies	Government or organisational funding dedicated to physical activity infrastructure and programs, such as walking paths and bike lanes.	Funding for infrastructure supports community-wide physical activity by making it safer and more appealing to be active.	Lack of funding can limit the development of physical activity infrastructure, contributing to more sedentary lifestyles.

FIGURE 8.10 Schools are encouraged to adopt policies to support physical activity, such as providing bike racks to promote students riding to and from school.

on Resources

Weblink Safe cycling

8.2.7 Core concepts of the social-ecological model

The social-ecological model provides a framework for understanding the many factors that influence physical activity and sedentary behaviour. These factors may act as either enablers or barriers. The model helps to comprehend a specific problem in a certain context, situation or setting. The social-ecological model can be used to:

- inform strategies or programs aimed to have a positive influence on physical activity levels (these are often referred to as strategies)
- support the implementation of such interventions
- guide the evaluation of these strategies or programs.

The social-ecological model is based on four core principles, each of which is discussed in the following sections.

Core principle 1: multiple factors influence behaviour

The first core principle acknowledges that behaviour is influenced by a wide range of factors. Attempts to change physical activity behaviour must therefore be wide-ranging and target all four levels of the social-ecological model. Interrelationships exist between the four layers of the model: each of the four layers (individual, social environment, physical environment and policy) all have an impact on each other. An illustration of this can be seen in figure 8.1.

Evidence suggests that interventions to promote physical activity are more successful when multiple components of the model are targeted. For example, a program that includes education about the benefits of an activity (individual level); encourages peers to exercise together (social environment level); promotes physical activity that can be done in any location (physical environment level); and provides equipment as part of a government funding program (policy level) is more likely to be successful than one that is missing one or more of these levels.

FIGURE 8.11 Addressing a wide range of factors promotes physical activity.

Individual: learning the benefits of this particular exercise routine from the teacher/instructor promotes a positive attitude towards movement.

Social environment: encouraging peers to exercise together can help reinforce a positive attitude.

Physical environment: a location that allows physical activity (e.g. gymnasium with enough space) helps create an active lifestyle.

Policy: funding for equipment that supports the activity (e.g. mats to exercise on), encourages physical activity behaviour.

Core principle 2: environments are multidimensional and complex

This core principle highlights that both the social and physical environments contain a vast array of features and characteristics. This includes attributes such as size, temperature, facilities, safety, community norms, cultural backgrounds and accessibility.

As a consequence of these variables, environments are unique and include features that can both encourage physical activity or act as a deterrent. For example, planting attractive flowers and trees may increase the appeal of using a walking track for some, while for others the pollen may trigger hay fever, and hence be a deterrent.

Core principle 3: human–environment interactions can be described at varying levels of organisation

The social-ecological model recognises that human interaction with the environment occurs at many levels. This includes interactions between individuals, small groups, community groups and larger populations. Consequently, interventions can be targeted towards these different levels. For example, physical-activity strategies could include targeting individuals to be more active, encouraging workplaces and schools to promote healthy behaviour and population-based programs. The effectiveness of such programs is enhanced when targeting different levels of human–environment interaction.

Core principle 4: interrelationships between people and their environment are dynamic

A dynamic relationship exists between people and their social, physical and policy environments. Individuals can have an impact on the health of these environments, and these environments can have an impact on the behaviour of individuals, groups and populations.

The environment can determine, help or hinder the type and amount of physical activity people undertake. Changes in the environment can enhance the opportunity for movement and physical activity (see figure 8.12). Some examples of such interrelationships between people and their environment include the following:

- A physical environment that is regularly cold, wet and windy reduces people's capacity to engage in activities such as swimming and walking (environment affecting behaviour).
- If many people are walking to and from the town centre, this behaviour could encourage a local council to build safe, flat and well-lit walking paths (behaviour affecting the physical environment).
- A social environment that encourages people to ride to work or school is likely to influence more people to use active transport (environment affecting behaviour) (see figure 8.13).

FIGURE 8.12 Does this help to promote physical activity or hinder it?

FIGURE 8.13 Provision of footbridges and running tracks can promote engagement in physical activity.

- Role models, such as sports stars, health professionals and educators, engaging in physical activity is likely to promote a culture in which sport and recreation are seen as positive and desired (behaviour affecting the environment).
- A school policy environment that allows students to wear their sneakers at lunch time and recess to play sport may increase the level of activity among the students (environment affecting behaviour).
- The presence of many school students playing downball at school may influence school leaders to build more downball courts for the students (behaviour affecting environment).

There is much evidence to suggest that if the physical environment is conducive to physical activity, then other strategies and programs aimed at increasing physical activity are likely to be more successful. Conversely, there have been many examples of theoretically good interventions that ultimately end up unsuccessful due to poor physical environmental conditions. Understanding the core principles of the model is an important part of appropriately applying the social-ecological model to design, implement and critique interventions aimed at promoting physical activity and reducing sedentary behaviour.

FIGURE 8.14 Student participation in physical activity at recess and lunch can influence school leaders' decision to build more facilities.

8.2 Activity

8.2 Quick quiz on

8.2 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 5	4, 6, 7	3

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Identify** the four components of the social-ecological model.
2. The social-ecological model has been designed as a framework for explaining the complex nature of human behaviour, in which many elements interact, are interrelated and interdependent.
   Define the terms *interact*, *interrelated* and *interdependent*.
3. Using an example, **explain** why health-promotion strategies are unlikely to be effective unless they address all the four levels of the social-ecological model.
4. **Identify** the layer of the social-ecological model that the family is part of, and **explain** how it may affect their physical activity levels.
5. **Outline** two examples of physical environmental influences on physical activity.

APPLY your understanding

6. **Identify** a physical-activity behaviour that you engage in, and **discuss** how each of the four elements of the social-ecological model acts as enablers for you.
7. **Identify** a sedentary behaviour that you engage in, and **discuss** how each of the four elements of the social-ecological model influences this activity.

8.2 Exam questions

Question 1 (2 marks)
Using an example, **explain** the relationship between education and physical activity levels.

Question 2 (1 mark)
Identify the type of motivation that is most likely to lead to higher levels of physical activity.

Question 3 (4 marks)
Explain how peers can act as both a barrier and enabler to physical activity.

More exam questions are available in your learnON title.

8.3 Population-based initiatives that promote physical activity

Key knowledge	Key skills	Subtopic
• a range of population-based initiatives that target enablers of and barriers to physical activity	• apply the social-ecological model to critique and create physical activity initiatives and strategies aimed at increasing physical activity and/or reducing sedentary behaviour.	**8.3**

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

8.3.1 Social-ecological model

Topic 7 explored how different sociocultural factors act as enablers and barriers to individual physical activity, and primarily focused on social environmental factors. These factors have an influence on the way population-based initiatives target population groups; however, for a population-based initiative to be effective it needs to target all four levels of the social-ecological model.

The social-ecological model (SEM) is used by health-promotion educators and experts to design strategies and programs to promote healthy lifestyle choices, such as increasing the level of physical activity and reducing sedentary behaviour in individuals, populations and subpopulation groups. Examples of subpopulation groups include those based on gender, ethnicity, First Nations status, people with disabilities and age.

There are many **stakeholders** (see figure 8.15) interested in promoting healthy behaviours. These include schools, workplaces and specific community groups and organisations. In addition, there is a range of local, state and national organisations that implement programs in specific settings. Examples include government-funded organisations such as VicHealth, Get Active Victoria, and local councils and non-government organisations including the National Heart Foundation and Women's Health Victoria.

stakeholders individuals or groups of people who have a vested interest in a particular issue or outcome

FIGURE 8.15 Numerous stakeholders design population-based initiatives that reflect the socio-ecological model

8.3.2 Intersectoral approach

The term **intersectoral** collaboration refers to different sectors (distinct groups, organisations and people) working together to achieve a common goal. In the context of physical activity, different organisations must work together to increase physical activity and decrease sedentary behaviour.

intersectoral different sectors working together

Get Active Victoria's Kids Voucher program

Get Active Victoria is a population-based initiative aimed at encouraging more people to engage in daily physical activity. The program's website serves as a valuable resource, offering numerous ideas and guided workouts to help people stay active at home anytime. Registration is free and provides access to various benefits, including an extensive library of workouts. The overarching goal is to enable all Victorians to find enjoyable and suitable ways to be active every day.

One of the key components of Get Active Victoria is the Kids Voucher program, which targets under-represented groups facing barriers to participating in sports and recreation. By providing financial assistance, the program addresses barriers to sports participation, increasing access for those who would otherwise be unable to participate.

This program addresses multiple layers of the social-ecological model as shown in table 8.5.

Table 8.5 How the Get Active Victoria Kids Voucher program addresses multiple layers of the social-ecological model

Level of social-ecological model	How it reflects the social-ecological model
Individual	Reduces financial barriers to make sports participation more accessible for children, especially those from lower socioeconomic backgrounds, enhancing motivation and access. For example, a Victorian child uses a voucher at Auskick for registration fees.
Social environment	Collaborates with various organisations (e.g. Athletics Victoria, Little Athletics Victoria, Scouts Victoria, Basketball Victoria) and sporting clubs to provide a broad range of affordable activities, fostering a supportive community environment.
Physical environment	Supports access to quality, safe and well-maintained facilities for physical activities by funding registration for reputable providers. For example, gaining access to well-maintained athletics tracks and equipment by Little Athletics Victoria.
Policy	Offers financial aid up to $200 to cover membership, registration or participation fees; supports broader policies (e.g. Victoria's public health and wellbeing plan) to increase physical activity among youth. This initiative aligns with broader Victorian and Australian policies aimed at increasing physical activity and reducing sedentary behaviour among youth.

FIGURE 8.16 The Kids Voucher program helps promotes access to high-quality facilities such as athletics tracks.

CQUniversity 10 000 Steps program

Originally developed in 2001 by CQUniversity, the 10 000 Steps program is part of a broader strategy to encourage more Australians to be more physically active by completing 10 000 steps each day.

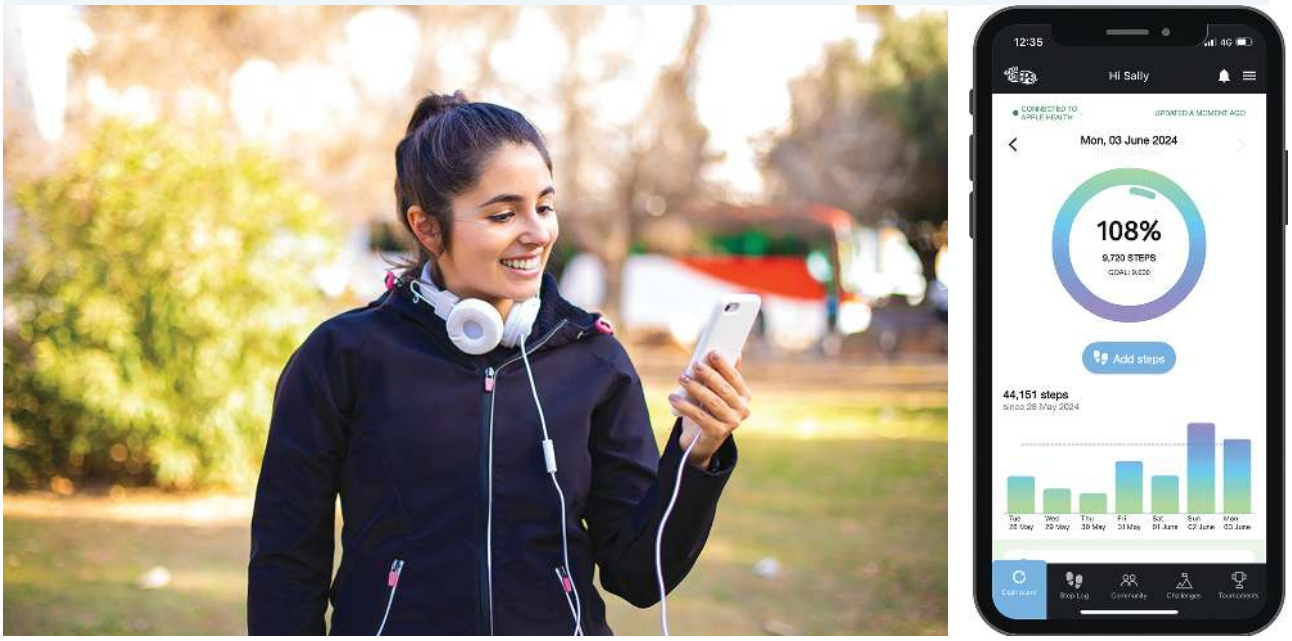
The program is designed to be accessible to all. Individuals register via the 10 000 Steps website or by downloading the mobile app. There are many ways to count your steps. It can be via wearable technology or a smartphone application. Often the program will automatically upload data from your mobile, making it very user-friendly.

This physical-activity intervention targets the multiple layers of influence in social-ecological model in the ways shown in table 8.6.

TABLE 8.6 How the physical-activity intervention targets the multiple layers of the social-ecological model

Level of social-ecological model	How it reflects the social-ecological model
Individual	Personal progress tracking to motivate individuals and foster accountability. Educational content on physical activity benefits to promote a positive attitude.
Social environment	Encourages sharing of experiences and participation in competitions to enhance social interaction and support
Physical environment	The 10 000 Steps program encourages people to use social media to highlight the places they can walk in their communities, such as beaches, local walking paths, national park hikes, playgrounds and other green spaces, which helps other people find an environment to complete their daily step goal.
Policy	The application and many resources provided by the 10 000 program is funded by Health and Wellbeing Queensland and Preventative Health SA

FIGURE 8.17 The 10 000 Steps mobile app



Source: 10 000 Steps is a physical activity program delivered by CQUniversity and proudly funded by the Queensland Government through Health and Wellbeing Queensland. https://www.10000steps.org.au

VicHealth's Walk to School program

VicHealth is an organisation fully funded by the Victorian government. The VicHealth Walk to School program is an annual event that has been in existence since 2006. It provides awareness to students about the physical, social and environmental benefits of active transport via walking. It encourages students to walk to and from school more often.

The program takes place each October. Students are encouraged to walk to school from the first day of term 4 to the end of October. It is hoped that the experience of walking during this time encourages students to continue walking throughout the remaining school months. In addition to this program, VicHealth has developed a range of walk-to-school programs and funds Victoria Walks.

This physical-activity intervention targets the multiple layers of influence in social-ecological model in the following ways (see table 8.7).

TABLE 8.7 How the VicHealth Walk to School program addresses multiple layers of the social-ecological model

Level of social-ecological model	How it reflects the social-ecological model
Individual	The program provides awareness of the physical health benefits of walking to and from school and links the program to the Australian Physical Activity and Sedentary Behaviour Guidelines. Walk to School increases awareness of the other benefits of walking, including the better social and environmental outcomes of walking instead of driving.
Social environment	Encourages students to walk together. Local councils provide support, education and funding to schools, fostering community involvement in promoting walking.
Physical environment	Some local councils have made changes such as increased lighting on walking paths and tracks to enhance perceived safety when walking to and from school. Less traffic leads to decreased congestion and reduced environmental impact.
Policy	VicHealth provides $10 000 of funding to local councils to increase the opportunities for schools to get involved with the program. VicHealth provides free resources, such as stickers, pamphlets and an app, that schools and students can use to enhance the awareness and opportunities for students to walk to and from school.

FIGURE 8.18 VicHealth is a government organisation that promotes good health and disease prevention in the community through programs such as Walk to School.

VicHealth's This Girl Can program

This Girl Can is a population-based initiative to inspire all women to be 'more active, whenever and wherever they choose, without being judged'. It was launched in 2018. This Girl Can — Victoria advocates for all women (cis, trans, non-binary and gender diverse) to get active in supportive and welcoming environments. In 2022, This Girl Can — Victoria inspired almost 273 000 women to be more active (see table 8.8).

Some of the strategies that have successfully motivated more women to be active include the use of inspirational stories, breaking down challenges associated with stereotypes, providing a variety of resources and creating a supportive environment that builds women's confidence.

TABLE 8.8 How VicHealth's This Girl Can program targets the multiple layers of the social-ecological model

Level of social-ecological model	How it reflects the social-ecological model
Individual	The program addresses motivation by providing case studies of successful women who have become more active. The initiative provides advice on ways to find women's group training sessions in their local area, which can reduce psychological barriers some women may have to engage in rigorous physical activity.
Social environment	Through various social media campaigns and local ambassador the community has become more supportive for women who want to increase their physical activity levels.
Physical environment	This Girl Can promotes educational resources such as videos for women to engage in physical activity without leaving the home, and therefore physical environmental factors such as the safety and weather are often not an issue. On their website, there are many 'Get Active @ Home' activities that range from under 10 minutes to over 30 minutes to accommodate for a range of women's different needs
Policy	The This Girl Can initiative obtained funding to help establish and strengthen partnerships through high-profile sporting organisations and funding new, social and flexible activities for Victorian women and girls to get active.

FIGURE 8.19 This Girl Can has successfully inspired many more women to engage in physical activity.

National Heart Foundation's Jump Rope for Heart

Jump Rope for Heart is a program developed by non-government, not-for profit organisation the National Heart Foundation (NHF) (see figure 8.20). It has been a highly successful program. Since its inception in 1983, over 8 million students and 90 per cent of all Australian schools have participated. Approximately 280 000 students and 1400 schools participate annually.

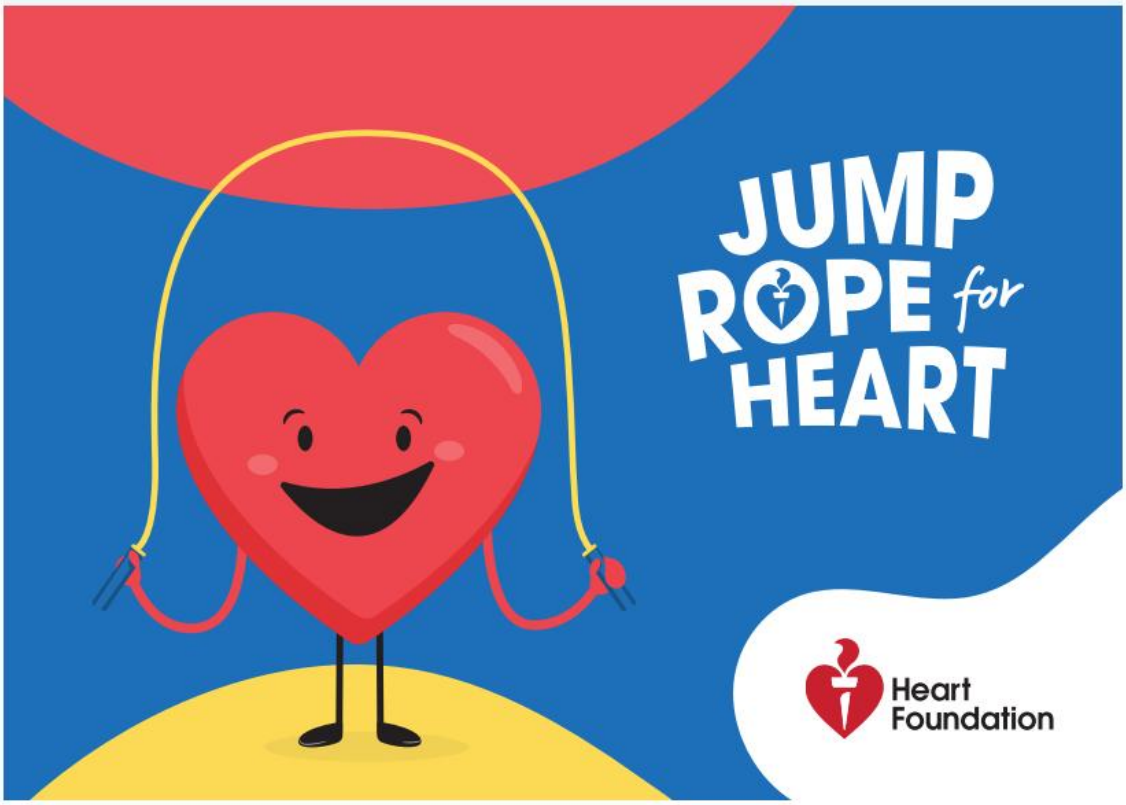
Jump Rope for Heart has mutually beneficial outcomes for both schools and the NHF. Jump Rope for Heart supports students to get fit and learn new skills; it teaches students about community and compassion and raises funds for schools to purchase sports equipment. At the same time, the NHF raises funds to further its ability to deliver heart health messages to the Australian population.

This physical-activity intervention targets the multiple layers of influence in the social-ecological model in the ways shown in table 8.9.

TABLE 8.9 How the Jump Rope for Heart program addresses multiple layers of the social-ecological model

Level of social-ecological model	How it reflects the social-ecological model
Individual	Jump Rope for Heart provides awareness and education about the link between exercise and improved health outcomes. Jump Rope for Heart teaches students how to skip, increasing their skill level, self-efficacy and motivation.
Social environment	Skipping with peers is used as a motivational tool to get more students involved. Teachers are used to provide encouragement and support for students.
Physical environment	Skipping can be done any time of the year, indoors or outdoors, on virtually any surface. The school provides the facilities for the students.
Policy	The NHF fully funds the provision of skipping ropes and resources, ensuring there is no cost to the school. The NHF donate some of the funds back to the school, making it more attractive for schools to get involved.

FIGURE 8.20 Jump Rope for Heart encourages school-aged children to get active through skipping.



Sporting Schools

Sporting Schools is an Australian government initiative designed to help schools increase children's participation in sport and connect them with community sport opportunities. According to the Australian Sports Commission:

> Research shows that quality sport and physical activity in schools has a positive influence on children's confidence, competence and motivation to be active at school and throughout their life.
>
> Sporting Schools programs are provided free to children and their families to help students build the confidence and capability to be active for life.

To help achieve this, the Australian Sports Commission has partnered with more than 35 national sporting organisations (NSOs) and national sporting organisations for people with disability (NSODs). There is a program for primary schools, and a targeted program for Year 7 and 8 students in secondary schools.

Sporting Schools offers a range of coach-delivered programs for primary and secondary schools which helps strengthen their knowledge and skills.

Table 8.10 shows how this initiative targets multiple layers of influence in the social-ecological model.

TABLE 8.10 How the Sporting Schools program addresses multiple layers of the social-ecological model

Level of social-ecological model	How it reflects the social-ecological model
Individual	The program helps address children's confidence through building the skills and knowledge to increase competence in a range of sports which can motive them to continue to be physically active throughout their life. For example, improving students' confidence and skills in rugby union via to tri-tag rugby (see figure 8.21).
Social environment	The program provides many opportunities for coaches, teachers and peers to interact, which helps build a supportive network for children to be more physically active. The program helps engage students in free, high-quality programs at schools, helping communities of different socioeconomic backgrounds (including attending schools in disadvantaged areas).
Physical environment	Funding can be spent on the hiring of sports facilities outside the school property. These facilities are often needed to provide the optimal physical environment the sport (e.g. pool hire).
Policy	The program is funded by the Australian Sports Commission. These grants often target junior secondary schools, to help develop sport-based programs that help build students' capability to be active for life (e.g. funding transport for coaches to deliver programs in rural areas). It also provides funding for schools (up to $1500 of each grant) to spend on essential equipment to deliver a Sporting Schools partner sport. This funding can be modified to meet the needs of people with a disability.

FIGURE 8.21 Sporting Schools has partnered with Gridiron Australia to introduce Flag Football in schools – an engaging and inclusive introduction to American football.

Indigenous Marathon Project

The Indigenous Marathon Project (IMP) uses running to change lives and provide a renewed sense of empowerment, purpose and pride among First Nations people. It was established in 2009 by the World Champion marathon runner and 1983 Australian of the Year, Robert de Castella. The IMP program is a social change program to promote the benefits of active lifestyles. It is not a sports program.

Every year a group of 12 Aboriginal and Torres Strait Islander people between the ages of 18 and 30 are selected to run in the prestigious New York City Marathon. No previous running experience is necessary. Since 2009, 142 IMP graduates have run the marathon and have since become influential role models in their own communities.

Education is a compulsory part of the IMP program. Members gain the following qualifications and/or training:

- a Certificate in Indigenous Leadership and Health Promotion
- a Level 1 Recreational Running Coach Accreditation through Athletics Australia
- CPR and first aid qualifications
- Aboriginal and Torres Strait Islander Mental Health First Aid
- media training.

Table 8.11 shows how this program targets the different levels of the social-ecological model.

TABLE 8.11 How the IMP addresses multiple layers of the social-ecological model

Level of social-ecological model	How it reflects the social-ecological model
Individual	Members of the squad push themselves to their physical limits, improving their capabilities and confidence. The program is tailored to Indigenous groups, motivating more people of this population group to be physically active.
Social environment	There are week-long training camps, which consist of meeting influential leaders and providing a supportive network for each other within their existing communities to encourage them to achieve their personal best.
Physical environment	IMP squad members attend four training camps per year in the lead up to New York, which all provide a physical environment conducive to success in marathon running.
Policy	The IMP covers all costs for members of the squad throughout the IMP year, including travel to and from camps, accommodation, education costs, equipment and uniform (excludes any personal spending money during camps). The Indigenous Marathon Foundation, which runs the IMP program, is heavily funded by the Australian government's Department of Health and Aged Care. This funding allows the success of the initiative.

FIGURE 8.22 Population-based initiatives can target a range of population groups when done right.

Lauren Vason
Indigenous Marathon Project Graduate #139
Murray Bridge, South Australia

2023

Lauren is Ngarrindjeri woman who works as an Aboriginal Community Education Officer and a School Support Officer and is studying a Bachelor of Primary Education. Lauren started running in 2014 with Murraylands IMF RAW and runs with her brother-in-law, IMP Graduate Daniel Lloyd. After overcoming adversity with her daughter's health, Lauren applied for IMP to show her daughter what her Mum can achieve, and for a challenge, drawing on the strength of her young daughter. 'As a family we have overcome many physical and mental battles [recently]. During this time, I learnt new coping skills, and how to advocate for my daughter which taught me a new strength I didn't know I had. This is the reason I applied for IMP.'

on Resources

Weblinks Get Active Victoria
Queensland Walk Explore Steps Challenge Resources
Walk To School
This Girl Can
This Girl Can — Victoria
Jump Rope For Heart
Sporting Schools
Indigenous Marathon Project

8.3.3 Creating your own program that promotes physical activity and/or reduces sedentary behaviour

When designing a program to encourage physical activity or reduce sedentary behaviour, it's essential to consider all four levels of the social-ecological model. Below are key considerations for each level.

FIGURE 8.23 Multiple levels of influence should be addressed to achieve positive changes in physical activity levels.

Level of the social-ecological model	Considerations at each level when designing a program
Individual level	• Assess the fitness level required to participate. Ensure the program is accessible to people with varying fitness levels. • Identify and address common barriers specific to your target population, such as lack of motivation, time constraints or cultural influences.
Social environment level	• Leverage social networks to enhance participation and support for the program. • Collaborate with different sectors or organisations to enhance the program's reach and success. • Foster community support to facilitate active engagement in the program's activities.
Physical environment	• Ensure the physical space accommodates all participants safely (unlike the image to the left) or consider modifications to enhance safety and accessibility. • Evaluate transportation options to the program location. Ensure the program is easily accessible on foot or provide alternative transport solutions. • Consider the equipment needed for participation. Ensure it is suitable for all participants, including those with disabilities.
Policy	• Determine if your program requires funding and identify potential sources. • Establish necessary policies or rules to maximise participation and ensure smooth operation. • Explore opportunities to advocate for policies that support engagement and promote the long-term sustainability of your program.

EXAM TIP

When creating a program, make sure you explicitly refer to each of the four levels of the social-ecological model. Assessors want to see that you understand each of the levels of influence, and how they will likely affect physical activity and sedentary behaviour.

doc-41943

PRACTICAL ACTIVITY Influences on physical activity

Goal

To determine how each level of the social-ecological model influences your participation in sport

Instructions

Participate in a game of basketball. Throughout the game, consider the factors that influence your level of physical activity.

Primary data/Reflection

On completion of the activity, list all the enablers and barriers that influenced your participation and classify the level of influence in the table below.

Enabler/Barrier	SEM level

Questions

1. Referring to the primary data above, justify which level of influence had the greatest impact on your physical activity behaviour.
2. Explain how the social-ecological model could be used to increase basketball participation in your school.

8.3 Activity

8.3 Quick quiz on

8.3 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 3	2, 4, 5, 6	7

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **List** two subpopulations that are often the targets of population-based initiatives.
2. **Discuss** how Sporting Schools reflects the individual level of the social-ecological model.
3. **Outline** one way the This Girl Can program works with different communities to overcome societal norms about women's participation in sports. **Identify** which level of the social-ecological model this addresses.
4. a. **Identify** and **discuss** a potential policy barrier that could affect the implementation of a program aimed at increasing physical activity for youth.
   b. **Outline** how you would address these barriers in your program design to ensure successful outcomes.

APPLY your understanding

5. You are a principal of a primary school. Use the social-ecological model to **describe** two strategies for each layer of the model that will promote greater levels of moderate to vigorous exercise at school.
6. You are a principal of a primary school. Use the social-ecological model to **describe** two strategies per layer of the model that will reduce levels of sedentary behaviour in the classroom.
7. Use the **Sports Without Borders** weblink in the Resources panel to answer the following questions in your own words.
   - **Identify** the aim of this non-profit organisation.
   - **Describe** one initiative this organisation has implemented to encourage people from culturally diverse backgrounds to be physically active. Explain what benefits the initiative brings to the participants and the wider community.
   - **Devise** a sports program for your community that could encourage people from culturally diverse backgrounds to participate.

8.3 Exam questions

Question 1 (1 mark)

Providing PE classes that teach children basic motor skills targets which level of the social-ecological model?

A. Individual
B. Social environment
C. Physical environment
D. Policy

Question 2 (2 marks)

Outline two things a PE curriculum should do in order to meet the individual level of the social-ecological model.

Question 3 (4 marks)

Source: *ACHPER 2017, Trial Exam Unit 2, Section B, Q.2;* © ACHPER

Franklin Primary School was very concerned about their students' low levels of physical activity and high levels of sedentary behaviour throughout the school day. They decided to put in place some interventions to help combat the problems of low physical activity in the yard during breaks and high levels of sedentary behaviour throughout the day in their classrooms.

It was decided to utilise the social-ecological model (SEM) to design their intervention strategies.

They decided to start with decreasing the students' sedentary behaviour. They need help with the design of strategies to reduce sedentary behaviour within the classroom, as the students are currently sitting for up to 5–6 hours per day. Some classes are also sitting for extended periods of time without standing.

Use your knowledge of the social-ecological model (SEM) to design strategies that would reduce sedentary behaviour in their classrooms.

The strategies must address the four levels of the SEM and you need to write the SEM level and the strategy for each.

Level:
Strategy:

Level:
Strategy:

Level:
Strategy:

Level:
Strategy:

More exam questions are available in your learnON title.

8.4 Key skills

Key skill

- apply the social-ecological model to critique and create physical activity initiatives and strategies aimed at increasing physical activity and/or reducing sedentary behaviour

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

8.4.1 Tell me

To address the key skill, it is important to remember the following:

- the term 'critique' is used when asked to evaluate a practice in a detailed and analytical manner
- when critiquing population-based initiatives using the social-ecological model, specific references to the levels of influence are required
- when critiquing a program, suggest way/s to improve its effectiveness, linking to the social-ecological model
- when creating/designing initiatives or strategies to promote physical activity and/or reduce sedentary behaviour, each level of influence must be considered and addressed explicitly in order for the program to be effective
- a stem will provide clues to what has been done to promote physical activity — reading this carefully is vital.

8.4.2 Show me

Practice question (9 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

Source: *Adapted from ACHPER 2021, Unit 2 Trial Exam, Section B, Q.1;* © ACHPER

The playground pictured has been built in urban Melbourne to encourage children and families living in the area to undertake more physical activity. Local council workers have noticed the playground is rarely used. The play equipment is in the sun all day and it is quite close to a busy road.

a. **Critique** the *effectiveness* of this strategy to *encourage physical activity* for people living in urban Melbourne using the social-ecological model (SEM). (5 marks)

b. **Design** a physical activity initiative, to *encourage children* living in urban Melbourne to *increase physical activity and/or reduce sedentary behaviour*. (4 marks)

Decode the question

Strategies to decode the question

- **Identify the action words:**
  Critique — to review the values and/or limitations of a concept or idea
  Design — the idea or plan that guides decisions
  Key terminology — *effectiveness, encourage physical activity, encourage children, increase physical activity and/or reduce sedentary behaviour*
- **Key concept/s** — social-ecological model (SEM), physical activity intiative.
- **Marking scheme** — 9 marks — always check marking scheme for the depth of response required, linking to key information highlighted in the question.

Sample response and marking scheme

a.
- This program is unlikely to be effective as it only appears to address one out of the four levels of influence. For an initiative to be effective in promoting *physical activity behavior and/or reduce sedentary behaviour*, it *needs to target all levels of the SEM model.*
- The playground itself is an example of a change to the environment. It is bright and colourful. The aesthetics would appeal to children. However, it may be more appealing to parents if there were also sun shelters installed.
- Currently, it does not appear to address the individual level. In this example, pairing it with an education campaign (*individual intervention*), so families understand the importance of play and physical activity for young children, would increase the likelihood of parents taking their kids to the playground and participating in physical activity there.
- Currently, it does not appear to address the *policy level*. Mandatory supervision of local council city staff members who have a Working with Children Check would help parents feel more confident about letting them students play at the playground.
- This strategy does not appear to address the *social environment level*. If organisations or community group members facilitated regular games for children, the environment would be more supportive for children to play on the playground. *This would provide an opportunity for peers to encourage each other to be active.*

Award 1 mark for identifying that this program is likely to not be successful as it has not targeted all layers of the social-ecological model.
Award 1 mark for suggesting a way for the strategy to address the individual environment.
Award 1 mark for suggesting a way for the strategy to address the social environment
Award 1 mark for addressing the physical environment by linking to the aesthetics of the playground.
Award 1 mark for suggesting a way for the strategy to address the policy component of the SEM.

b. A 'Melbourne Movers' initiative could be created to encourage children in urban Melbourne to increase physical activity levels and reduce sedentary behavior through fortnightly 5-kilometre bike rides.
- *Individual level:* education could be provided through social media via regular posts about *the benefits of cycling*, which include physical health and social interaction advantages. Affordable, safe bicycles would be provided for event participants, ensuring inclusivity for disadvantaged children.
- *Social environment*: the program would *encourage riding with family and friends* to build a supportive cycling community. There would also be coaching on safe cycling practices by collaborating with local councils, promoting a culture of safety among young cyclists.
- *Physical environment:* aesthetically pleasing and safe tracks specifically suited for large groups would be selected, enhancing the cycling experience. Well-advertised routes would promote the event and specific routes well in advance to ensure participants feel confident and informed.
- *Policy:* The implementation of safety policies including mandatory presence of staff trained in first aid and clear safety protocols during the ride. Rules for the program would involve community leaders and volunteers riding along, positioned strategically throughout the group to monitor and assist participants as needed, during every event.

Award 1 mark for a response which identifies a physical activity initiative.
Award 1 mark for a description of how the initiative will engage children and make physical activity enjoyable, leading to increased physical activity and reduced sedentary behavior.
Award 1 mark for consideration to practical aspects, such as safety, accessibility, and cost-effectiveness.
Award 1 mark for consideration/application to children living in urban Melbourne.

8.4.3 Let me do it

Question 1 (5 marks)

Jump Rope for Heart is a program developed by the National Heart Foundation (NHF). It has been a highly successful program. Since its inception in 1983, over 8 million students and 90 per cent of all Australian schools have participated. Approximately 280 000 students and 1400 schools participate annually.

Jump Rope for Heart has mutually beneficial outcomes for both schools and the NHF.

The school supports students to get fit and learn new skills, and it teaches students about community and compassion while raising funds for the school to purchase sports equipment. It provides free resources to get the program started. The program can be delivered at any time of the year in any venue that the school chooses. It uses teachers to encourage students to join.

Use the social-ecological model to **critique** why the NHF's Jump Rope for Heart program has been successful. In your critique, **explain** why this program has been successful, using examples from the information provided.

8.5 Review

Hey students! Now that it's time to revise this topic, go online to:

Review your results

Watch teacher-led videos

Practise exam questions

Find all this and MORE in jacPLUS

8.5.1 Summary

The social-ecological model and its components

- The social-ecological model is used to design, implement and critique strategies and programs that promote physical activity and reduce sedentary behaviour.
- This model adopts a systems-thinking approach to behavioural change, such as reducing sedentary behaviour and increasing physical activity levels, supported by models used across various disciplines.
- The social-ecological model includes four components: individual, social environment, physical environment and policy.
  - Individual level: knowledge, attitudes, beliefs, perceived barriers, motivation, enjoyment, motor skills, age, gender, socioeconomic status, self-efficacy, injuries and disabilities.
  - Social environment level: family, partners, peers, institutions, organisations, social support, healthcare professionals, educators, community norms, cultural backgrounds and community socioeconomic status.
  - Physical environment level: natural environment, availability and access to sport and recreation facilities, aesthetics, safety, community design and public transport.
  - Policy level: urban planning policies, education policies, workplace policies and funding policies.
- The first core principle states that behaviour is influenced by multiple factors.
- The second principle highlights that environments are multidimensional and complex.
- The third principle describes human–environment interactions at various levels.
- The fourth principle notes that the interrelationships between people and their environments are dynamic.

Designing and critiquing an initiative

- For a population-based initiative to succeed, it must incorporate all levels of the social-ecological model.
- Design your program to promote physical activity and reduce sedentary behaviour by addressing all levels of the social-ecological model and ensure as many barriers and enablers are addressed as possible.
- When critiquing a program, use the social-ecological model framework to suggest improvements for greater effectiveness (when appropriate).

8.5.2 Key terms

intrinsic motivation an individual's inner drive to perform a certain action or behave in a specific way. Examples include doing something for pleasure or believing a specific action is the correct thing to do.
intersectoral different sectors working together
sedentary lifestyle when an individual spends six or more hours a day sitting or lying down, without any significant physical movement in their daily life
self-efficacy an individual's belief that they can execute behaviours that can achieve a certain level of success
social-ecological model a framework used to develop, implement and critique health-promotion strategies aimed at improving health by promoting physical activity and limiting sedentary behaviour
stakeholders individuals or groups of people who have a vested interest in a particular issue or outcome
systems thinking a framework for understanding the world by the ways that different entities within a system influence one another

8.5 Exam questions

8.5 Section A — Multiple choice questions

Question 1 (1 mark)

Source: *ACHPER 2021, Trial Exam Unit 2, Section A, Q.13;* © ACHPER

Which of the following examples would be considered a social-environmental approach which could be implemented in a workplace setting?

A. Train leaders in the workplace on the importance of physical activity and develop strategies to encourage staff to be active together during their lunch breaks
B. Put up posters in the staffroom reiterating the consequences of being inactive and why being active is beneficial
C. Provide changerooms and shower facilities within the workplace
D. Subsidise staff memberships for gyms

Question 2 (1 mark)

Identify the level of influence that the socioeconomic status of the community relates to in the social-ecological model.

A. Individual
B. Social environment
C. Physical environment
D. Policy

Question 3 (1 mark)

Limited facilities in rural areas are an example of which level of influence not being addressed?

A. Individual
B. Social environment
C. Physical environment
D. Policy

Question 4 (1 mark)

Source: *ACHPER 2022, Trial Exam Unit 2, Section A, Q.9;* © ACHPER

Which of the following would be a social environmental enabler, increasing physical activity levels in the workplace?

A. Providing change-room facilities
B. Displaying signs promoting the use of stairs
C. Promoting physical activity during breaks
D. Negotiating discounted rates for employees at facilities such as gyms

Question 5 (1 mark)

Source: *ACHPER 2021, Trial Exam Unit 2,* Section A, Q.*15;* © ACHPER

A primary school has implemented an active transport program where students are encouraged to walk to school. Traffic calming devices to increase student safety, such as reduced speed limits, were taken into consideration when evaluating the program.

Which level of influence would this be?

A. Personal environment
B. Physical environment
C. Social environment
D. Workplace

Question 6 (1 mark)

Source: *ACHPER 2020, Trial Exam Unit 2,* Section A, Q.*4;* © ACHPER

Providing bike racks and shower facilities onsite at workplaces is a strategy used to encourage active transport to and from work.

What level of the social-ecological model (SEM) does this address?

A. Individual
B. Social environment
C. Physical environment
D. Policy

Question 7 (1 mark)

Source: *ACHPER 2020, Trial Exam Unit 2,* Section A, Q.*7;* © ACHPER

Which of the following is **not** an environmental barrier to physical activity?

A. Rainy weather
B. No changing facilities at sporting club
C. Living in a suburb without footpaths
D. Bicycle lanes

Question 8 (1 mark)

Source: *ACHPER 2020, Trial Exam, Unit 2,* Section A, Q.*8;* © ACHPER

An individual strategy to promote physical activity is:

A. the use of television campaigns to encourage individuals to change their physical activity levels.
B. the use of government funding to build new community facilities.
C. to increase an individual's knowledge about the benefits of physical activity.
D. to make local areas safer for individuals to exercise.

Question 9 (1 mark)

Source: *ACHPER 2020, Trial Exam Unit 2,* Section A, Q.*14;* © ACHPER

Which of the following would be considered an example of a policy within the SEM?

A. Staff versus student basketball games during lunch times
B. The availability of secure bike sheds
C. Informative posters of benefits of being active around locker bays
D. Mandating time for Physical Education within the school timetable

Question 10 (1 mark)

Source: *ACHPER 2020, Trial Exam Unit 2,* Section A, Q.*5;* © ACHPER

Jump Rope for Heart was established by the Heart Foundation to encourage children to develop a positive attitude towards exercise, healthy eating and heart health while raising money to fight heart disease.

Children often participate as part of a 4- to 6-week program in a school, logging skips on the online portal and working towards a Jump Off day to show off new skipping skills.

Which of the following influences does **not** contribute to successful participation in this program?

A. Teachers provide support and instruction to help students improve fitness and learn new skipping skills
B. Equipment can be supplied by the school PE department
C. Parent volunteers
D. The program provides awareness of the physical health benefits of skipping

8.5 Section B — Short answer questions

Question 1 (2 marks)

Describe one way you could promote physical activity in your school by incorporating a social-environment intervention.

Question 2 (2 marks)

Source: *ACHPER 2019, Trial Exam Unit 2, Section B, Q.1c.i.v;* © ACHPER

The social-ecological model (SEM) suggests a 'one size fits all' approach can be effective.

Identify and **justify** if this statement is true or false.

Question 3 (4 marks)

Source: *ACHPER 2019, Trial Exam Unit 2,* Section B, Q.*7;* © ACHPER

Tony is a Year 10 student who has struggled to maintain a healthy body weight throughout secondary school.

His light body weight and late maturation has led him to be quite self-conscious about his appearance. His self-efficacy in many physical activities is low and his motivation to participate in a traditional competitive sporting program is also lacking.

In order to encourage students like Tony to increase participation in physical activity, his teacher organised a registered skate coach from the state sporting association representing skateboarding to conduct a learn to skate program at the local skate park as part of the Year 10 Physical Education program.

The presenter hopes to reduce barriers to participation by providing an introduction to skateboarding and the skate park and reducing the risks of injury. They also encourage schools, skate parks, skate coaches, council managed and private skate parks and program providers to network and support participation.

Using the template below, apply the social-ecological model (SEM) to **analyse** the potential of this intervention strategy to influence Tony's participation in physical activity.

Level of influence in SEM	Two examples of the influence	Example of strategy in the program which may promote Tony's participation in physical activity
Individual factors		
Social factors		
Physical environment		
Policy		

Continue to build your exam skills

Access the Unit 2 Area of Study 1 Review at the end of Topic 9. This includes:

- Practice extended response
- Practice examination
- Practice school-assessed coursework.

9 Promoting physical activity through a personalised plan

9.1 Overview

Hey students! Bring these pages to life online

Watch videos

Engage with interactivities

Answer questions and check results

Find all this and MORE in jacPLUS

LEARNING SEQUENCE

9.1 Overview
9.2 Health-related fitness components and factors
9.3 Functional Movement Assessment
9.4 Creating a personalised physical activity plan
9.5 Evaluating a personalised physical activity plan
9.6 Key skills
9.7 Review

9.1.1 Introduction

Did you know that one in every two adults and two in every three children are not meeting the physical activity guidelines? While most people have good intentions to be more active, for many people the barriers to meeting their relevant physical activity guidelines prove too challenging to overcome. An effective plan should take into account the individual's physiological, psychological and sociocultural considerations to promote physical activity sustainably. A well-prepared, individualised plan can be the difference between good intentions and physical activity actually becoming a part of a person's daily routine.

In this topic, you will conduct a Functional Movement Assessment before designing, implementing and evaluating a personalised physical activity plan.

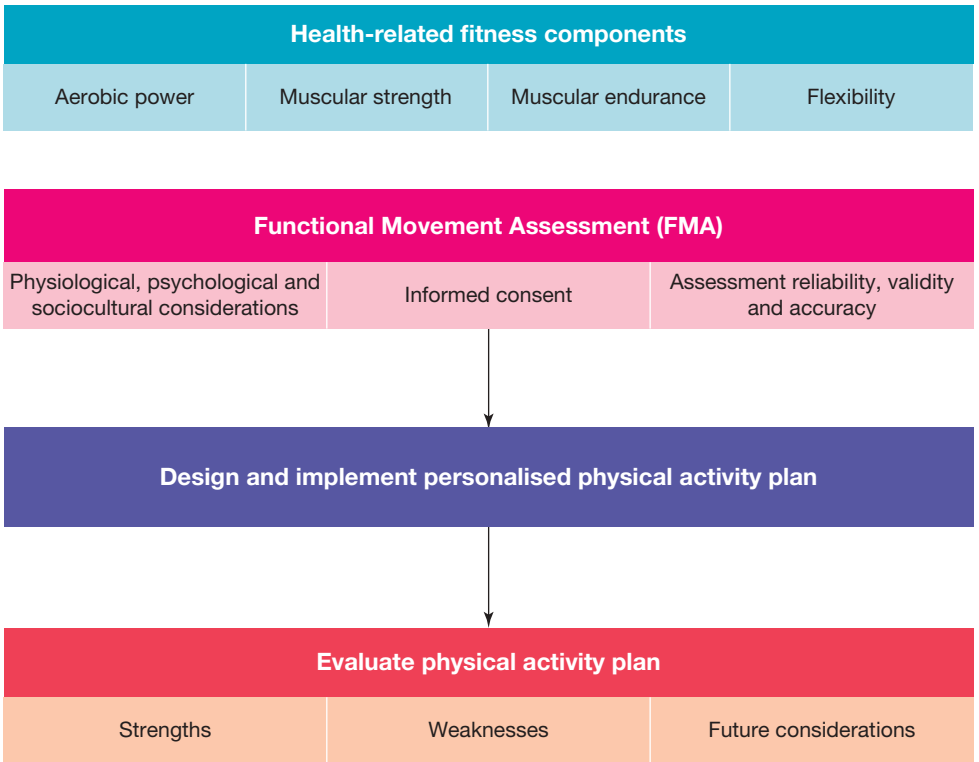
FIGURE 9.1 Effective plans take the various considerations for the individual into account, helping physical activity to become a sustainable part of their lives.

9.1.2 Key knowledge and Key skills

Key knowledge	Key skills	Subtopic
• health-related fitness components and factors affecting aerobic power, muscular strength and endurance and flexibility	• explain health-related fitness components, including factors affecting each component	**9.2**
• Functional Movement Assessment: – physiological, psychological and sociocultural considerations – pre-participation health screening – informed consent – assessment reliability, validity and accuracy	• justify an appropriate FMA for a targeted individual/group, from a physiological, psychological and sociocultural perspective • conduct and evaluate an FMA using reliable, valid and accurate methodology	**9.3**
• considerations of a personalised plan, including self-management skills, used to promote physical activity and reduce sedentary behaviour	• using self-management skills, design a sustainable personalised plan that promotes adherence to physical activity and sedentary behaviour guidelines • implement strategies from a personalised plan to gather primary data about strengths and limitations of the program design	**9.4** **9.5**

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

9.1.3 Topic preview



9.2 Health-related fitness components and factors

Key knowledge	Key skill
• health-related fitness components and factors affecting aerobic power, muscular strength and endurance and flexibility	• explain health-related fitness components, including factors affecting each component

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

9.2.1 Fitness components

What do you think it means to be fit? The term 'fitness' is used in a variety of ways. To describe fitness accurately, the fitness components should be referred to. The aim of most physical activity plans is to promote general health and fitness through adherence to the relevant physical activity guidelines. This is a broader approach to improving fitness than that of a *training program*, which targets specific fitness components with the aim of improving sporting performance. A balanced physical activity plan should address multiple health-related fitness components, including aerobic power, muscular strength, muscular endurance and flexibility.

9.2.2 Aerobic power

Aerobic power is the maximum rate of energy production from the aerobic energy system (i.e. the energy produced in the presence of oxygen).

The cardiovascular and respiratory systems work together to deliver oxygen to the working muscles for any physical exertion that requires aerobic power. A person with high aerobic power can complete longer periods of aerobic physical activity with less fatigue. This can increase enjoyment of physical activity, enhance performance and speed up recovery.

Aerobic power is of high importance in the following types of physical activities:

- active transport, such as cycling to school
- endurance activities, such as cross-country running, triathlons and marathons
- most team sports, such as Australian Rules football, basketball, netball, rugby and hockey
- some forms of active play, such as games of tiggy.

FIGURE 9.2 Locomotive activities such as jogging require aerobic power.

aerobic power the maximum rate of energy production from the aerobic energy system

TABLE 9.1 Factors affecting aerobic power

Factor	Effect on aerobic power
Age	Aerobic power (VO_2 max.) peaks in a person's mid-20s and then decreases as age increases. This is due to the decreased elasticity of the lungs (decreased oxygen uptake), decreased haemoglobin (decreased oxygen transport) and decreased muscle mass and therefore mitochondria (decreased oxygen utilisation).
Sex	Males generally have a higher aerobic power (VO_2 max.) than females. This is because males tend to have larger lungs (increased oxygen uptake), higher haemoglobin levels (increased oxygen transport) and more muscle mass, and therefore mitochondria (increased oxygen use) compared to women.
Muscle fibre type	A greater percentage of slow-twitch fibres will increase aerobic power (VO_2 max.). Slow-twitch fibres work aerobically. Therefore, the more slow-twitch fibres a person has, the greater their ability to work aerobically.

9.2.3 Muscular strength

Muscular strength is the peak force that a muscle can develop.

Muscular strength allows you to perform daily activities safely, such as lifting heavy school bags, playing on playground equipment or moving furniture. Having adequate muscular strength reduces the risk of injury during these tasks. It also increases opportunities for other physical activities that may require a strength base to perform safely, including a variety of sports and exercises.

FIGURE 9.3 Muscular strength is necessary for weightlifting.

Muscular strength is of high importance for:

- the arms while playing on monkey bars
- the legs while climbing stairs
- the core, back and arms while doing gardening/landscaping work
- weightlifting.

muscular strength the peak force that a muscle can develop

TABLE 9.2 Factors affecting muscular strength

Factor	Effect on strength
Speed of muscle contraction	The more slowly a muscle contracts, the more force it can create. Compare an isometric contraction with a powerful, isotonic contraction. A 1 repetition maximum (RM) weight lift is performed much more slowly than 12 RM movements, because it requires more strength.
Length of muscle fibre	If the muscle is slightly stretched, it is in the best position to create its maximum force. This is demonstrated when long jumpers lower their centre of gravity just before take-off — a movement that stretches the quadriceps just before they contract to achieve the powerful leap. Performers need to account for this fact along with the best 'joint angle' specific to the particular joint around which the movement is centred.
Age of the performer	Strength peaks in performers aged 20–30 years, then decreases with the body's diminishing ability to process protein. Regular exercise can slow this process.
Warm up	Warmed-up muscles have a greater ability to create strength than muscles that are not warmed up.
Fibre type	Fast-twitch (or light pink) fibres are capable of greater strength output than are slow-twitch (or red) fibres.
Cross-sectional area	The larger the muscle, the greater the strength potential. But this relates to the muscle mass, not the total body area in which the muscle is found. The diameter of the biceps, for example, may include both muscle and fat.
Sex of the performer	Males generally have greater muscle mass, so they have greater absolute strength. Relative to the cross-sectional area of muscle, there is no difference in the strength available to males and females.
Joint angle around the muscle	For each joint angle in movement, there is an optimal angle for the creation of strength.

9.2.4 Muscular endurance

Muscular endurance is the ability of a muscle or group of muscles to sustain repeated or sustained contractions against resistance for an extended period.

muscular endurance the ability of a muscle or group of muscles to sustain repeated or sustained contractions against resistance for an extended period

Any physical activity that requires high repetitions of repeated or sustained muscular contractions is using muscular endurance.

Muscular endurance is of high importance for:

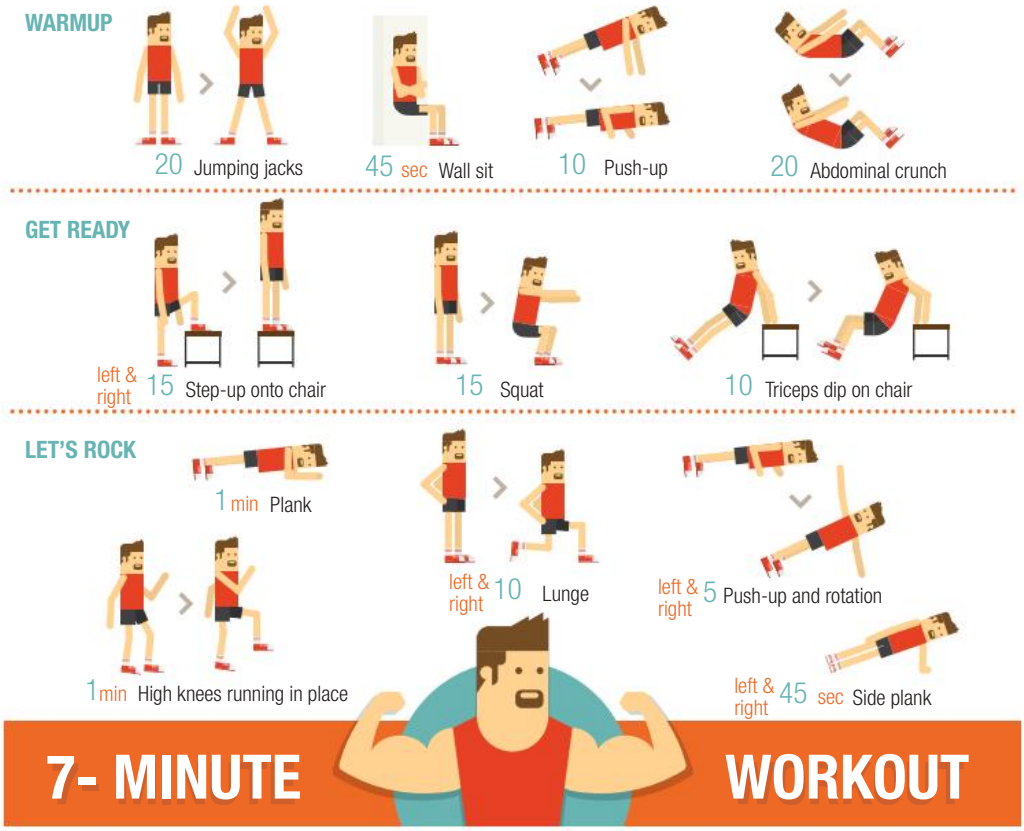
- the arms, legs and abdominals for a tennis player in a long rally
- the abdominals during a static hold such as a plank
- the arms while maintaining a grip on a wheelbarrow
- the legs while walking up a long hill.

FIGURE 9.4 The multiple repetitions against resistance required for push-ups rely on muscular endurance.

TABLE 9.3 Factors affecting muscular endurance

Factor	Effect on muscular endurance
Sex	Males generally have greater muscular endurance than females. Males have greater aerobic capacity and muscular strength, and therefore increased endurance, compared to females.
Muscle fibre type	A greater percentage of slow-twitch fibres will increase muscular endurance. Slow-twitch fibres work aerobically. Therefore, the greater the number of slow-twitch fibres, the greater the ability to work aerobically and contract repeatedly over a longer period. Slow-twitch fibres have greater resistance to fatigue than fast-twitch fibres.
Lactate tolerance	The greater the lactate tolerance, the greater the anaerobic capacity. The more metabolic by-products that can be tolerated, the more high-intensity efforts/longer high-intensity efforts can be made.

FIGURE 9.5 Circuits such as the '7-minute workout' can develop both muscular endurance and muscular strength depending on the resistance, repetitions and work-to-rest ratios used.



9.2.5 Flexibility

Flexibility is the range of movement around a joint. It is the interaction between the body's skeletal and muscular systems to allow a full and unimpeded range of joint movement for muscle actions.

Flexibility should be promoted in all physical activity plans, as poor flexibility can increase the risk of both chronic and acute injuries. For example, if a person is including activities such as running in their physical activity plan, they should consider stretching dynamically prior to the run to reduce the risk of muscle strain. They should also include flexibility training, such as static stretching, as a part of their recovery or cool down.

Many lifestyle-based physical activities also pose the risk of injury if the person isn't flexible enough. For example, when bending down (hip flexion) to remove weeds while gardening, a person may risk injury if their hamstring and erector spinae muscles lack flexibility.

FIGURE 9.6 Flexibility is important for full range of motion around a joint.

flexibility the range of movement around a joint

TABLE 9.4 Factors affecting flexibility

Factor	Effect on flexibility
Somatotype	Endomorphs with their extra bulk (from extra adipose tissue) have limited flexibility. Mesomorphs also may have limited flexibility because they have trained with a limited range of movement or because they have extra muscle tissue. Ectomorphs generally have quite good flexibility because they have lower amounts of body tissue.
Skin resistance	Skin has lower elasticity than ligaments and tendons, so it can restrict higher ranges of movement.
Sex	Hormonal differences mean that females are generally more flexible than males.
Type of joint	Specific joints are designed for either strength or mobility, or a combination of both. The shoulder has great mobility but is prone to dislocation in contact sports. The hip joint has high stability, but less mobility than the shoulder.
Resting length of ligaments and joint capsule	Stretching these surrounding structures in training may increase a joint's flexibility.
Age	Increasing age decreases flexibility.
Warm up	Warm-up routines generally increase the temperature of both the muscles and the structures within the joints, which increases flexibility.
Length of muscles at rest	If muscles at rest are shortened, then flexibility is limited. This may happen if the individual does too much sedentary work (which chronically shortens the hamstrings). If weight-training exercises are not performed through the full range of motion, then the muscles will shorten.
Bone	Depending on the joint, the bone type and structure will vary and thus have different effects on the actual flexibility of the joint.

doc-41962

PRACTICAL ACTIVITY 7-minute workout

Goal

To participate in a body weight circuit that can develop muscular strength and or muscular endurance

To manipulate factors within a circuit to develop different fitness components

Instructions

Access the **7-minute workout** weblink in the Resources panel. Complete the 7-minute workout and decide whether you believe the circuit would develop muscular endurance or muscular strength.

Create a modified circuit that targets a different fitness component.

Primary data/Reflection

Physiological reflection:
Which activities did you personally find the most fatiguing? Why?

Psychological reflection:
On a scale of 1–10, how motivated were you to try your best during this workout? Why?

Sociocultural reflection:
What sociocultural factors affected your participation (either positively or negatively) while completing this workout?

Questions

1. Identify the activities in the 7-minute workout as either muscular endurance or muscular strength based activities.
2. Discuss at what intensity each activity was completed, using a rate of perceived exertion or the talk test.
3. Explain how the time this workout takes to complete may help adults adhere to the relevant physical activity guidelines.
4. Discuss how you could modify the 7-minute workout to develop a different fitness component.

9.2 Activity

9.2 Quick quiz on

9.2 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 3	4	5, 6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Define** *aerobic power*.
2. **Define** *flexibility*.
3. **Outline** two factors affecting muscular strength.
4. **Describe** two physical activities that require muscular endurance, with specific reference to the muscles involved.

APPLY your understanding

5. **Justify** why activities that develop flexibility should be included in a personalised physical activity plan.
6. The 24-hour movement guidelines recommend that people of all ages undertake activities that develop muscular strength. **Explain** with reference to improving general health why developing muscular strength is important for people of all ages.

9.2 Exam questions

Question 1 (1 mark)

Which of the following activities requires high levels of muscular endurance?

A. Lifting heavy grocery bags
B. Vertical jumping while rebounding a basketball
C. Completing 20 calf raises
D. 1 RM bench press

Question 2 (2 marks)

Compare muscular strength and muscular endurance, and give examples of physical activities that require these fitness components.

Question 3 (2 marks)

Discuss two common barriers that people may experience when attempting to complete physical activities that improve aerobic power.

9.3 Functional Movement Assessment

Key knowledge	Key skills
• Functional Movement Assessment: – physiological, psychological and sociocultural considerations – pre-participation health screening – informed consent – assessment reliability, validity and accuracy	• justify an appropriate FMA for a targeted individual/group, from a physiological, psychological and sociocultural perspective • conduct and evaluate an FMA using reliable, valid and accurate methodology

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

9.3.1 Functional Movement Assessment

A **Functional Movement Assessment (FMA)** forms the basis for a successful personalised physical activity plan. Conducting an FMA maximises the likelihood of the physical activity plan being effective, safe and sustainable for the individual.

An FMA is not intended to diagnose musculoskeletal conditions. It involves observation of the participant through a variety of physical movements. The individual's movements are then evaluated to determine the efficiency of their movement in preparation for prescribing safe physical activity within a personalised activity plan. A low score on an FMA suggests an increased risk of sustaining a musculoskeletal injury.

To support the FMA and development of a personalised physical activity plan, a number of physiological, psychological and sociocultural considerations need to be taken into account.

FIGURE 9.7 An individual must be closely observed throughout their FMA before a varied physical activity plan that includes activities such as basketball can be created.

Physiological considerations

The FMA should be chosen by taking into account the **physiological considerations** and perspective of the participant, such as their current fitness, injuries and health conditions. A person's current physical activity and sedentary behaviour levels can be determined using a range of subjective and objective measures.

One of the most effective ways to gain information about a person's physiological state is to do pre-participation health screening, such as the Physical Activity Readiness Questionnaire (PAR-Q). Pre-participation health screening involves asking a series of questions about the participant's current health, including their heart health, previous and current injuries, and current exercise levels.

Information from the pre-participation screening can then be analysed to determine what movements are appropriate for the participant to complete during an FMA, and if any movements could pose a risk of injury. For example, if the participant states that they experience joint pain in the knee due to a previous injury, then a deep squat, which requires a high level of knee flexion, may not be appropriate for that individual, and that movement should not be included in the FMA. This information will also be used to determine what physical activity can be prescribed in the personalised physical activity plan.

Functional Movement Assessment (FMA) involves observing the participant through a variety of movements to inform the design of a physical activity plan

physiological considerations relate to the physical state and function of the participant, such as age, weight, fitness levels and health conditions, and which may influence the FMA

FIGURE 9.8 The Physical Activity Readiness Questionnaire provides a physiological perspective.

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	**1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	**2. Do you feel pain in your chest when you do physical activity?**
☐	☐	**3. In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	**4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	**5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____ DATE _____

SIGNATURE OF PARENT _____ WITNESS _____

or GUARDIAN (for participants under the age of majority)

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

CSEP | SCPE

© Canadian Society for Exercise Physiology www.csep.ca/forms

on Resources

Digital document Pre-test screening questionnaire (doc-22227)

Psychological considerations

The current psychological state of a participant should also inform the choices made in the FMA and personalised physical activity plan. These are the **psychological considerations** that need to be examined. Psychological safety can be supported while conducting an FMA by ensuring that the participant can complete their FMA in relative privacy, away from spectators. The genders of the participant and the person conducting the FMA should also be considered to ensure the participant is comfortable being assessed.

psychological considerations relate to the mental and emotional state of the participant, such as motivation, confidence and self-efficacy

sociocultural considerations relate to the interaction of social and cultural elements such as family, peers, community, gender, socioeconomic status, cultural beliefs and traditions

When designing a physical activity plan, thought should be put into maximising the enjoyment and motivation of the participant. This can be done through:

- goal setting
- selecting physical activities that the individual enjoys
- engaging social support by planning for physical activity to be done with others
- including rewards/incentives for completing physical activity within the plan.

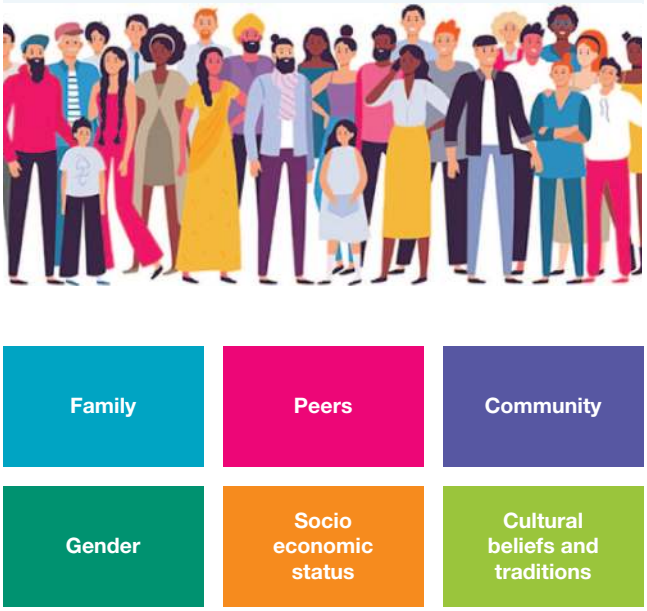
Sociocultural considerations

Sociocultural factors include family, peers, community, gender, socioeconomic status, cultural beliefs and traditions (see figure 9.9). These are the **sociocultural considerations** that need to be examined. These factors will influence both how an FMA should be conducted, and the design of the personalised physical activity plan.

Sociocultural factors can have both a positive and negative influence on an individual's current physical activity levels. For example, a person with a high socioeconomic status is more likely to have access to a gym membership.

Sociocultural factors can also influence the psychological state of the individual when completing physical activity. For example, going for a run with a friend (a sociocultural factor) may increase motivation and enjoyment (a psychological factor) (see figure 9.10).

FIGURE 9.9 Sociocultural factors play an important role in people's health and activity levels.



9.3.2 Informed consent

Most accredited fitness centres now have standard forms for their clients to complete to give their informed consent to an FMA. This includes their acknowledgment of the risks associated with the FMA and the physical activity plan they will undertake. These forms may also acknowledge that all FMA results are confidential and will only be used for the agreed purpose of improving the physical activity and/or movement patterns of the individual. Informed consent aims to protect the interests of both the participant and the person conducting the FMA. It has both legal and ethical implications.

Informed consent documentation must:

- clearly identify the organisation and the departments or individuals involved in conducting the FMA
- clearly explain the nature of any movement to be performed
- outline any possible risks
- clearly outline that the individual can withdraw consent, freely and without prejudice, at any time before, during or after the FMA

- outline the specific uses of the information obtained from the FMA and insure that the confidentiality of the information obtained will be protected
- require participants to advise the tester if they have any injury, illness or physical defect at the time of completing the FMA
- obtain the participant's signature. When the participant is under 18 years of age, the consent of a parent or guardian is required. In this case, the consent documentation needs to include a statement signed by the parent or guardian.

FIGURE 9.10 Exercising with a friend can increase motivation and enjoyment.

9.3.3 Assessment reliability, validity and accuracy

The results of the selected FMA must be interpretable and comparable, and the participant should receive feedback about:

- what the results represent
- how the results compare with previous results, if relevant
- how the results compare with those of other participants in the reference group
- the consequences and implications of the results in relation to a physical activity plan.

FIGURE 9.11 Each FMA must be valid, accurate and reliable, which means the criteria shown here must be upheld.

Strong FMA

Validity	Accuracy	Reliability
The FMA should measure what it claims to measure	**How close the test results are to the actual physical ability or characteristic being measured**	**The FMA must be able to be replicated with consistency**
For example, if an FMA claims to assess whole body functional movement, then it should include a variety of whole body movements, not only lower body or upper body movements. **Example** Lower body assessment includes squats and lunge patterns.	• Adequately trained administrators • Clear protocols to follow • Accurate and high quality equipment • Appropriate and stable environmental conditions and facilities **Example** Is the administrator trained? Were the protocols followed?	• Perform the same warm up (or no warm up if appropriate for FMA) • Conduct the same sequence of movements • Provide the same recovery period between movements • Assess the participant at approximately the same time of day • Assess the participant when they are in a similar hydration and nutritional state • Conduct the tests in similar environmental conditions (heat, humidity and air movement)

Resources

Digital document FMA templates (doc-42027)

9.3 Activity

9.3 Quick quiz on | **9.3 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 5, 6	3	4, 7, 8, 9

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **State** the purpose of a functional movement assessment (FMA).
2. **Identify** three pieces of physiological information that should be taken into account when completing a functional movement assessment.
3. **Describe** and provide an example of a sociocultural factor.
4. **Explain** the purpose of a pre-participation health screen, such as the PAR-Q.
5. **Outline** two ways that an FMA can be conducted accurately.
6. **Outline** two ways that an FMA can be conducted reliably.

APPLY your understanding

7. With reference to reliability, **explain** why it is important to complete the same sequence of movements if an FMA is to be repeated.
8. **Design** a Functional Movement Assessment for a peer including at least six functional movements.
9. **Justify** the activities you have included in your FMA with reference to physiological considerations.

9.3 Exam questions

Question 1 (1 mark)

Which of the following is not a sociocultural consideration?

A. Peers
B. Fitness levels
C. Gender
D. Family

Question 2 (2 marks)

Using an example, **explain** how sociocultural factors can influence the design of an FMA.

Question 3 (2 marks)

Explain why a functional movement assessment should be completed before the design of a personalised physical activity plan.

9.4 Creating a personalised physical activity plan

Key knowledge	Key skills
• considerations of a personalised plan, including self-management skills, used to promote physical activity and reduce sedentary behaviour	• using self-management skills, design a sustainable personalised plan that promotes adherence to physical activity and sedentary behaviour guidelines • implement strategies from a personalised plan to gather primary data about strengths and limitations of the program design

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

9.4.1 Planning for success

To ensure the greatest chance of success, a physical activity plan should be tailored to the individual, as would be done for a training program. To do this, the plan should consider the following.

- Current levels of physical activity
  - Aim for adherence to the relevant Australian physical activity guidelines.
- Current levels of sedentary behaviour
  - Aim for adherence to the relevant Australian Physical Activity and Sedentary Behaviour Guidelines.
- Physiological information gathered from the Functional Movement Assessment, such as:
  - pre-existing injuries or health conditions
  - mobility or movement issues
  - current fitness levels.
- Sociocultural information, such as:
  - social connections with physical activity (e.g. does the individual enjoy exercising with friends or family)
  - availability of equipment and resources (e.g. does the individual have a gym membership or a bicycle)
  - community opportunities (e.g. is there a program in the local community that the individual could participate in, such as parkrun).
- Psychological information, such as:
  - any feelings of anxiety or low self-efficacy relating to being physically active
  - motivation levels.
- Physical activity goals
  - The goals the individual would like to achieve, using the SMARTER goal-setting framework (see figure 9.12).

SMARTER goal setting increases the individual's likelihood of achieving their goals. This success, in turn, is a powerful motivational factor that can lead to further goal attainment. For an activity plan to be successful, it is important to base the plan around SMARTER goals, developed together with the participant. Once these goals have been established, the personalised physical activity plan can be designed.

FIGURE 9.12 SMARTER goal setting can help increase the success of a physical activity plan.

S — **Specific** — make your goals as specific and detailed as possible.

M — **Measurable** — your goals should be measurable and assessed against a standard of previous performance, otherwise there is no way of determining whether or not you have achieved them.

A — **Accepted** — all of the parties involved in the setting of the goals (e.g. the individual, trainer, coach) should accept them.

R — **Realistic** — your goals need to be challenging, but also achievable. Goals should be framed in a positive manner and focused most importantly on improvement.

T — **Time-framed** — short-term and long-term goals should be set and there should be a specific date for when they will be achieved.

E — **Exciting** — the goals set should challenge, excite and inspire the individual.

R — **Recorded** — the agreed goals should be recorded by the individual and trainer/coach so as to provide a constant reminder and to act as a source of motivation.

FIGURE 9.13 Some people need variety and social interaction to stay motivated to exercise.

9.4.2 Sedentary behaviour

While increasing physical activity is associated with decreased sedentary behaviour, an active person can still be highly sedentary; the behaviours occur independently of each other. A good physical activity plan will create opportunities to be active while also decreasing sedentary behaviour. However, this is not always possible.

FIGURE 9.14 Cycling even part of the way to work or school decreases the time spent sedentary.

For some people, a separate plan that aims to decrease sedentary behaviour may be required. A decreasing sedentary behaviour plan should be created in a similar way to the physical activity plan. Assess the current levels, compare to the relevant guidelines, consider the enablers and barriers and create the plan.

One of the easiest ways to increase physical activity and decrease sedentary behaviour is through active transportation. Even if you live a great distance from work or school, by parking further away or taking public transport you can decrease the sedentary behaviour of sitting and increase your physical activity through walking or riding part of the journey.

A physical activity plan should last for at least six weeks in order to see any health benefits. The plan should also be modified regularly to ensure long-term physical activity and health benefits.

9.4.3 Preliminary information

After conducting an FMA and gathering preliminary information about the participant's current levels of physical activity and sedentary behaviour, as well as their enablers and barriers to physical activity, you can create a personalised physical activity plan. For participants who are not currently meeting the Australian Physical Activity and Sedentary Behaviour Guidelines, such as recommended amount of movement they do within a 24-hour period (24-hour movement guidelines), a progressive adjustment towards meeting these is recommended.

While developing the physical activity plan, it can be useful to refer to the training principles of frequency, intensity, type and time/duration (FITT) as shown in figure 9.15.

FIGURE 9.15 The FITT principles can be used to inform the physical activity plan.

Frequency	Intensity	Type	Time/Duration
How often per week physical activity is completed	Level of physical exertion or how hard you work (e.g. light, moderate, vigorous)	The mode of activity being undertaken (e.g. aerobic, such as cycling or weight training)	How long you are active for, usually measured in minutes

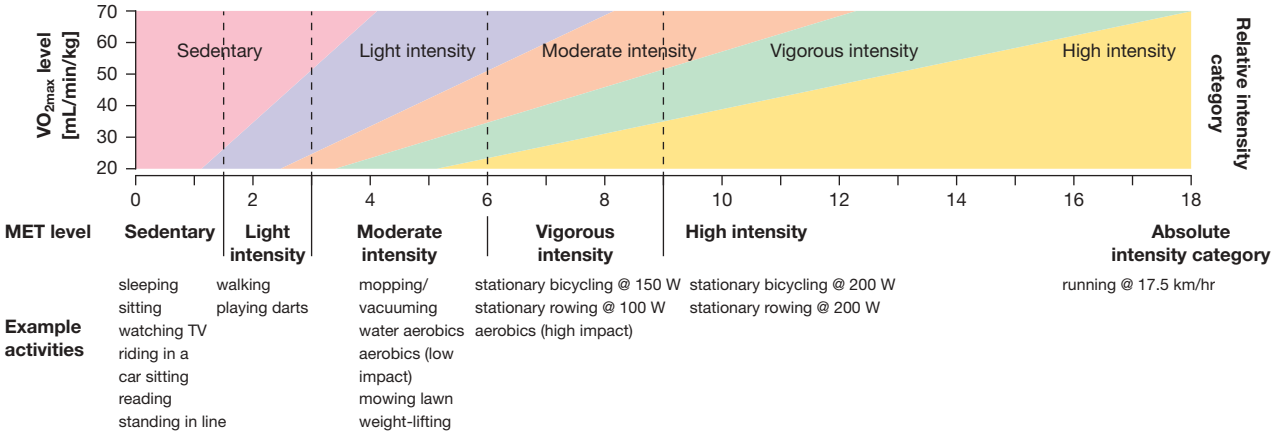
These training principles are explored in more detail when designing training programs to enhance performance. However, they can also be used to provide clarity and structure to a physical activity plan. Each principle (frequency, intensity, type and time/duration) is referred to in the 24-hour movement guidelines for different age groups, and language from the guidelines (e.g. light, moderate and vigorous intensity) can be used in the plan. Examples of activities at the different intensities are given in table 9.5 and figure 9.16.

The type of physical activities included in the plan should include a variety of movements and muscle groups, to improve the health-related fitness components (see subtopic 9.2).

TABLE 9.5 Examples of activities of different intensity

Light	Moderate	Vigorous
• Leisurely walking • Lawn games such as Finska • Yoga	• Hiking • Mowing the lawn • Dancing • Cycling <16 km/h • Brisk walking	• Jogging, running • Basketball/netball • Cycling >16 km/h • Swimming laps • Weightlifting (vigorous)

FIGURE 9.16 Intensities of a variety of activities



9.4.4 Sample personalised physical activity plan

Description of subject: 15-year-old female living in a high-SES area. Subject has completed a recall survey to indicate current physical activity levels, which indicated relatively high levels of physical activity, especially on weekends, due to playing Australian Rules football for a local club and completing a local community parkrun each Saturday. However, the individual was not meeting the 24-hour movement guidelines, as they were not accumulating 60 minutes of moderate to vigorous physical activity every day.

A Functional Movement Assessment was completed, which indicated no risks from completing physical activity.

To achieve the individual's larger goal of meeting the 24-hour movement guidelines, smaller goals were set, including:

- using active transport to school at least three times per week
- completing physical activity with family members, and including them in the plan
- using three lunchtimes per week at school to play physically active games with friends.

TABLE 9.6 A sample personalised physical activity plan

Day	Activities	Intensity	Duration (minutes)	Reflection/comments
Monday	☐ Walk to school	L	20	
	☐ PE class (basketball)	M–V	60	
	☐ Kicking footy at lunchtime	M–V	30	
	☐ Walk home from school	L	20	
Tuesday	☐ Run before school	M–V	25	
	☐ 4-square at lunchtime	L	30	
	☐ Aussie Rules football team training	M–V	90	

Wednesday	☐ Ride to school	M	10	
	☐ Sport Ed (touch rugby) class	M–V	60	
	☐ Ride home from school	M	10	
	☐ Play basketball in backyard	M	15	
	☐ Walk dog with sister	L	30	
Thursday	☐ Ride to school	M	10	
	☐ PE class (basketball)	M–V	60	
	☐ Ride home from school	M	10	
	☐ Walk dog with sister	L	30	
Friday	☐ Run before school	M	30	
	☐ Kicking footy at lunchtime	M–V	30	
	☐ Online body weight circuit with mum	M	15	
Saturday	☐ Community 5-km parkrun	M	30	
	☐ Aussie Rules football game	M–V	80	
	☐ Walk dog with sister	L	30	
Sunday	☐ Bike ride with friend	M	60	
	☐ Gardening (mow lawn)	M	30	
	☐ Online yoga with mum	L	20	

on Resources

Digital document Physical activity plan template (doc-41963)

9.4 Activity

9.4 Quick quiz on | **9.4 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2	4, 7, 8	3, 5, 6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Identify** how many days per week a 16-year-old should be completing moderate to vigorous physical activity.
2. **Describe** two ways in which motivation can be increased for a participant completing a physical activity plan.
3. **Describe** what is meant by moderate and vigorous activity.
4. **Predict** two barriers to physical activity that an adult may experience, and suggest one way you could overcome each of these barriers with reference to a personalised physical activity plan.
5. Maintaining records of physical activity during a plan is essential for effective self-management. **Explain** why it is important to keep a record of physical activity levels as well as other reflections, such as psychological reflections, when completing a personalised physical activity plan.

APPLY your understanding

6. Create a flowchart to show the steps in creating a personalised physical activity plan and **justify** the role of each step.
7. Using the template in the digital documents section of the Resources panel, devise a physical activity plan for yourself and **discuss** how it could be modified if you were to go on holidays.
8. Using the template in the digital documents section of the Resources panel, devise personalised physical activity plans for two family members, **discuss** how they differ and explain why.

9.4 Exam questions

Question 1 (1 mark)

Which of the following would be considered a sociocultural factor that may influence a physical activity plan?

A. Current fitness levels
B. Pre-existing injuries
C. Whether the participant has siblings they could be active with
D. The participants motivation to be physically active

Question 2 (2 marks)

Explain, using a relevant example, why promoting self-management is important when completing a physical activity plan.

Question 3 (2 marks)

Discuss, using an example, one way that someone can increase physical activity while also decreasing sedentary behaviour through the implementation of a physical activity plan.

9.5 Evaluating a personalised physical activity plan

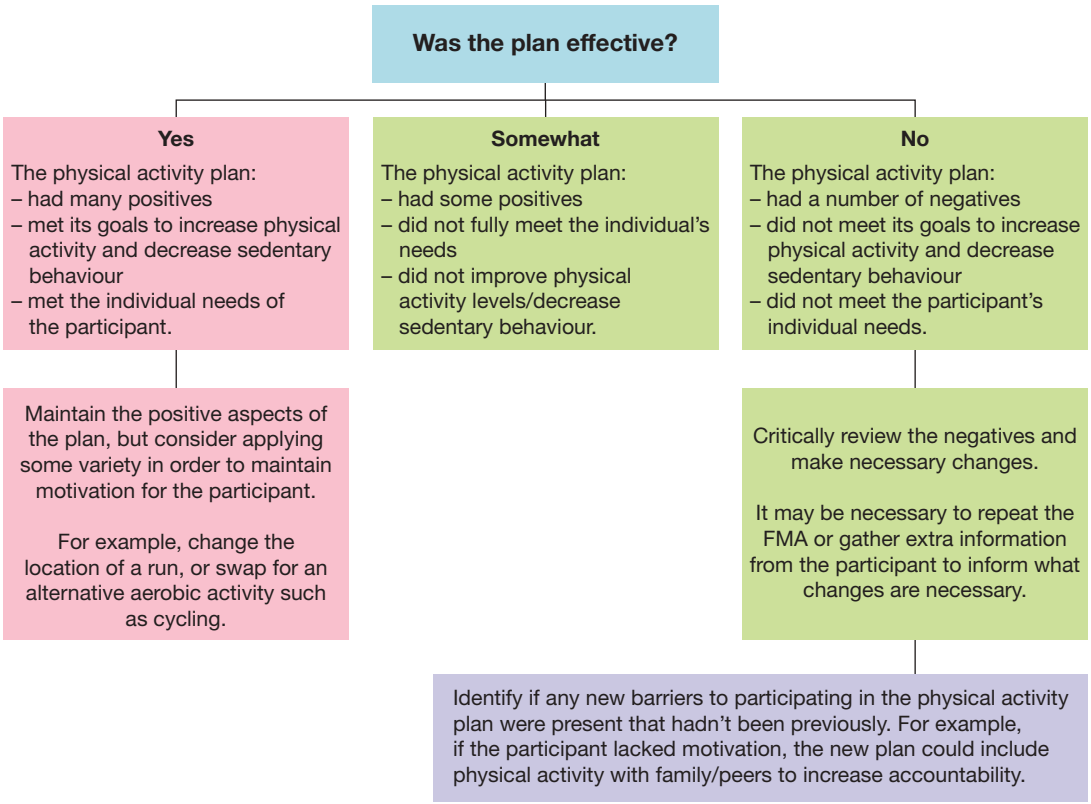
Key knowledge	Key skills
• considerations of a personalised plan, including self-management skills, used to promote physical activity and reduce sedentary behaviour	• using self-management skills, design a sustainable personalised plan that promotes adherence to physical activity and sedentary behaviour guidelines • implement strategies from a personalised plan to gather primary data about strengths and limitations of the program design

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

9.5.1 The importance of evaluation

Once you have created and implemented the physical activity plan, you should evaluate it regularly to ensure its long-term effectiveness. When evaluating if a plan has been successful, you should gather information to determine its strengths and weaknesses to guide the next steps. To evaluate your plan, you will need to:

- *Step 1*. Record current (post-implementation) levels of physical activity and sedentary behaviour (adherence to relevant Australian Physical Activity and Sedentary Behaviour Guidelines), preferably in the same way as the initial levels were recorded.
- *Step 2*. Compare the current levels (post-implementation) to the initial levels (pre-implementation). The participant's personal reflections should also be reviewed to gain information about the impact of physiological, psychological and sociocultural factors on their completion of the physical activity plan. From here, an overall judgement can be made regarding whether the plan was effective, somewhat effective or ineffective.



9.5 Activity

9.5 Quick quiz on

9.5 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 3	4	5, 6, 7

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Explain** why it is important to regularly evaluate a physical activity plan.
2. **Outline** the role of evaluation in a physical activity plan.
3. **Suggest** two forms of primary data that could be analysed when evaluating the effectiveness of a physical activity plan.

APPLY your understanding

4. Not all physical activity plans will automatically decrease sedentary behaviour. **Suggest** two ways you can increase physical activity while decreasing sedentary behaviour.

5. Based on the information provided in the graphs below, answer the questions that follow.

FIGURE 9.17 Sedentary behaviour levels pre- and post-individual physical activity plan

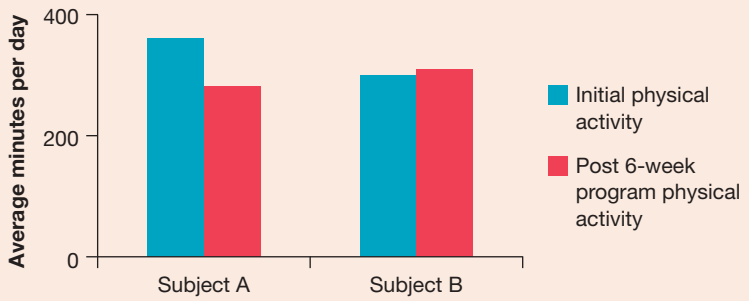
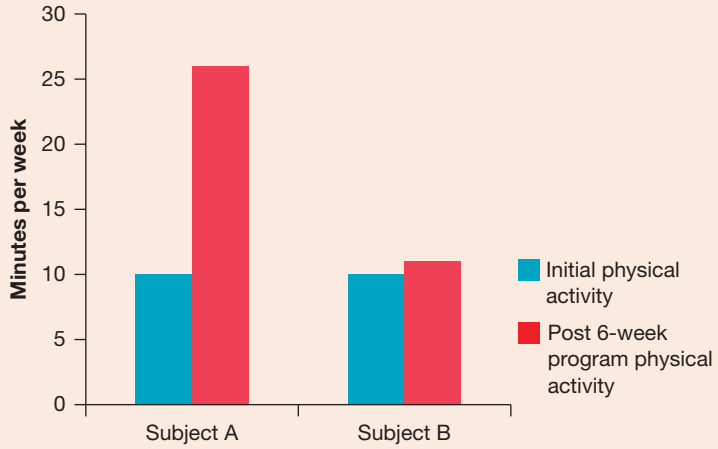


FIGURE 9.18 Physical activity levels pre- and post-individual physical activity plan



a. Which subject experienced the most significant change in behaviour?
b. What other information would be helpful in order to complete an accurate evaluation of the subjects?
c. Based on the data in the graphs, **evaluate** the effectiveness of the physical activity plans for Subject A and Subject B.

6. **Evaluate** the effectiveness of the physical activity plan you created for yourself. You should include any strengths, weaknesses, future considerations and the overall effectiveness in your evaluation.
7. **Critique** the effectiveness of the physical activity plan you created for a family member. You should include any strengths, weaknesses, future considerations and the plan's overall effectiveness in your evaluation.

9.5 Exam questions

Question 1 (1 mark)
Outline the first step in an evaluation.

Question 2 (2 marks)
Briefly **discuss** how you will know if your plan has been effective.

Question 3 (1 mark)
Discuss why it is important to use the same method for measuring sedentary/physical behaviour levels pre- and post-implementation of the physical activity plan.

9.6 Key skills

Key skills

- explain health-related fitness components, including factors affecting each component
- justify an appropriate FMA for a targeted individual/group from a physiological, psychological and sociocultural perspective
- conduct and evaluate an FMA using reliable, valid and accurate methodology
- using self-management skills, design a sustainable personalised plan that promotes adherence to physical activity and sedentary behaviour guidelines
- implement strategies from a personalised plan to gather primary data about strengths and limitations of the program design.

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

9.6.1 Tell me

To address the key skills for this topic, it is important to remember the following:

- a personalised physical activity plan needs to be evidence-based in its design. It should promote adherence to relevant physical activity and sedentary behaviour guidelines while also considering the individual's physiological, psychological and sociocultural considerations.
- there are many templates and formats that can be used to create a personalised physical activity plan. It is important to allow for the participant to record reflective primary data throughout the implementation of the plan, to gain a detailed understanding of the plan's strengths and weaknesses.
- a personalised physical activity plan should include activities from a variety of domains and target the development of the health-related fitness components.

9.6.2 Show me

Practice question (16 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

Jin is a 38-year-old single mother of two primary school aged–children. Jin works Monday to Friday in a retail job selling household appliances at the local shopping centre. She starts work at 9:00 am after dropping her children to school, and finishes at 4:30 pm, in time to pick her children up from after-school care. Jin has mentioned that since having children she has been incredibly busy, lacks motivation and has not regularly participated in much physical activity.

When she was younger, she really enjoyed recreational running and used to do group classes at the gym. Although she lives in a low-SES area and is a low-income earner herself, Jin has access to lots of public facilities in her local community, including walking trails and parks with public exercise equipment. Jin scored well on a Functional Movement Assessment, which showed that she had no higher risk than usual of injury, and it was safe to complete most types of physical activity. Her current physical activity includes:

- one 45-minute run (moderate intensity) on a Saturday morning while her children attend a Saturday language school
- playing with her children at the park on the weekends.

a. **Identify** a psychological factor and a physiological factor that could be considered as barriers to participating in a *physical activity plan* for Jin. (2 marks)

b. **Discuss** two sociocultural factors that should be considered in the design of a *personalised physical activity plan* for Jin. (4 marks)

c. Based on the information provided, use the following table to **design** a 7-day *personalised physical activity plan* for Jin that reduces sedentary behaviour and promotes adherence to the *relevant physical activity guidelines*. (10 marks)

Day	Activities	Intensity L,M,V	Duration (minutes)	Reflection/Comments
Monday	☐			
Tuesday	☐			
Wednesday	☐			
Thursday	☐			
Friday	☐			
Saturday	☐			
Sunday	☐			

Decode the question

Strategies to decode the question

- **Identify the action words:**
  Identify — determine the key characteristics or features
  Discuss — present a clear, considered and balanced argument
  Design — To plan or make
- **Key terminology** — *physical activity, enablers and barriers*
- **Key concepts** — personalised physical activity plan, Australian Physical Activity and Sedentary Behaviour Guidelines, Functional Movement Assessment, physiological, psychological and sociocultural factors
- **Marking scheme** — 15 marks — always check the marking scheme for the depth of response required, linking to key information highlighted in the question

Sample response and marking scheme

a. Lack of motivation
Award 1 mark for identifying one relevant psychological factor (lack of motivation, possible low self-efficacy or confidence).

b. Jin is a low-income earner from a low-SES area, so *physical activity that is free* should be included in the design of the physical activity plan, such as walking/running on the available walking trails.
Jin's *family should be considered* in the design of the plan, as physical activity that involves her children needs to be included, such as playing in the park.
Award 2 marks for identifying two relevant sociocultural factors (low SES, low income, family, works locally, availability of resources locally such as trails with public exercise equipment).
Award 1 mark for discussing how the first sociocultural factor might impact the design of the program.
Award 1 mark for discussing how the second sociocultural factor might impact the design of the program.

c.

Day	Activities	Intensity L,M,V	Duration (minutes)	Reflection/comments
Monday	☐ Brisk walk to park with colleague to eat lunch	M	30	
Tuesday	☐ Park further from work and walk	L–M	20	
	☐ Play ball games with children at school pick-up	M–V	30	
Wednesday	☐ Brisk walk to park with colleague to eat lunch	M	30	
	☐ After-school walk with children	L–M	25	

Thursday	☐ Run after work, before school pick-up	V	30	
	☐ *Online home workout (body weight circuit)	M–V	20	
Friday	☐ Park further from work and walk	L–M	20	
	☐ Walking to shops with children	L	20	
Saturday	☐ Run on local trails	V	45	
	☐ *Garden/yard work	M	60	
Sunday	☐ *Body weight exercises at playground	M	30	
	☐ *Guided home Pilates video (online)	M	20	

*Indicates muscle-strengthening activities

Award 9–10 marks (a high response) for a detailed personalised activity plan that includes the following:

- physical activity every day
- at least 2.5 hours moderate and 1.25 of vigorous physical activity across the week
- clear promotion of adherence to relevant guidelines
- muscle-strengthening activities on at least two days
- the correct intensity associated with each activity
- clear consideration of Jin's physiological, psychological and sociocultural factors
- a variety of physical activities across the week
- opportunities to reduce sedentary behaviour.

9.6.3 Let me do it

Question 1 (4 marks)

The following personalised physical activity plan was made for a 17-year-old male high-school student living in a high-SES area. The subject has completed a recall survey to indicate their current physical activity levels, which suggests that although he completes some physical activity during the week, he is largely inactive on weekends and is not currently meeting the 24-hour movement guidelines for his age group. He plays basketball on a Friday night and have mentioned that he enjoys cycling and exercising with friends to increase his motivation.

The personalised physical activity plan includes his personal reflections/comments. The check boxes indicate whether the physical activity was completed or not.

Day	Activities	Intensity	Duration (minutes)	Reflection/comments
Monday	☐ Walk to school	L	20	*Woke up too late to walk to school, got a lift since mum was driving my little brother anyway.*
	☑ PE class (softball)	M–V	60	
	☑ Play basketball at lunchtime with friends (king of the court)	M–V	30	
	☐ Walk home from school	L	20	
Tuesday	☐ Walk to school	L	20	*Raining so didn't want to walk to school.*
	☑ Basketball training	M–V	60	
	☐ Walk home from school	L	20	
Wednesday	☐ Walk to school	L	10	*Lunchtime B'Ball was good, I enjoyed it.*
	☑ Play basketball at lunchtime with friends (king of the court)	M–V	30	
	☐ Walk home from school	L	20	
Thursday	☑ Walk to school	L	20	*It was raining so PE class was cancelled. I walked to school but it was boring.*
	☐ PE class (softball)	M–V	60	
	☑ Walk home from school	L	20	
Friday	☐ Walk to school	L	20	*Couldn't be bothered walking to school. Did it yesterday and it was boring.*
	☑ Basketball game	V	40	
	☐ Walk home from school	L	20	
Saturday	☑ Kick footy with brother	M	30	
	☑ Gardening (mow lawn)	M	30	
Sunday	☐ Run in park	M	30	*Couldn't be bothered going for a run. Had heaps of homework and was tired from bike ride.*

a. For the above case study, **evaluate** the effectiveness of the personalised physical activity plan in promoting adherence to the 24-hour movement guidelines. **(4 marks)**

b. Based on the primary data collected by the participant, **discuss** one psychological and one sociocultural factor that negatively affected his participation in the plan. **(2 marks)**

c. Based on the individual's reflections above, **describe** two changes you could make to the plan to increase motivation. **(2 marks)**

d. **Outline** two possible additions to the physical activity plan above that could be included to decrease sedentary behaviour. **(2 marks)**

9.7 Review

Hey students! Now that it's time to revise this topic, go online to:

Review your results

Watch teacher-led videos

Practise exam questions

Find all this and MORE in jacPLUS

9.7.1 Summary

Health-related fitness components and factors

- For a personalised physical activity plan to be effective in the long term, it needs to be tailored to the individual's needs. A one-size-fits-all approach is unlikely to be effective.
- The physical activity plan should be balanced to address multiple health-related fitness components, including aerobic power, muscular strength, muscular endurance and flexibility.

Functional Movement Assessment

- A Functional Movement Assessment (FMA) forms the basis for a successful personalised physical activity plan. Conducting an FMA maximises the likelihood of the physical activity plan being effective, safe and sustainable for the individual.

Creating and evaluating a personalised physical activity plan

- Physiological, psychological and sociocultural considerations should inform the design of the personalised physical activity plan.
- The relevant Australian Physical Activity and Sedentary Behaviour Guidelines should be referred to. The plan should aim to increase physical activity and decrease sedentary behaviour.
- A personalised physical activity plan should be regularly evaluated and modified for long-term success.

9.7.2 Key terms

aerobic power the maximum rate of energy production from the aerobic energy system
flexibility the range of movement around a joint
Functional Movement Assessment (FMA) involves observing the participant through a variety of movements to inform the design of a physical activity plan
muscular endurance the ability of a muscle or group of muscles to sustain repeated or sustained contractions against resistance for an extended period
muscular strength the peak force that a muscle can develop
physiological considerations relate to the physical state and function of the participant, such as age, weight, fitness levels and health conditions, and which may influence the FMA
psychological considerations relate to the mental and emotional state of the participant, such as motivation, confidence and self-efficacy
sociocultural considerations relate to the interaction of social and cultural elements such as family, peers, community, gender, socioeconomic status, cultural beliefs and traditions

9.7 Exam questions

9.7 Section A — Multiple choice questions

Question 1 (1 mark)

Which of the following are the health-related fitness components that should be addressed by a physical activity plan?

A. Muscular power, muscular strength, cardiovascular endurance and balance
B. Muscular strength, muscular endurance, aerobic power and flexibility
C. Aerobic speed, muscular strength and agility and flexibility
D. Agility, reaction time, anaerobic capacity and aerobic power

Question 2 (1 mark)

Which of the following physical activities require high levels of muscular endurance?

A. A landscaper gripping the handles of a wheelbarrow while they push it
B. Lifting heavy grocery bags into a shopping trolley
C. Completing a 100-metre sprint
D. A soccer goalkeeper diving to make a save

Question 3 (1 mark)

Experiencing joint pain and limited range of motion in the knee while completing a deep squat movement as a part of an FMA is an example of:

A. psychological information.
B. sociocultural information.
C. physiological information.
D. an acute injury.

Question 4 (1 mark)

In order to gain informed consent before conducting an FMA, which of the following should be included in the informed consent documentation?

A. Clearly explain the nature of any movement to be performed.
B. Outline any possible risks.
C. Clearly outline that the individual can withdraw consent, freely and without prejudice, at any time before, during, or after the FMA.
D. All of the above

Question 5 (1 mark)

Which of the following must be taken into account when developing a personalised physical activity plan?

A. Current adherence to the relevant national physical activity guidelines
B. Physical activity goals
C. Family responsibilities
D. All of the above

Question 6 (1 mark)

Which of the following is the least accurate measure of intensity?

A. Heart rate
B. METS
C. Talk test
D. Observation

Question 7 (1 mark)

Which of the following strategies supports self-management when completing a personalised physical activity plan?

A. The participant keeping a diary/log, including reflections, for the duration of the plan
B. Employing a professional coach to motivate the participant during physical activity
C. Only including physical activity in the plan that is completed individually to avoid distractions
D. Repeating a six-week physical activity plan with no changes if the plan was originally effective

Question 8 (1 mark)

Which of the following is not an example of a strength activity?

A. Push-ups
B. Jogging
C. Squats
D. Plank

Question 9 (1 mark)

Which of the following activity types are recommended for inclusion in an elderly person's personalised physical activity plan?

A. Flexibility
B. Balance
C. Strength
D. All of the above

Question 10 (1 mark)

A good physical activity plan will work for anyone. This statement is:

A. false — every plan needs to be specific to the individual's enablers and barriers.
B. true — as long as they have the motivation to follow it.
C. true — as long as it goes for six weeks.
D. true — as long as it adheres to the training principles.

9.7 Section B — Short answer questions

Question 1 (20 marks)

Kay is a 48-year-old father of two who works six days a week at an accounting firm in the CBD. Kay lives close to a train station and catches the train to work. Kay generally lacks motivation to complete physical activity as he is often tired from his busy work schedule, but he does enjoy spending time being active with his children when he can.

a. **State** the relevant physical activity guidelines for Kay. **(2 marks)**

b. **Identify** two barriers to physical activity that Kay is likely experiencing, and suggest two strategies that could be incorporated into a personalised physical activity plan to overcome these barriers. **(4 marks)**

c. **Identify** one sociocultural factor that could be considered an enabler to being physically active. **Explain** how this sociocultural factor could support Kay to be physically active. **(2 marks)**

d. Using the information above and the template below create a one-week sample of a personalised physical activity plan that would support Kay to meet the relevant physical activity guidelines. **(10 marks)**

Day	Activities	Intensity L,M,V	Duration (minutes)	Reflection/Comments
Monday	☐			
Tuesday	☐			
Wednesday	☐			
Thursday	☐			
Friday	☐			
Saturday	☐			
Sunday	☐			

e. **Describe** two ways that Kay could decrease his sedentary behaviour while completing this physical activity plan. **(2 marks)**

Question 2 (2 marks)

Explain why it is important to collect primary data such as physiological and psychological reflections when completing a physical activity plan.

Question 3 (2 marks)

A common barrier to being physically active is lack of time. **Describe** two ways you can overcome this barrier in the design of a physical activity plan.

Continue to build your exam skills

Access the Unit 2 Area of Study 1 Review at the end of Topic 9. This includes:

- Practice extended response
- Practice examination
- Practice school-assessed coursework.

AREA OF STUDY 1 How do physical activity, sport and exercise contribute to healthy lifestyles?

OUTCOME 1

On completion of this unit, the student should be able to collect and analyse data related to individual and population levels of participation in physical activity and sedentary behaviour and conduct an FMA to create, undertake and evaluate a personalised plan that promotes adherence to the relevant physical activity and sedentary behaviour guidelines.

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission

REVIEW CONTENT SEQUENCE

U2 AOS1 Extended response — Build your exam skills
U2 AOS1 Practice examination online only
U2 AOS1 Practice school-assessed coursework online only

U2 AOS1 Extended response — Build your exam skills

Tell me

To address these questions, it is important to remember:

- socioeconomic status can impact (as an enabler and barrier) physical activity behaviour by… increasing access/decreasing to facilities and equipment and other resources.
- the physical activity and sedentary behaviour guidelines for adults aged over 18 are *Be active on most, preferably all days with at least 150 minutes of mod — vig activity per week. Muscle strengthening activities 2 times a week. Minimise and break up prolonged periods of sitting.*
- the benefits of regular participation in movement include increased health of muscles, bones and heart. Also includes increased mental health benefits such as decreased anxiety and increased ability to think and process.
- when outlining trends always use data and consider all data
- Subjective methods such as a recall survey or interview are efficient ways of assessing physical activity particularly for large groups.

Show me

Practice question (8 marks)

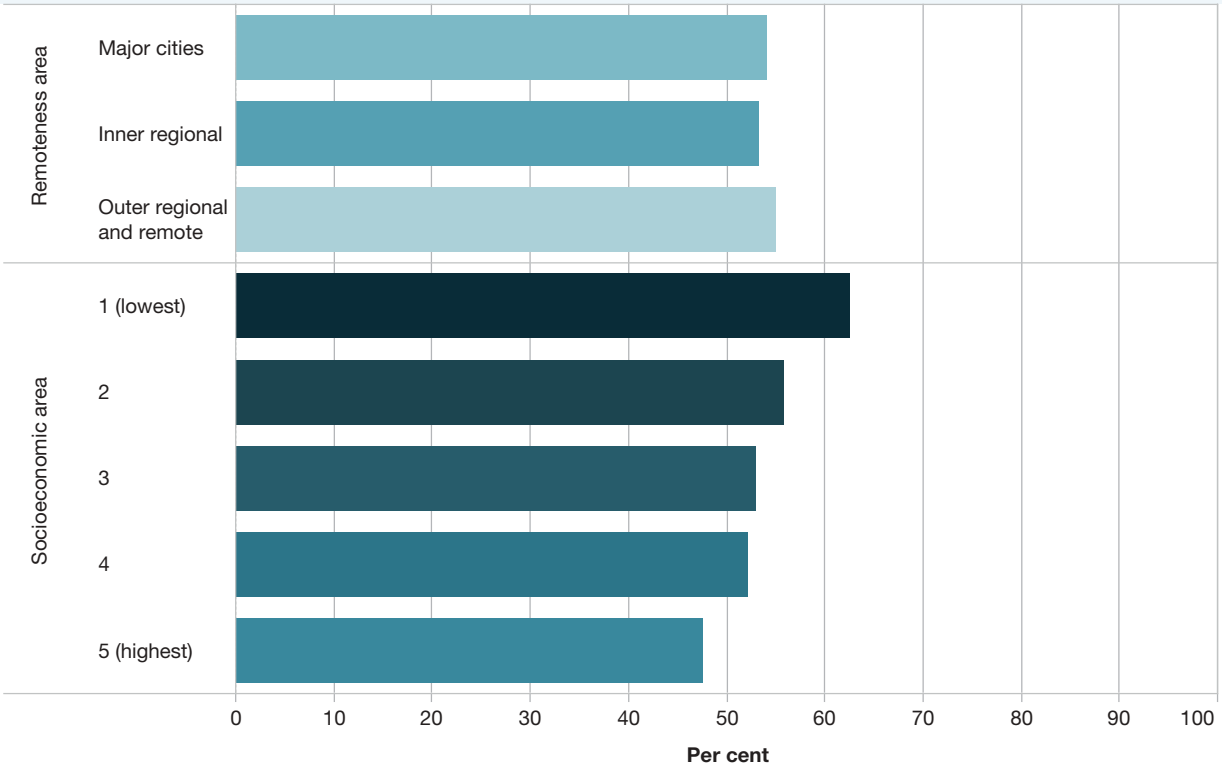
KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

Suggest how the data below was *likely* to have been collected, how sociocultural barriers may have led to these results and then **explain** the *implications* of the findings using your understanding of:

- sociocultural enablers and barriers to individual physical activity behaviour
- physical activity and sedentary behaviour guidelines for different age population groups
- physical, social, mental, emotional and spiritual benefits of regular participation in types of movement.

FIGURE 1 Prevalence of insufficient physical activity among adults aged 18 and over, by selected population characteristics, 2017–18



Decode the question

Strategies to decode the question

- **Identify the action words:**
  Suggest — put forward a possible answer for consideration
  Explain — provide detail to show the relationship between concepts
- **Key terminology** — *likely*, *implications*
- **Key concepts** — sociocultural enablers and barriers to individual physical activity behaviour, physical activity and sedentary behaviour guidelines for different age population groups, physical, social, mental, emotional and spiritual benefits of regular participation in types of movement
- **Marking scheme** — 8 marks — always check the marking scheme for depth of response required, linking to key information highlighted in the question.

Sample response

The data would have had to have been collected using a measure like recall via surveys or interviews. Whilst there are *cognitive challenges/bias* when using these they can efficiently gather a range of information (duration, frequency and type of physical activity), as well as socioeconomic status for large groups as shown in graph.

The data suggests that the lower your socioeconomic status the *more likely you are to be insufficiently active*. For example, the lowest Socioeconomic status had approximately 63% insufficiently active compared to approximately 48% for the highest socioeconomic status group.

As the physical activity guidelines for adults over 18 are to be active on most, preferably all days with at least 150 minutes of moderate — vigorous activity per week as well as muscle strengthening activities 2 times a week, the information

Low socioeconomic status can act as a barrier to physical activity as it may decrease the access to facilities such as gyms which can encourage physical activity.

Consequently, by not meeting the guidelines it could mean that those who from lower socioeconomic status groups are *less likely to experience* the many benefits of being active such as decreased risk of CVD and mental health conditions. By not attending gyms and being active *they may also be missing out* on opportunities to create meaningful relationships with other community members.

Marking guide

High range response	• Thorough analysis of data including identifying that the lower the SES the more likely you are to be insufficiently active • A detailed link between low socioeconomic status and barriers to physical activity • Demonstrates correct and detailed understanding of the relevant physical activity guidelines • Justifies the use of recall to collect data whilst also acknowledging limitations • Clear and accurate connection between inactivity and the lack of physical, social, mental, emotional and spiritual benefits from regular participation in types of movement • Frequently uses correct terminology that is written in a sophisticated manner
Mid range response	• Identify that the lower the SES the more likely you are to be insufficiently active • Links low socioeconomic status and barriers to physical activity • Demonstrates some aspects of the relevant physical activity guidelines • Identifies the use of recall to collect data • Attempts to make connection between inactivity and the lack of physical, social, mental, emotional and spiritual benefits from regular participation in types of movement
Low range response	• Little to no link made between SES and physical activity levels • Incorrect or lack of understanding of relevant physical activity guidelines • Fails to correctly identify how information was collected • Response is difficult to follow • Limited use of terminology

Let me do it

Extended response question learn on

Question 1 (8 marks)

parkun Australia

parkun is a free 5 km walk, jog, run or volunteering community event that is held every Saturday 9.00am and is organised entirely by local volunteers. It is open to everyone and encourages people to get connected to their community while empowering older people to be more mobile.

Critique the initiative, using the SEM, to increase physical activity to meet the relevant guidelines and increase fitness, in particular the fitness components aerobic power, muscular strength, muscular endurance and flexibility for large populations.

Hey students! Now that you have completed the Extended Response, access the following in learnON

- Practice examination
- Practice SAC
- Receive immediate feedback

Find all this and MORE in jacPLUS

Hey teachers! Now access learnON to assign the quarantined school-assessed coursework

- Assign the quarantined school-assessed coursework
- Track your students' results
- Identify strengths and weaknesses

Find all this and MORE in jacPLUS

UNIT 2

AREA OF STUDY 2

What are the contemporary issues associated with physical activity and sport?

OUTCOME 2

On completion of this unit, the student should be able to explain a range of intrapersonal and interpersonal contemporary issues that influence access to, and inclusion, participation and performance in, physical activity and sport at the local, national and global levels.

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

TOPIC SEQUENCE

10 Intrapersonal issues 358

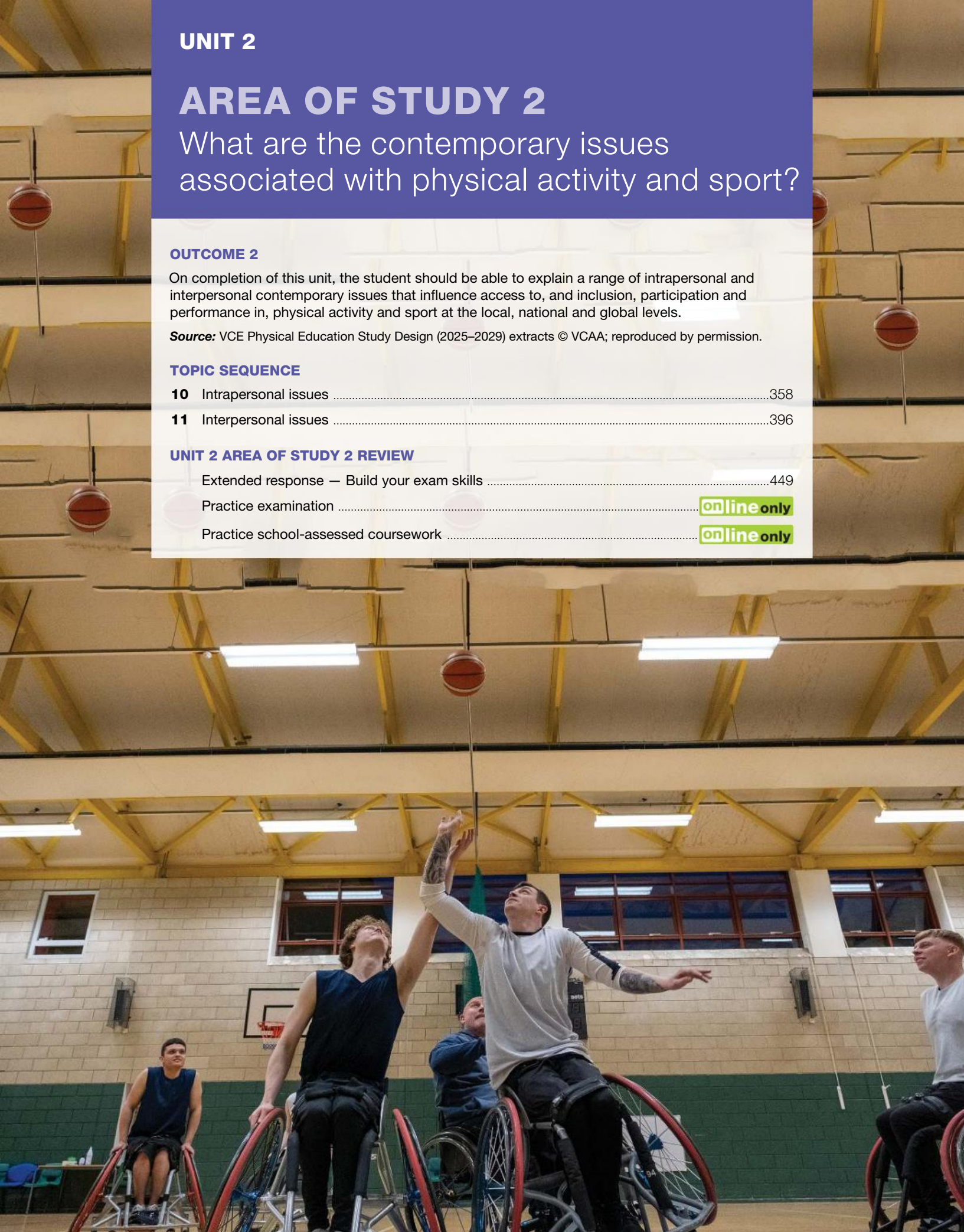
11 Interpersonal issues 396

UNIT 2 AREA OF STUDY 2 REVIEW

Extended response — Build your exam skills 449

Practice examination ..... online only

Practice school-assessed coursework ..... online only



10 Intrapersonal issues

10.1 Overview

Hey students! Bring these pages to life online

Watch videos

Engage with interactivities

Answer questions and check results

Find all this and MORE in jacPLUS

LEARNING SEQUENCE

10.1 Overview
10.2 Hormonal considerations
10.3 Injuries
10.4 Psychological skills
10.5 Mental fitness in physical activity and elite pathways
10.6 Key skills
10.7 Review

10.1.1 Introduction

Intrapersonal factors are those which arise from within an individual rather than those around them. These issues can affect all areas of life, but this topic will cover how intrapersonal issues affect an individual's ability to access and participate in a range of physical activities and sports.

The factors include hormonal considerations, injuries, psychological skills and mental fitness. Each of these factors will affect the amount and types of activity in which an individual can participate.

We will also explore how consideration of these factors has changed over time as well as different local, national and global views. This topic also links to topic 11, which focuses on interpersonal issues in sport.

The interpersonal issues discussed in topic 11 will relate to how an individual is affected by those around them in society and how this affects their involvement in physical activity and sport.

FIGURE 10.1 How can we ensure that our knowledge and understanding of the intrapersonal factors that affect an individual's access to, and participation and performance in, physical activity enables everyone to take part?

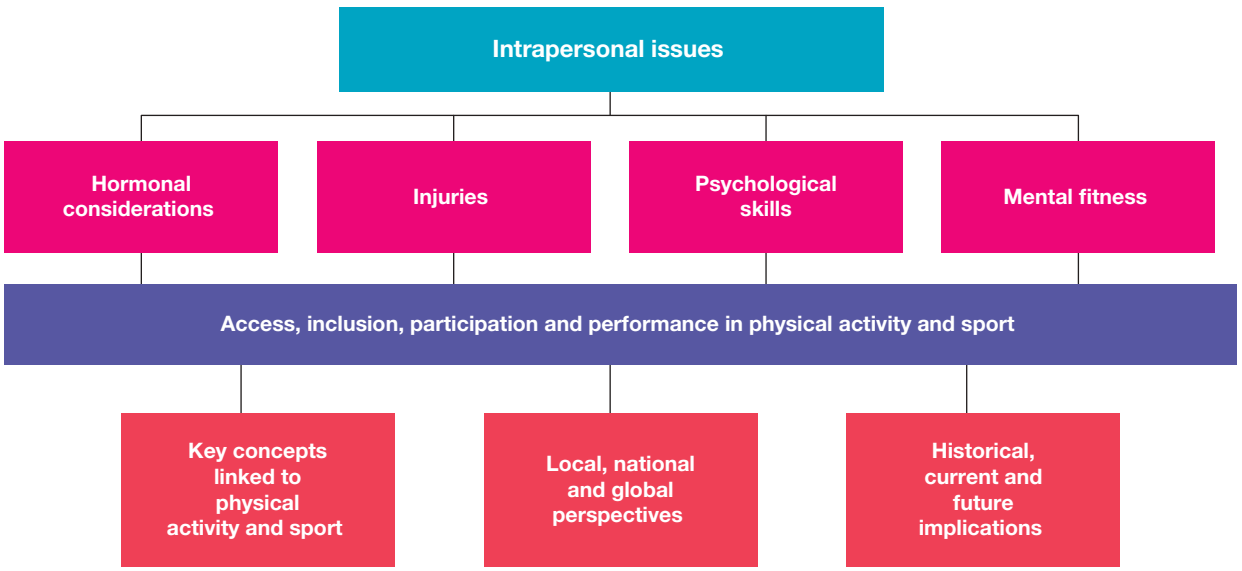
intrapersonal factors describes factors affecting individuals that come from within themselves, such as attitudes, self-esteem, self-regulation and decision-making

10.1.2 Key knowledge and Key skills

Key knowledge	Key skills	Subtopic
• intrapersonal issues that influence access to, and inclusion, participation and performance in, physical activity and sport, such as: – hormonal considerations for physical activity prescription – injuries, such as concussion and knee injuries, and safety – psychological skills, including sleep and accompanying strategies – mental fitness, including the role of physical activity and the responsibility of elite sport pathways	• explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport	**10.2** **10.3** **10.4** **10.5**
• key concepts within the selected contemporary issue linked to participating in physical activity and/or sport in society	• collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media	
• local, national and/or global perspectives on the selected issue	• propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport	
• historical, current and future implications of the selected issue	• prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue • analyse the historical, current and future implications of the selected issue	

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

10.1.3 Topic overview



10.2 Hormonal considerations

Key knowledge	Key skills
• intrapersonal issues that influence access to, and inclusion, participation and performance in, physical activity and sport, such as: – hormonal considerations for physical activity prescription – injuries, such as concussion and knee injuries, and safety – psychological skills, including sleep and accompanying strategies – mental fitness, including the role of physical activity and the responsibility of elite sport pathways	• explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport
• key concepts within the selected contemporary issue linked to participating in physical activity and/or sport in society	• collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media
• local, national and/or global perspectives on the selected issue	• propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport
• historical, current and future implications of the selected issue	• prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue • analyse the historical, current and future implications of the selected issue

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

10.2.1 Hormonal considerations and their impact on physical activity

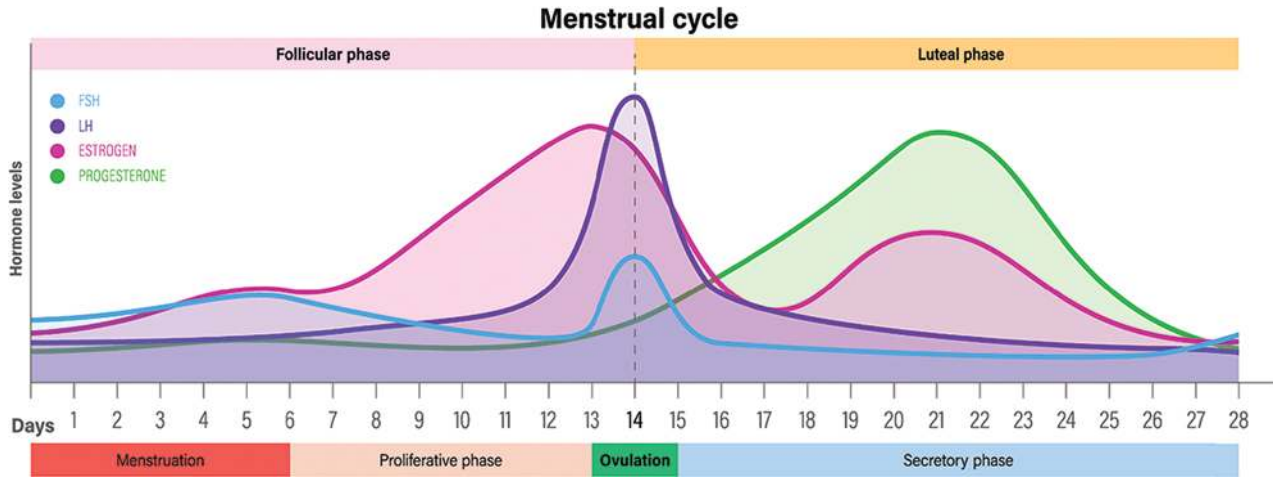
Although women have been participating and competing in physical activity and sport for as long as men, the amount of research into the effect of the hormonal (endocrine) system on the female athlete is still relatively small compared with their male counterparts. **Hormones** affect some key areas of physiology, including muscular development, energy levels, metabolism and reproduction. The impact of the menstrual cycle on females' hormones is an area which is currently being explored by many scientists, in an effort to prescribe more effective exercise programs for women at all levels of the sporting continuum.

Figure 10.3 shows the changing levels of hormones in the female body over the course of the menstrual cycle. It highlights that the female body has different needs and requirements during each phase.

FIGURE 10.2 There is an increasing awareness of the hormonal changes that take place within the body and the impact that these have on participation in physical activity.

hormones chemicals that help to control many functions in your body. Hormones circulate through your blood to your organs, skin, muscles and other tissues.

FIGURE 10.3 Hormone levels over the course of the menstrual cycle



Although it is vital to consider the physiological impact of this on the female body, this topic will focus on the sociological impact and how it affects female participation and performance in physical activity and sport.

10.2.2 Access and inclusion

Many girls cite **menstruation** as a reason for not taking part in regular sporting activities. A recent study in the United Kingdom found that, of the girls surveyed, nearly 80 per cent admitted avoiding physical activity when they had their period. The reasons for not wanting to take part in physical activity cited by respondents included pain, fatigue and self-consciousness.

There are also certain cultures in which menstruation is still surrounded by stigma and taboo, which can lead to further shame and embarrassment when girls and women are discussing and managing menstruation needs. This can act as a further barrier to involvement in physical activity and exercise. Another issue about which there is growing awareness is **period poverty**. In some low-income communities there may be poor access to period supplies. This can lead to girls and young women being less likely to take part in physical activity.

menstruation monthly process in which the female body sheds the lining of the uterus. This results in bleeding from the vagina, typically lasting between 3–7 days.

period poverty the lack of access to menstrual products, sanitation facilities and adequate education surrounding menstruation

10.2.3 Participation and performance

As shown in figure 10.3, there are a number of hormonal fluctuations that can affect the female body during menstruation. These changes can result in decreased participation in physical activity and sport because of the physical discomfort (cramps, fatigue and headaches) that some women and girls experience. Females can also experience decreased energy levels during menstruation. This can lead to both a decrease in physical performance and decreased motivation to participate in physical activity and sport.

The impact of high-level physical activity on the female body is an area of keen interest for sports scientists, with many researchers now focusing on the long-term impacts of regular exercise on the menstrual cycle.

FIGURE 10.4 Menstruation can cause a decrease in energy levels, severe pain and discomfort, as well as a decrease in motivation to exercise.

There are also a number of organisations promoting the normalisation of discussion about menstruation at all levels of sport. One of these is the 'I'm an Athlete. Period.' initiative, which was created by Active Inclusion and the Office for Sport, Recreation and Racing (OSRR) in South Australia. The aim of this campaign is to remove the stigma around the subject of menstruation and promote female athletes and their successes.

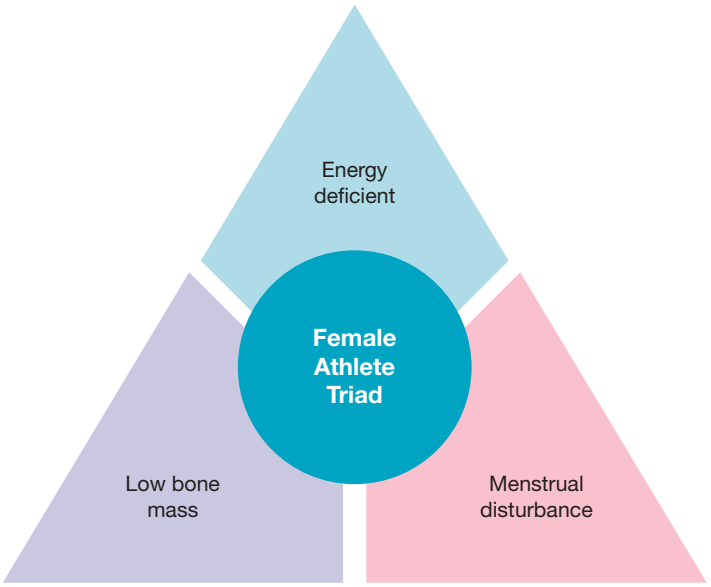
on Resources

Weblink I'm an Athlete. Period.

Increased coverage of the issues relating to menstruation and sport has also encouraged debate about the topic of **amenorrhea** among high-level performers and elite athletes. Amenorrhea is the loss of menstruation in women of reproductive age. It can be caused by a number of factors, including low body weight and excessive weight loss. It has long been known that the demands of sport at this level can have dramatic effects on the menstrual cycle. However, it is only now that the long-term negative impacts of amenorrhea on the development and health of the female body are being highlighted.

The Female Athlete Triad (see figure 10.5) is a condition in which amenorrhea, disordered eating (causing low energy levels) and osteoporosis (low bone density) combine to create wider ranging health issues. To decrease the likelihood of this condition occurring and to ensure athletes' health is maintained, coaches, team doctors and the athletes themselves must take proactive steps to prevent and address these issues. This can include promoting healthy approaches to nutrition, promoting a healthy body image, monitoring menstrual health, ensuring energy intake meets training demands and prioritising bone health in training programs.

FIGURE 10.5 The three components of the Female Athlete Triad



10.2.4 Local, national and global perspectives

As the awareness surrounding hormonal changes and their effects on female participants at all levels of sport increases, many organisations have offered support. Local governments have aimed to decrease the prevalence and impact of period poverty by making sanitary products freely available. In 2020, free pad and tampon vending machines were installed in all public schools in Victoria to ensure that pupils had access to the items required to support their menstrual cycle.

amenorrhea the absence of menstruation, often attributed to low body weight, excessive exercise, disordered eating and other causes

CASE STUDY

Helping schools promote positive menstrual health

Free pads and tampons are available in every government school in Victoria — because being able to access period products shouldn't be a barrier to students getting the most out of their education.

Victoria is the first state or territory in Australia to ensure every government school student has access to free period products. The $36.2 million initiative began in Term 3 in 2019 and we installed dispensing machines in every school by the end of Term 2, 2020.

A lack of easy access to pads and tampons can affect students participating in sports and everyday school activities. Students may not be able to concentrate in class, feel comfortable or confident doing physical activity or they may miss school altogether. By making pads and tampons available and free at school, we are one step closer to educational equality.

Schools have an important role to promote positive culture around menstrual health and build supportive environments. The initiative aims to reduce the stigma of periods and make school a more inclusive place where students can focus on their studies.

We will continue to normalise periods and provide cost-of-living relief through our $23 million package to provide free pads and tampons at up to 700 public locations across the state. They will be available in public hospitals, courts, TAFEs, public libraries, staffed train stations, and major cultural institutions like the State Library and Melbourne Museum in 2024.

Source: Victorian government, 'Improving sexual, reproductive and mental health outcomes for young Victorians, 24 August 2023, www.vic.gov.au.

doc-41968

PRACTICAL ACTIVITY Menstrual cycle modified training

Goal

To identify how training could be modified to suit female athletes during their menstrual cycle

Instructions

Research how the female body is affected by different stages of the menstrual cycle. Prepare a circuit training program with between five and six stations that takes into account the physiological changes that are occurring.

Primary data/Reflection

Write a brief paragraph about how participation in two stations of the circuit could be affected by physiological changes during a specific stage of the menstrual cycle.

Questions

1. Identify the two main phases of the menstrual cycle.
2. Identify the main hormones involved in the menstrual cycle.
3. Explain how the menstrual cycle could have an effect on the participation of a beginner female athlete.

on Resources

Weblink Understanding the menstrual cycle

Australia-wide schemes such as the 'Share the Dignity' campaign have focused on the issue of period poverty as well as increasing awareness of the issue across all of society.

Within the high-performance and elite levels of sport in Australia, there has also been an increase in the promotion of a more healthy understanding of the impact of the menstrual cycle on performance and, more importantly, the dangers surrounding amenorrhea. The Australian Institute of Sport (AIS) has also created specific guidelines and resources to support athletes, coaches and medical practitioners who are working within the high-performance sphere. The AIS has also outlined its next steps, including raising awareness about menstrual cycle tracking, improving education for athletes and encouraging more high-quality research in this area.

On a global scale, many sporting bodies are working to ensure more supportive and effective exercise prescription that supports the hormonal considerations of female athletes. The English Institute of Sport (EIS) has become the first in the world to trial a new technology that provides real-time female hormone data, which can then be used to improve training and performance. The technology uses saliva analysis to measure and track female athletes' hormone levels to ensure that programs are designed to complement the athlete's menstrual cycle.

10.2.5 Historical, current and future implications

In the past, it was a mark of honour for athletes to lose their period while taking part in intense training programs. This view was particularly prevalent in sports in which weight and aesthetics are more important, such as gymnastics, dance and long-distance running. In these sports there was increased pressure on female athletes to maintain a very low body-fat percentage, and therefore led to a rise in disordered eating practices and excessive weight-loss regimes. The research surrounding exercise physiology has also historically been biased towards male athletes, which has meant that programs for women did not take into account the different needs and processes of the female body.

There is, however, a growing trend towards taking hormonal changes into consideration, with many professional athletes, teams and sporting organisations focusing on their impact on athletic performance. Like any sporting advancement that begins at the professional level, it will take time for it to filter down to ordinary participants. However, the conversation surrounding the menstrual cycle and sport will help increase participation at the community level as the stigma surrounding periods and physical activity is eroded.

CASE STUDY

Period shame stops countless girls from continuing sport

In the lead up to the first FIFA Women's World Cup hosted in the Southern Hemisphere, host nations Australia and New Zealand are forging other firsts, including efforts to break the shame, stigma and taboo that continue to shroud periods.

FIGURE 10.6 Many steps are being taken in order to reduce the impact of period shame on elite athletes and to decrease the stigma surrounding the topic.

In April, both teams unveiled new kits that included period leak protections, together with materials and tailoring that specifically respond to the needs of high-performance women footballers. New Zealand has also swapped out its traditional white shorts for teal blue to help combat period anxiety. Similar changes are occurring across the global sporting landscape, albeit more slowly in some quarters.

Despite initial reluctance, last year the All England Club relaxed the long-held tradition that Wimbledon players wear all white, so women can now wear dark undershorts.

In rugby, the Irish national women's team have permanently switched white shorts for navy, while New Zealand referees are no longer required to wear white shorts.

The impact of these changes should not be underestimated. The shame and taboo associated with periods stops many young girls from continuing sport, and misinformation about menstruation affects the performance and health of countless elite athletes. The 2023 FIFA Women's World Cup is an opportunity to dispel period myths and put a focus on the specific needs of athletes who menstruate.

Women athletes aren't small men

Women's elite sport continues to be professionalised, yet their training protocols have often been based on research evidence derived from male cohorts. This research doesn't consider the physical and psychological changes that women athletes may experience at each phase of the menstrual cycle, nor how that may affect peak performance.

Research into how the menstrual cycle affects the performance of women athletes is growing. Teams are employing methods to work with the period cycle, rather than against it. FIFA Women's World Cup champions the United States say that menstrual tracking is one of their performance weapons.

No longer a mark of honour

Ignoring and generalising the needs of women athletes not only hurts performance but also can damage health.

Overly intense training can cause some athletes to stop having periods. This has often been considered normal by coaches and a mark of honour among athletes themselves. Indeed, there's a dangerous notion in many high-performance sporting cultures that the absence of menstruation equates to an ideal elite athlete.

But this can lead to serious health consequences, including a condition called RED-S — relative energy deficiency in sport. Symptoms include periods stopping or becoming irregular, reduced performance, mood changes, and recurrent illnesses and injuries including stress fractures.

Australian research involving 112 women elite and pre-elite athletes found almost 80 per cent of participants demonstrated at least one symptom consistent with RED-S. Nearly 40 per cent experienced at least two symptoms.

Like women in other workplaces, elite athletes are often reluctant to discuss the impact of their periods, fearing assumptions they are a liability in team environments, less capable and not deserving of development opportunities.

Source: Michelle O'Shea, Hazel Maxwell and Kylie Steel, 'Period shame stops countless girls from continuing sport. The Women's World Cup can help break this stigma', *The Conversation*, 12 July 2023, www.theconversation.com.

on Resources

Weblink How periods impact athletic performance

10.2 Activity

10.2 Quick quiz on | **10.2 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2, 4	3	5, 6, 7

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Identify** one way in which the menstrual period negatively affects female participation in physical activity.
2. **Define** *period poverty* and explain its impact on the accessibility of sport to female athletes.
3. **Summarise** how one physical impact of menstruation affects female participation in physical activities and sports.
4. **Name** two initiatives or organisations that are working to address the issue of period poverty and promote awareness of hormonal considerations in sports.
5. Read the article 'Period shame stops countless girls from continuing sport. The Women's World Cup can help break this stigma'. **Evaluate** how the view of menstruation in athletes has changed over time.

APPLY your understanding

6. Access the **How periods impact athletic performance** weblink in the Resources panel and watch the video.
   a. **Explain** the benefits of normalising conversations about menstruation.
   b. **Discuss** the challenges facing female athletes managing their menstrual cycles.
7. **Explain** how each element of the Female Athlete Triad can affect an elite athlete's performance.

10.2 Exam questions

Question 1 (1 mark)

Which of these is the Female Athlete Triad?

A. Energy surplus, menstrual disturbance, low bone mass
B. High bone mass, energy deficiency, menstrual disturbance
C. Energy deficiency, menstrual disturbance, low bone mass
D. Normal menstruation, energy deficiency, low bone mass

Question 2 (2 marks)

Read the case study 'Helping schools promote menstrual health'. **Explain** what is being done to help combat period poverty in Victoria.

Question 3 (2 marks)

Explain how elite sportspeople are helping to reduce the stigma around menstruation.

10.3 Injuries

Key knowledge	Key skills
• intrapersonal issues that influence access to, and inclusion, participation and performance in, physical activity and sport, such as: – hormonal considerations for physical activity prescription – injuries, such as concussion and knee injuries, and safety – psychological skills, including sleep and accompanying strategies – mental fitness, including the role of physical activity and the responsibility of elite sport pathways	• explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport
• key concepts within the selected contemporary issue linked to participating in physical activity and/or sport in society	• collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media
• local, national and/or global perspectives on the selected issue	• propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport
• historical, current and future implications of the selected issue	• prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue • analyse the historical, current and future implications of the selected issue

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

10.3.1 Injuries and their impact on physical activity

Between 2018 and 2019 the estimated cost of treating physical activity-related injuries in the Australian public health system was around $764 million (Australian Institute of Health & Welfare). Despite the likelihood of general injury increasing with age, the data for sports-related injuries reveals that the most at-risk group is those aged between 10 and 19 years old (see table 10.1).

It is vital to consider the impact that these statistics may have on sports participation in all population groups as well as participation in sports with greater risk of injury, such as collision-based and extreme sports.

FIGURE 10.7 Injuries can affect a person's physiology and psychology. Although they are a common occurrence in sport, we should understand the impact of injuries at all levels of participation.

TABLE 10.1 Data from the AIHS report on the economics of sports injury and participation showing the total cost of physical activity (PA) related emergency department presentations per age group

Age group	Males PA cost ($)	Per person ($)	Males PA %	Females PA cost ($)	Per person ($)	Females PA %
<1 year	1 038 722	6.66	11	600 110	4.08	7
1–4 years	8 124 509	12.48	14	4 133 877	6.71	9
5–9 years	9 394 163	11.36	17	4 472 667	5.70	11
10–14 years	13 026 866	16.51	19	5 272 250	7.00	2
15–19 years	11 205 259	14.59	16	3 937 472	5.41	8
20–24 years	9 947 804	11.13	14	3 545 949	4.17	8
25–29 years	8 796 662	9.28	14	3 253 922	3.45	8
30–34 years	7 001 122	7.55	13	2 800 477	2.95	8
35–39 years	6 079 347	6.98	13	2 566 022	2.91	8
40–44 years	5 456 217	6.87	13	2 450 808	3.06	8
45–49 years	5 275 633	6.41	12	2 589 014	3.03	8
50–54 years	4 465 789	5.95	12	2 518 722	3.22	9
55–59 years	4 034 026	5.35	12	2 666 048	3.40	9
60–64 years	3 329 138	4.98	11	2 496 212	3.54	10
65–69 years	2 933 984	4.95	11	2 309 180	3.70	9
70–74 years	2 651 713	5.21	11	2 245 684	4.25	9
75–79 years	2 151 581	6.28	10	1 964 713	5.24	9
80–84 years	1 832 056	8.21	10	1 903 708	7.00	8
85 years and over	2 391 985	12.34	9	3 111 507	9.88	7
Total	**109 136 576**	**8.74**	**14**	**54 838 340**	**4.32**	**9**

Source: Economics of sports injury and participation — Preliminary results (aihw.gov.au).

10.3.2 Access and inclusion

Many parents are becoming increasingly fearful of the dangers associated with particular sports. This is having a dramatic effect on the number of young people participating in these activities, leading some sports teams and clubs having to disband due to low attendance figures.

As the research into the long-term effects of concussion has increased, a number of sports are having to reconsider the way these sports are played to ensure young people want to take part. An example of this is in the game of rugby union, which has changed the legal tackle height in the community game to reduce the chances of head-on-head collisions. The tackle height has been lowered from below the shoulder to below the base of the sternum. Responsibility for safety has also been placed on the person being tackled as well, to ensure that risk is mitigated as much as possible.

on Resources

Weblink Lower tackle height law

Sports injuries can also lead to some athletes feeling excluded from their sports for a period of time. This is especially true in a team sports environment, where training and competition continues despite one team member's injury. Many sports clubs do not have the training or medical facilities to support athletes who are injured, and this can lead to an athlete feeling disengaged and excluded from the sporting environment.

FIGURE 10.8 Tackles in Rugby Union have been lowered from 'below the shoulder' to 'below the sternum' in the community game to decrease injury risk and increase participation rates.

Education about concussion in recent years has aimed to reduce the stigma around head injury and the time it takes someone out of their sport. Due to the lack of obvious signs and symptoms in concussed athletes, many continue to play to avoid letting down coaches, teammates and other stakeholders. By fostering a culture of understanding and acceptance, injured individuals may feel empowered to take the necessary steps to withdraw from sport when needed and give themselves the adequate time for recovery.

10.3.3 Participation and performance

The Australian Sports Commission AusPlay 2023 report found for the first time that 'injury/poor health' was the top barrier to participation for males and females under the age of 15, pushing 'not enough time' into second place. This statistic correlates with other research which suggests that, although technology surrounding injury and risk prevention is improving, the number of young athletes being affected by injury is increasing. A reason for this is the improvement in the quality of coaching, equipment, nutrition and facilities. These improvements are increasing the speed and strength of many young athletes. This in turn has increased the rate and intensity of impacts and collisions within certain sports.

In order to ensure that injury risk is reduced, there are a number of strategies that coaches, parents, clubs and sporting organisations can follow. These include, but are not limited to:

- pre-activity assessment to ensure that there are no underlying or existing conditions or risk-factors
- warm up and cool down to prepare the muscles, joints and cardiovascular system for the demands of the activity as well as aiding recovery and preventing muscle soreness
- coaching correct technique and form, especially within collision sports where the safety of the opponent also needs to be considered
- strength and conditioning programs to help physical fitness and increase resilience to injuries
- adequate rest and recovery to prevent fatigue and injuries related to overtraining
- safety equipment and clothing to reduce the risk of injury occurring. It must be well-fitted and regularly maintained.
- nutrition and hydration to support injury prevention. Food and drink should balance energy needs, allow muscular recovery and support overall health.
- assessment of the physical environment to reduce the chances of injuries occurring. This includes checking playing surfaces and equipment as well as ensuring weather conditions will not cause further risk to participants.
- injury prevention programs to target common health concerns within a sport. These can include training to increase specific muscular strength and improve flexibility.
- education and awareness for athletes, coaches and parents. Education should include prevention strategies, early warning signs of injury and injury-management techniques.

on Resources

Weblink The management of sport-related concussion in AFL

Athletes at the highest levels are also now being given access to supplemental techniques to help them recover from injury faster than ever. The cost of many of these facilities means that they are only available to the clubs and organisations with the most financial resources. Examples of injury prevention and recovery techniques include cryotherapy, dynamic air compression and hot/cold immersion treatments.

Some local clubs also now have access to physiotherapists to support their junior, men's and women's teams. This enables medical support to be provided during participation in the sport. as well as during periods when an individual is injured and requires advice and rehabilitation strategies.

FIGURE 10.9 Many professional teams are using technologies such as dynamic air compression in order to reduce athlete absences caused by injury.

10.3.4 Local, national and global perspectives

Despite the closure of the Victorian Sports Injuries Taskforce in 2013, many of its guidelines and recommendations are still in place to support risk management and injury prevention within the state. Many local clubs and councils also have their own programs to support injury prevention and increase the safety of their communities. The Victorian government has also published the Active Victoria 2022–2026 strategic framework, which aims to develop sports facilities and resources that provide a safe environment. A safe environment includes injury prevention, heat health, maintaining equipment and grounds, and establishing health-promoting settings.

on Resources

Weblink Strategic framework for sport and active recreation

doc-41969

PRACTICAL ACTIVITY Injury reduction

Goal

To identify how injuries can be reduced in order to maximise inclusion and participation

Instructions

Participate in a game of netball as a class. Throughout the game and during rest breaks, think about possible injuries that could occur during play, and if there are any strategies in place to ensure that the risk of injury is minimised.

Primary data/Reflection

On mini-whiteboards or in the classroom, write down the possible causes of injuries as well as any strategies that were in place in order to reduce the likelihood of injuries.

Questions

1. Identify two possible causes of injury that could occur (excluding player-on-player contact).
2. Explain two factors which could reduce the likelihood of injuries occurring in the game.

The Australian government has also developed policies on child safety within sport, and commissioned Sport Integrity Australia to develop national safeguarding frameworks and resources to provide safe sporting environments. An overview of some of the key providers of information and resources in this area is shown in the following section.

- Sport Integrity Australia: a government agency committed to providing Australian sporting environments that are safe, supportive and friendly for children and young people
- Play by the Rules: developed originally in South Australia, this program now covers all of Australia and provides information, resources, tools and free online training to assist sporting stakeholders to prevent and deal with discrimination, harassment, child safety, inclusion and integrity issues in sport.
- Clearinghouse for Sport: an information coordination website that shares news, evidence and insight into sport, human performance and physical activity
- Water & Snow Safety Program: an Australia-wide government program that aims to reduce drownings and snow-related injuries and deaths through prevention and intervention.

CASE STUDY

Will introducing independent doctors at games help the AFL tackle its concussion problem?

The Australian Football League (AFL) recently announced it is 'considering appointing independent doctors at all AFL games to assist club medical staff in identifying and assessing players for potential head injuries'.

The announcement came after recommendations of a coronial inquiry into the death of former AFL player Shane Tuck, who died by suicide in 2020.

A post-mortem examination of Tuck's brain found an advanced case of Chronic Traumatic Encephalopathy (CTE), a neurodegenerative disease linked with repetitive head trauma.

CTE is a form of dementia which is more frequently diagnosed in people with exposure to repeated head trauma, like athletes in contact sports.

FIGURE 10.10 The AFL is taking steps to reduce the likelihood, severity and long-term health impact of concussion on players at all levels of the game.

The governing bodies of these sports, including the multiple football codes in Australia, have been striving for several years to assure players, parents and the public that their games are safe to play.

Why are independent doctors needed?

One of the most significant concerns about concussion (otherwise known as a mild Traumatic Brain Injury or mTBI) is the potential for an athlete to incur serious neurological damage if they suffer recurrent brain injuries within a short period of time.

This is why many contact sport organisations around the globe and in Australia have developed exclusion protocols for concussed players, to prevent their brain from receiving more trauma while it is still recovering.

In Australia, mandatory exclusion periods vary between different sports. The AFL recently announced it would adopt the Australian Institute of Sport's (AIS) recommendation for 21 days of exclusion from games and training for non-elite or 'community' athletes.

The rules are different for players in the elite AFL and AFLW competitions, who are only required to sit out for 12 days post-injury.

The first step in this exclusion process is determining whether or not a player has sustained a brain injury. Currently, this decision is made by a club doctor — a licensed medical doctor who is employed by an AFL or AFLW team.

Concerns have been raised about the impartiality of club doctors, and the potential for their decisions to be knowingly or unknowingly influenced by a desire to see their club succeed.

The subsequent suggestion is, if independent doctors are employed by the AFL or AFLW, rather than the clubs, they would be better able to make a diagnosis without being influenced by coaching staff or other players.

With pressure comes risk

Being embedded in a high-performance sporting environment can influence people, including doctors, to adopt a win-at-all-costs attitude.

If the AFL and AFLW decide to adopt independent concussion doctors, not only will it relieve club doctors of some of their responsibilities regarding players' brain health, it will also remove another key decision-making group from the process — coaches.

Some coaches are vocal opponents of removing coaching staff and club doctors from decisions about brain injuries. In the National Rugby League (NRL), where independent doctors have been employed since 2022, coaches Ricky Stuart and Wayne Bennett argue it is a sign the governing bodies do not trust coaching staff or club doctors.

However, the code argues it is not an issue of trust, rather it is about ensuring decisions on player welfare are made dispassionately by those who have specific training in the area.

It has been argued from performance, legal, and moral perspectives that care for athletes should be central to the practice of sport across all codes.

Indeed, some coaches have been major public advocates for this and there is no suggestion that coaches or clubs do not care for the health of their players.

However, the pressures of elite sport and the backgrounds and training of many coaches, particularly those who are former players, can create an environment where player health is seen as a reasonable sacrifice for high-performance and competitive success.

Removing doctors from this environment is intended to help them make more impartial decisions about concussions.

Are independent doctors the right move?

The introduction of independent doctors is a step-change for the AFL rather than a fundamental shift.

The AFL's approach to managing brain injuries is precisely that — it 'manages' brain injuries because the league, along with the people who manage other high-contact games, know that any significant reduction to the incidence of brain trauma would require fundamental changes to the way their sports are played.

Ultimately, the introduction of independent doctors is an exercise in tinkering, which will have no tangible impact on reducing the number of brain injuries sustained by elite players.

It also remains to be seen how the AFL might seek to introduce a similar system of concussion watchers for the hundreds of thousands of recreational footballers across Australia, who play the same games as their professional counterparts with far fewer eyes watching them.

It is also important to note that emerging evidence tells us the risk of developing a long-term neurodegenerative disease like CTE is most strongly related with repeated micro-concussions, which cannot be diagnosed by a doctor, independent or otherwise.

If the AFL and AFLW adopt independent doctors, it will be a positive move toward further prioritising player welfare, but it will not fix the concussion problem.

Source: Stephen Townsend and Steven Rynne, 'Will introducing independent doctors at games help the AFL tackle its concussion problem?', *The Conversation*, 8 April 2024, www.theconversation.com.

Globally, there is increasing pressure to protect athletes from the long-term damage caused by repeated sporting injuries, specifically repeated head trauma and concussion. There are a number of examples of sports that are struggling to attract players due to the negative media coverage they receive. In recent years there has also been an increase in former professional athletes taking legal proceedings against the lawmakers of their sports. An example of this is former Western Bulldogs AFL player Nigel Kellett, who has argued that the concussions he suffered during his career have led to dementia and other long-term neurological concerns.

10.3.5 Historical, current and future implications

The 'shake it off' mentality surrounding injury and concussion prevailed in the world of sport for many years. This attitude saw injuries as just an aspect of taking part in the game, and that those involved should just carry on playing. This was based on a poor understanding of the short-term risks of continuing to play, as well as poor knowledge of the longer-term effects on the athlete's health and wellbeing.

FIGURE 10.11 Law-makers in soccer are looking to outlaw heading of the ball in certain age groups to reduce the chances of head injury.

This view reflected the stereotype of the athlete as being tough, which was seen as a strength. This is because the athlete did not need to seek support or take time away from practice and competition. This process often also involved the minimisation of concussion-related symptoms by both players and coaches to ensure a player's continued involvement in the game.

The lack of awareness of the long-term negative impacts of head trauma also affected how athletes were treated by teammates, coaches, parents and medical practitioners. This often led to the misdiagnosis of many injuries and the premature return to play for athletes, which put them at further risk of immediate injury and continued health issues.

The modern view of the athlete has identified wellbeing as a higher priority. Organisations such as Sport Integrity Australia now put the safety and protection of young athletes at the forefront of their policies to ensure that their journey through sport is safe and enjoyable. They also want to ensure that these athletes stay active as they grow older. Rule-makers in sports are also reacting to the changing emphasis on wellbeing by altering rules to help prevent injury. This is not only the case for collision sports, such as Rugby League and Australian Rules football, but also games such as soccer, where the head is used to control the ball.

Sports are also introducing clear protocols on return-to-play for athletes to ensure that, once diagnosed, a player does not put themselves in any further danger through their continued participation. Many of these protocols include clear, non-subjective rules around the time frames for return-to-play. They place the responsibility on the clubs and teams to ensure that players do not feel pressured to participate during their recovery.

With increased research into the long-term impacts of repeated injuries, it is likely that different sports will continue to adapt their rules to ensure the safety of their participants. The current trend towards professional athletes seeking financial compensation for perceived long-term health damage will also likely increase.

on Resources

Weblinks Guidance on heading in youth training sessions
NFL settlement fails to address impact of collision sports

The technology that currently allows for the assessment of these injuries at the top levels of professional sport will eventually become available to community sporting groups. Now that there is greater awareness of these issues, it is also likely that the number of injuries and safety concerns will reduce as the ways that sports are played, coached, officiated and managed are changed.

10.3 Activity

10.3 Quick quiz on | **10.3 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2	3, 4, 5, 7	6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Define** *concussion* and how it can affect an individual's involvement in sport.
2. According to the data from the AIHW report, which age group is identified as the most 'at-risk' for sports-related injuries?
3. **Discuss** has been done in recent years to decrease the impact of concussion in amateur and professional sports.
4. Access the **Management of sport-related concussion in AFL** weblink in the Resources panel and read the document.
   Create a poster that includes the following information.
   - **Define** concussion and explain the immediate symptoms.
   - **Identify** the health risks caused by concussion.
   - **Summarise** how concussion is managed when it occurs in AFL.
   - **Identify** the four stages of return-to-play.
5. From a sport of your choice, research and **discuss** a rule change which has been implemented in order to reduce the likelihood and severity of an injury occurring.

APPLY your understanding

6. **Explain** how injury can affect an individual's access and inclusion in physical activity and sport.
7. Read the article 'Will introducing independent doctors at games help the AFL tackle its concussion problem?' and answer the following questions.
   a. **Evaluate** the effectiveness of the AFL's proposed initiative to appoint independent doctors at all AFL games to assist club medical staff in identifying and assessing players for potential head injuries.
   b. **Assess** the impact of the AFL's response to addressing concussion and head trauma in the AFL.

10.3 Exam questions

Question 1 (2 marks)
Outline two forms of recovery athletes use to reduce the risk of injury.

Question 2 (3 marks)
Discuss how head-injury protocols have helped to reduce the impact of injuries in sport at all levels.

Question 3 (2 marks)
Explain the strategies that can be implemented to minimise the risk of injury from playing sport.

10.4 Psychological skills

Key knowledge	Key skills
• intrapersonal issues that influence access to, and inclusion, participation and performance in, physical activity and sport, such as: – hormonal considerations for physical activity prescription – injuries, such as concussion and knee injuries, and safety – psychological skills, including sleep and accompanying strategies – mental fitness, including the role of physical activity and the responsibility of elite sport pathways	• explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport
• key concepts within the selected contemporary issue linked to participating in physical activity and/or sport in society	• collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media
• local, national and/or global perspectives on the selected issue	• propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport
• historical, current and future implications of the selected issue	• prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue • analyse the historical, current and future implications of the selected issue

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

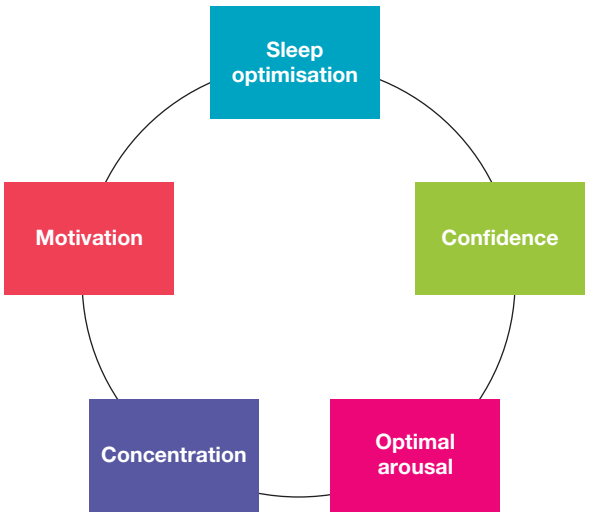
10.4.1 Psychological skills and their impact on physical activity

There are a number of key psychological skills that athletes use to optimise their performance in a range of sports. These include sleep optimisation, confidence, motivation, optimal arousal and concentration.

This subtopic will consider how these skills are used at different levels, as well as how recent developments in research and technology have changed how they are used. This subtopic will also discuss the physiological and performance advantages of using these psychological tools.

FIGURE 10.12 Athletes are adopting innovative psychological tools alongside better training methods. Athletes are seeing the benefits of controlling their minds for improved performance and mental wellbeing.

FIGURE 10.13 The key psychological tools athletes use to obtain and maintain optimal performance



10.4.2 Access and inclusion

Although athletes at the top of the sporting pyramid use many of these psychological techniques, it is also vital to consider how they affect new participants. A decrease in the confidence of an individual just entering a sport can have a dramatic impact on the likelihood of them choosing to continue. Confidence can empower an individual to overcome the obstacles involved in beginning a new activity, as well as give them the self-efficacy to engage no matter their level of ability or sporting background.

FIGURE 10.14 Many sports clubs, such as lawn bowls, promote the social benefits of participating as well as the sporting and physiological advantages.

Many activities allow an individual to feel included because they are social and involve elements of teamwork and cooperation. Many sports clubs and activities aim to attract participants by emphasising the social benefits offered as well as the physical benefits.

According to the Better Health Channel, some of the benefits of taking part in physical activities with a friend or in groups include the following:

- *It's more fun exercising with a friend.* You're less likely to get bored when you have a workout buddy, especially a friend.
- *You can build new friendships.* Exercising with someone you don't know well provides an opportunity to build a new friendship. Joining an exercise class can be a great way to meet people, get to know them better and make new friends.
- *You're more likely to stick to your commitment.* If you've arranged to meet a friend for a walk or booked an exercise class, you're more likely to keep that commitment.
- *You're more likely to succeed in your goal.* Having someone to motivate you can make all the difference to achieving your goal.
- *You'll work harder with someone else around.* When you exercise with a friend who's around the same fitness level as you, you're more likely to encourage each other and to push a little harder (to increase intensity, for example) than you might do on your own.

- *It can be more affordable exercising with a friend.* If you hire a personal trainer, or buy equipment, splitting the cost two ways will save you money. You can also save on travel costs by car-pooling to get to the destination.
- *Your friend may have new exercise ideas.* Your workout buddy probably has some skills and knowledge that you don't.
- *It's safer to exercise with someone else.* Having someone to spot you when you're lifting weights (that is, someone ready to support you, if need be), or to go running with you, especially at night, means you have help at hand if anything goes wrong.

Another important psychological aspect that encourages people to be physically active is motivation. Most motivation for physical activity at the access and inclusion stage comes from intrinsic motivation.

When an individual finds an activity rewarding and enjoyable, they are more likely to engage in it consistently without the need for external rewards or incentives. An element of motivation that has been studied more recently is autonomy support. This is the idea that an individual is more likely to feel motivated if they have a sense of control over how and when they participate in physical activity.

FIGURE 10.15 Group fitness classes, such as spinning and aerobics, use social interaction and the feeling of having a shared purpose to develop motivation and confidence.

Concentration is also an important psychological aspect of an individual's access to physical activity and sport, because it allows them to build effective relationships with teammates, coaches and other participants. These stronger relationships develop a sense of belonging and attachment to the community. Successful concentration at this level can also lead to a more rapid development of skills, because the individual is able to listen to instructions, take on feedback and communicate more effectively.

10.4.3 Participation and performance

As the level of sporting performance increases, so does the need to focus on specific psychological tools. Athletes need these tools to respond to the growing demands of success, as well as the risks of failure in their chosen sport.

One of the biggest areas of advancement has been optimising sleep for athletes in order to improve performance. The development of sleep-tracking devices and the data that they gather has given us a better understanding of the impact sleep has on performance, nutrition and recovery.

on Resources

Weblink AIS Sleep Information Factsheet

The availability of sleep-tracking devices has meant that many individuals are now able to monitor the effects of the amount of sleep and sleep quality on their performance. Many trackers are now able to give a 'readiness' score, which takes into account an individual's recent physical activity levels and sleep quality to gauge the amount of training or exercise they should undertake on any set day.

Many high-performance teams are now prioritising sleep optimisation for their athletes to ensure that they are training and competing at the highest possible levels. Professional cycling's Team Sky (now Ineos Grenadiers) was one of the first to optimise the sleep of its athletes by giving each athlete a personalised mattress to ensure they had a consistent experience when sleeping in different hotels. The team's management also provides hypoallergenic bedding, dehumidifiers and air purifiers to ensure that the sleep hygiene of their athletes is maintained at the highest possible standard.

It is also vital for athletes to be able to maintain optimal arousal levels. Optimal arousal is the ideal physiological and psychological alertness required for a particular activity. Optimal arousal can vary from person to person and from sport to sport, and ranges between extreme under-arousal, characterised by lethargy and demotivation, and high arousal, which is characterised by excessive anxiety, tension and nervousness.

Professional athletes and sports teams use a variety of techniques in order to maintain optimal arousal at all stages of competition. These include:

- mental imagery/visualisation
- relaxation strategies
- positive self-talk.

10.4.4 Local, national and global perspectives

The impact of psychological skills on participation in physical activity and/or sport is an important aspect of public health policy in Victoria, because of the positive societal impacts of a more active population. These include decreased health spending, increased mental wellbeing and increased success in high-level sports.

There are a number of state-wide programs which aim to ensure people are able to access and use the tools available. These include, but are not limited to:

- Better Health Channel: provides health and medical information to improve the health and wellbeing of people and the communities in which they live.
- Victorian Institute of Sport: provides facilities, support, scholarships and advice to high-level athletes
- Victorian Department of Health: provides information on preventative health measures, such as physical activity, healthy eating and psychological well-being.

The Australian Institute of Sport (AIS) has also produced its own advice to athletes regarding the psychological tools that can be used to optimise sporting performance. The AIS REST Hub highlights the importance of sleep and gives clear guidelines on effective sleep patterns and how they can be maintained during training and competition. The International Olympic Committee has also produced its own resource 'Sleep to Compete', which is an online course available to Olympic athletes, which educates them about better sleep habits and provides tools for using sleep for effective recovery.

FIGURE 10.16 The benefits of good sleep hygiene for general wellbeing as well as its effect on athletic performance

The impact of poor sleep on performance has also been discussed in relation to the timing of sporting events and the pressure to maximise global audiences. The case study that follows provides an insight as to how player performance might be affected.

CASE STUDY

Some Australian Open matches run extremely late. How does that impact player sleep and recovery?

For many Australians, January is synonymous with late nights spent watching the Australian Open tennis tournament. These night matches are a great spectacle, and many players consider the prime time slot on centre court as a privilege and reward for their hard work.

An early highlight of this year's tournament was the men's third seed Daniil Medvedev playing out a five-set thriller against unseeded Emil Ruusuvuori, with the match finishing at nearly 4am. Less than 48 hours later, Medvedev followed this up by winning his next round match.

In Medvedev's post-match interview, he discussed recovery and preparation strategies after the previous late-night finish. This included ice baths, medical treatment and physio work before finally going to bed at around 7 am. He managed to get five hours of sleep. Similarly, the first round match for women's number two seed, Aryna Sabalenka, didn't start until almost midnight.

FIGURE 10.17 Professional sports event organisers are now regularly altering schedules to increase TV viewership. But is this adversely affecting the players involved?

As sleep scientists, we know limited and disrupted sleep opportunities can impact the body. So what do these late nights and lack of sleep mean for players' recovery and performance?

Why a lack of sleep is bad for your muscles

The function of sleep is still not well understood, despite us spending close to a third of our life asleep. While we do know that sleeping less than six hours a night is linked to the increased risk of several chronic diseases, there is still much to investigate.

Several recent studies we've worked on have demonstrated the importance of sleep for optimal muscle function. For example, one night of sleep deprivation (pulling an 'all-nighter') or repeated nights of short sleep actually impair the muscles' ability to make new proteins, which is essential for repair and recovery.

Furthermore, other recent research suggests that a period of sleep loss (five nights, with four hours of sleep each night) can reduce mitochondrial function within your muscles. Mitochondria are known as the 'powerhouses of the cell' and are responsible for producing the energy needed to exercise — and win a tennis match. Therefore, the lack of sleep tennis players experience after such late-night finishes may well impact their recovery and subsequent performance.

Sleep loss directly affects athletic performance

It is well accepted that sleep loss negatively impacts cognitive function and decision-making. While the data is not definitive, there are also several studies that show sleep loss impacts athletic performance. A recent study in healthy young women accustomed to resistance exercise found that when they performed their weights session after several nights of restricted sleep, the quality and volume of their performance was reduced. The effort it took to complete the session increased too.

Losing sleep is also detrimental to anaerobic power and skill execution — both of which are critical for Australian Open hopefuls. One study found a decline in tennis serving accuracy with only five hours of sleep, while another found a decline in maximal power output.

Exercise can help you sleep — but it depends

It is a widely held belief that exercise improves sleep. However, falling asleep shortly after completing an adrenaline-fuelled, high-intensity tennis match is not always easy. Indeed, a recent study investigated the impact of high-intensity exercise on sleep quality. When the high-intensity exercise was performed in the early afternoon, deep sleep was improved. But when participants exercised shortly before bed, their sleep quality diminished. However, this effect also depended on whether the person was a morning lark or evening owl (scientists call this a chronotype). The sleep quality of evening types was unaffected by exercise in the evening.

When it comes to tennis stars, a late-night finish can also affect their circadian rhythm. By the time Medvedev or Sabalenka would have got to bed, their natural, tightly regulated internal clock would have been readying them to wake up. Such a misalignment between the body's circadian rhythm and the body's drive for sleep tends to result in disrupted, insufficient sleep.

Can players prepare to handle late-night matches?

Some players have voiced their concerns regarding late-night matches. But other players suggest it's just part of the game. So what can a player do to prepare for the sleep disruption? Professional athletes have a number of strategies available. For example, napping has myriad benefits for both cognitive function and physical performance.

A popular supplement, caffeine, has consistently been shown to improve physical performance and alertness. While endurance exercise has shown the largest performance benefits from caffeine, small to moderate improvements have been shown in muscle strength, sprinting, jumping and throwing performance. However, caffeine can be detrimental to subsequent sleep. While athletes preparing for late matches might have an evening caffeine hit, the average Australian should avoid drinking coffee after 3 pm.

Increasing sleep duration in the week leading up to late-night matches can also help. Studies have shown that sleep extension increases tennis serving and basketball free-throw accuracy by almost 10 per cent. Increasing sleep duration could really be the difference between hitting a winner or an unforced error. It remains to be seen if athletes like Medvedev and Sabalenka will overcome their disrupted sleep and prevail at this year's Australian Open. But there's certainly an advantage to having a good night's shut eye.

Source: Nicholas Saner and Olivia Knowles, 'Some Australian Open matches run extremely late. How does that impact player sleep and recovery?', *The Conversation*, 24 January 2024, www.theconversation.com.

10.4.5 Historical, current and future implications

In the past, most research on psychological skills has focused on how involvement in regular physical activity can help improve mental wellbeing. However, in more recent years, the focus has switched to how an improved mental state can positively affect participation and performance in sport, particularly at elite levels. Sports psychology has become a recognised discipline, and this has led to a growth in the number of studies investigating all aspects of the field.

Teams and coaches are now also using mental-skills training more regularly with their athletes. The focus on visualisation, goal-setting, confidence and arousal control for optimal performance remains, but there is also a better understanding of the benefits of a holistic approach to athlete wellbeing. This approach links physiological, psychological and social factors and places a greater emphasis on athletes' mental health, resilience and quality of life, rather than focusing solely on performance-based outcomes.

With the growth in awareness of mental health, it is likely that these factors will be supported more regularly in the future. Campaigns such as RUOK? Day have aimed to normalise mental-health conversations, and sports organisations have a responsibility to ensure they are supporting their athletes and members.

on Resources

Weblink International Olympic Committee (IOC) Mental Health Action Plan 2023

CONCEPT CONNECTOR

Something old, something new, something borrowed, something blue

Using four sticky notes, write something down about this topic which covers the four categories below. When you have finished, place the notes on the whiteboard to share your ideas.

Something *old*: Something that you *already* knew

Something *new*: Something that you *learned* (and remembered)

Something *borrowed*: Something which *links* to another subject that you study/have studied

Something *blue*: Something that you *don't understand* and that you need to do more research on

10.4 Activity

10.4 Quick quiz on | **10.4 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 2	6, 7	3, 4, 5

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Identify** the five key psychological tools used by athletes.
2. **List** the benefits of taking part in group sports activities.
3. **Explain** how the use of two different psychological skills can affect an individual's decision to participate in physical activity.
4. **Evaluate** the role of intrinsic motivation in sustaining long-term involvement in physical activity, specifically at the access and inclusion stage.
5. **Evaluate** how recent advancements in technology have helped optimise sleep for elite athletes.

APPLY your understanding

6. **Discuss** how psychological skills can affect an individual's participation and performance in physical activity and sport.
7. Access the **AIS Sleep Information Factsheet** in the Resources panel, and create a poster for the sports changing rooms at your school which covers:
   - why we need sleep
   - how much sleep we need
   - what can lead to poor sleep
   - how we can optimise our own sleep.

10.4 Exam questions

Question 1 (1 mark)

Which of these is *not* a psychological skill?

A. Writing lists
B. Arousal optimisation
C. Confidence
D. Motivation

Question 2 (3 marks)

Discuss how maintaining optimal arousal can help to improve the performance of elite athletes.

Question 3 (1 mark)

Explain how maintaining positive sleep health can help athletes at all levels.

10.5 Mental fitness in physical activity and elite pathways

Key knowledge	Key skills
• intrapersonal issues that influence access to, and inclusion, participation and performance in, physical activity and sport, such as: – hormonal considerations for physical activity prescription – injuries, such as concussion and knee injuries, and safety – psychological skills, including sleep and accompanying strategies – mental fitness, including the role of physical activity and the responsibility of elite sport pathways	• explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport
• key concepts within the selected contemporary issue linked to participating in physical activity and/or sport in society	• collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media
• local, national and/or global perspectives on the selected issue	• propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport
• historical, current and future implications of the selected issue	• prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue • analyse the historical, current and future implications of the selected issue

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

10.5.1 Mental fitness and its impact on physical activity

Just as physical training builds strength and increases our capability to take on the physical demands of life, **mental fitness** training allows us to cope more easily with the challenges of everyday life. Developing mental fitness can also give us the tools to control, recover from and prevent mental-health issues, such as stress, anxiety and depression.

It is becoming increasingly important for sports teams and organisations to protect their athletes from the mental-health issues that can occur in high-stress environments. Having mental fitness ensures that athletes are training and competing in a way that is not detrimental to their long-term psychological wellbeing.

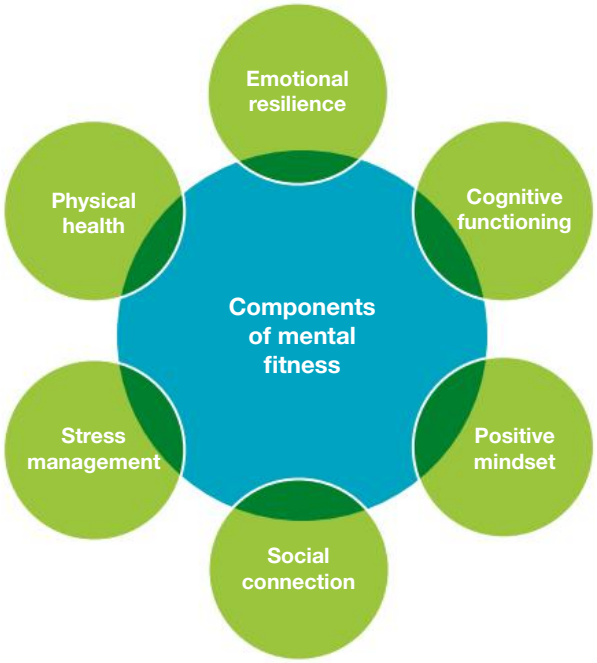
FIGURE 10.18 An individual with a high level of mental fitness will be better prepared to cope with high stress

mental fitness the ability to maintain psychological wellbeing and resilience in the face of challenges. It involves creating emotional stability and effective coping strategies to support mental health.

10.5.2 Access and inclusion

There are a number of factors related to mental fitness that can create barriers to participation for certain individuals. Poor mental fitness can lead to an individual feeling demotivated and having low energy levels. This makes it less likely that they will start a new activity or take on a challenge within their chosen sport. The ability to maintain a positive mindset is also important at the early stages of participation, because there are often more challenges at this level due to the new skills being developed. Effective coaching and teaching can ensure that positive feedback is received and a positive mindset is maintained.

FIGURE 10.19 The components of mental fitness



Another component integral to developing positive fitness habits is creating social connections through physical activity. This can be as simple as going for a walk with a friend or kicking a football with friends in the park. Meaningful social interactions have a big impact on the mental fitness of an individual and can create a sense of belonging when it involves a team or club environment.

Joining a team or a sports club can increase access to physical activity because:

- a common purpose can increase an individual's motivation
- set times, locations and schedules make it easier to participate regularly
- the expectation of teammates to show up makes it harder to miss training sessions or games
- meeting new people who enjoy the same activities can increase the chances of participation.

There are also a number of information sources that an individual can go to in order to find out about prospective teams and groups to join. These include:

- the AIS Find A Club Website, which partners with 38 national sporting organisations to support people to get involved in participating, coaching, officiating and volunteering in sports
- AAA Play, which is Australia's only dedicated referral and connection service for people with a disability to sports and recreational opportunities in Victoria
- Just Play, which is an online platform that highlights available clubs and teams in your area
- local notice boards at sports clubs, swimming pools and community centres
- local sports associations for your chosen sport.

CASE STUDY

How physical activity in Australian schools can help prevent depression in young people

Adolescence is a critical time for the development of mental health problems. In fact, depression is most likely to occur during adolescence and young adulthood. It's the leading cause of disability in young people worldwide. At least one quarter of young people will experience an episode of depression before 19 years of age. By Year 9, students who have experienced a mental disorder are on average two years behind in academic achievement compared to those without a mental disorder.

The consequences of depression in adolescence are serious and can be lifelong. These include an increased risk of depression later in life, poor social functioning and academic achievement and reduced employment security, as well as greater risk of suicide and self-harm. Many young people don't recover from depression,

despite treatment with the best available evidence-based treatment approaches. Given the scope and impact of depression in young people, and poor recovery rates, it's crucial to understand how to help prevent the development of depression in young people.

FIGURE 10.20 As people of all ages are becoming increasingly sedentary, physical activity is becoming more important to supporting mental health.

An increasing body of evidence indicates physical activity and exercise are effective for improving mood. We recently also examined studies to assess the efficacy of physical activity and exercise as a prevention for depression in young people. We found eight controlled research studies that examined this. These studies showed exercise and physical activity are effective as a depression-prevention approach for young people.

How much physical activity do young people need to do?

Few young people seek professional help for mental health concerns. It's important to engage young people in places that suit them to prevent the onset of mental health problems. Prevention and early intervention are crucial and especially relevant in the education setting. The Australian guidelines state young people should engage in 60 minutes of physical activity a day. The majority of young people don't reach this target. In fact, disengagement from regular exercise, physical activity and sporting clubs steadily increases during adolescence. This coincides with the average age of onset of depression.

Physical activity is an important part of the Australian curriculum. The Australian national policy requires government schools to provide at least two hours of physical activity per week during primary education and junior secondary education. The provision of any physical education is not required as part of the senior secondary curriculum. Even during primary education and junior secondary education, the mandated 120 minutes a week doesn't meet Australian guidelines. Schools are a key site for the promotion of healthy behaviours. Many long-term health-related behaviours and patterns — both positive and negative — are established during the developmental phase of adolescence and early adulthood.

How do we get them to do more?

The research indicates physical activity is associated with a reduced risk of depression in young people. Physical activity is an acceptable, non-stigmatising approach to promoting better mental health in young people. To meet the specific needs of young people, a physical activity program should facilitate self-reliance, motivation, and mental health and wellbeing literacy.

Motivation to engage in physical activity can be increased by offering a choice of activities, increasing skills and ability to engage in physical activity and opportunities for social connection. Schools are best placed to ensure physical activity is increased and protected within the Australian curriculum and that young people meet the Australian guidelines for physical activity each day.

Most school-based intervention studies of physical activity have used supervised programs of moderate to vigorous physical activity. These consist of 30 to 45 minutes, three to five days per week. The physical activity should include a variety of activities, be age-appropriate and enjoyable.

Source: Extracts from Alexandra Parker and Michaela Pascoe, 'How physical activity in Australian schools can help prevent depression in young people', *The Conversation*, 11 December 2018, www.theconversation.com.

10.5.3 Participation and performance

As the regularity of participation increases, so can the relative mental pressure on the individual involved. An individual needs to be capable of coping with these **stressors** in order to succeed in their chosen activity.

FIGURE 10.21 Coaches and teams can work together to increase resilience by ensuring they have a supportive and positive dynamic.

Stress-management techniques can assist in maintaining a consistent level of involvement and performance in an activity. Individuals can use strategies such as meditation, progressive muscle relaxation and controlled breathing to minimise the impact of stressors and prevent them from negatively affecting their sporting performance.

Individuals also need emotional resilience to keep them participating regularly in physical activity. **Resilience** allows them to cope with setbacks. This can be especially important for professional athletes at the highest level, where their livelihood depends on their ability to perform. Injuries can often lead to periods of time away from their sport, and it is important for coaches and managers to ensure that their athletes have the mental resilience to get themselves through these difficult periods.

There are a number of ways that teams and coaches can help to develop the resilience of their athletes and players. These include:

- developing a support network
- mindfulness and meditation practices
- goal setting
- positivity practices and outlook
- regular physical activity.

on Resources

Weblink International Olympic Committee — Mental Health Action Plan

Strong mental fitness also allows for effective cognitive functioning to take place. In a sporting environment, where hundreds of decisions need to be made in a matter of seconds, this component is essential. During training, effective cognitive functioning allows learning to occur and muscle memory to be established. During competition, it allows an athlete to think clearly and solve problems when directly facing an opponent or difficult obstacle.

Coaches and athletes need to remember the link between physical fitness, health and mental fitness. Without the necessary exercise, nutrition, sleep and self-care practices, it is much more challenging for an athlete to stay mentally strong.

stressor any external event or circumstance that triggers stress responses in an individual. These can range from academic pressures and relationship conflicts to financial difficulties or major life changes.

resilience the ability to adapt to and recover from stress, adversity and challenging situations

CONCEPT CONNECTOR

Using a mini-whiteboard or sticky notes, write down as many different sports or physical activities as you can. Use different coloured pens to identify which are team/group activities and which are solo/individual activities.

Think about how these activities would affect and individual's ability to gain the social connections needed for good mental fitness.

10.5.4 Local, national and global perspectives

A number of programs aim to improve mental fitness around Victoria and Australia. These include, but are not limited to, the following:

- *Smiling Mind.* A prevention-focused mental-health charity that creates tools to support people to maintain their mental health
- *This Way Up.* Online tools and programs to tackle stress, anxiety and low mood using cognitive behaviour therapies
- *Head to Health Victoria.* An Australian government initiative providing access to digital mental health services, information and support
- *Headspace.* Australia's youth mental health foundation, which provides early intervention mental health services for those aged 12–25
- *Aquatics & Recreation Victoria.* This organisation has created an online information resource on mental fitness and how to maintain and develop it.

The Australian Institute of Sport has also developed a program with the mental health charity, the Black Dog Institute. This program is designed to help young people manage their mental health and general wellbeing, and is run by Australian Olympic, Paralympic and Commonwealth athletes through school visits and online sessions. The program includes a six-week challenge that develops some of the key components of mental fitness, including mindfulness, social connections and a mental fitness plan.

on Resources

Weblinks Building Mental Fitness — Aquatics & Recreation Victoria
AIS Mental Fitness Program poster

10.5.5 Historical, current and future implications

Historically, there has been very little awareness of the need for mental fitness. Much of the stigma around mental-health problems was based on the assumption that those in need of support were weak or had suffered previous trauma. Within the world of professional sport, where sharing perceived weaknesses could advantage your opponent, hiding them was believed to be preferable.

However, there has been a movement towards a greater understanding of these issues and the need to develop mental fitness during periods of good mental health. Redressing this imbalance has led to more conversations about mental fitness in the world of professional sport. Many key sports people and coaches now discuss their own mental-fitness issues and what they do to maintain mental fitness during the fierce combat of sport. This is helping to normalise mental fitness and bring about a change within society.

In the future, it is likely that children and young people will be taught mental fitness much in the same way that they are taught physical fitness in school. This education will include the early warning signs of mental-health issues, the components that make up good mental fitness and the tools to use in order to maintain it.

CASE STUDY

More than 40 percent of elite sport coaches suffer mental ill-health

With the recent sudden death of former rugby league coach and player Paul Green, conversations about the mental health of elite coaching staff are paramount. Our research in 2020, published in July this year, found more than 40 per cent of coaches from Olympic sports we surveyed reported mental health symptoms at a level that would warrant professional treatment. But fewer than 6 per cent reported seeking treatment at the time. Despite facing immense pressure in their daily roles, the mental health needs of elite coaches have been largely neglected in public conversation.

FIGURE 10.22 Mental-health support is now being sought for coaches as well as athletes to prevent cases such as that of Paul Green.

Athletes increasingly discussing mental health

In recent years, we have seen many high-profile athletes across several sports talk openly about their mental health struggles. They include Naomi Osaka, Nick Kyrgios, Simone Biles, Michael Phelps, Bailey Smith and Majak Daw. UFC fighter Paddy Pimblett recently challenged mental health stigma and promoted seeking help in a post-fight interview. When elite athletes openly discuss mental ill-health, this is often publicly celebrated. This aligns with changing cultural attitudes, moving away from rigid stoicism and towards recognising mental ill-health as a reality rather than a rarity.

Coaches largely neglected

But it's rarer to see people talking about mental ill-health in elite coaches. Very few coaches have publicly discussed their experiences, with a small number of notable exceptions in the AFL. Former St Kilda player and Richmond coach Danny Frawley openly discussed experiencing depression and anxiety before his death in September 2019. Former Essendon player and coach James Hird also described experiencing suicidal thoughts, contacting Beyond Blue for crisis support and receiving inpatient treatment for depression.

However, public recognition of the pressures and mental health challenges experienced by elite coaches remains poor. Elite coaches experience immense pressure in their daily roles. They are subject to many of the same challenges as the elite athletes they coach. These include performance pressure, public scrutiny, online harassment, role insecurity, extended periods travelling for sport and missing significant life events as a result.

Coaches are also tasked with vast levels of responsibility for club and sporting success. Their role requires them to act as the face of club decisions, performance and injuries — and they're often exposed to blistering public opinion and scrutiny about such matters. In 2021, tennis player Naomi Osaka commented on the toll of post-match interviews — but no such discussions have been applied to coaches.

The research

In 2020, the Australian Institute of Sport (AIS) commissioned a survey of the mental health and wellbeing of coaches and support staff across Australian Olympic-level sports (the 2020 Mental Health Audit). Our team at youth mental health organisation Orygen and the University of Melbourne conducted this study, which represents one of the largest surveys of coach and support staff mental health and wellbeing.

We surveyed 78 coaches and 174 support staff from Australia's elite Olympic sport system. The survey assessed rates of mental health symptoms, psychological distress, sleep disturbance and alcohol use. We found elite coaches reported mental health symptoms at a similar level to elite athletes. Signs of mental health stigma were also apparent. For example, 30 per cent thought mental health problems would reflect poorly on them in a sport setting. This suggests coaches may feel unsafe sharing their mental health experiences.

Source: Extracts from Vita Pilkington and Courtney C Walton, 'More than 40 per cent of elite sport coaches we surveyed suffered mental ill-health. They need our support, not stigma', *The Conversation*, 19 August 2022, www.theconversation.com

Resources

Weblinks Chill out, cool down

10.5 Activity

10.5 Quick quiz on | **10.5 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 5	3, 6	2, 4, 7

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Identify** the six components of good mental fitness.
2. **Evaluate** the role of social connection and a related strategy in promoting mental fitness, especially in the context of individuals at the access and inclusion stages.
3. **Discuss** the significance of mental fitness in sports, particularly in relation to protecting athletes from potential mental-health issues arising from high-stress environments in the performance phase.
4. **Explain** how poor mental fitness can create barriers to participation in physical activities and sports, citing examples from the text.
5. **Identify** which of the following is not a component of mental fitness.
   - **A.** Physical health
   - **B.** Cognitive functioning
   - **C.** Skill level
   - **D.** Positive mindset

APPLY your understanding

6. Access the **Chill out, cool down** weblink in the Resources panel to read about athlete anxiety at the Winter Olympics. **Discuss** the impact of anxiety on the performance of elite athletes in this article.
7. **Analyse** the effectiveness of joining a team or sports club in increasing access to physical activity.

10.5 Exam questions

Question 1 (1 mark)

Which of these is NOT a component of mental fitness?

- **A.** Emotional resilience
- **B.** Stress management
- **C.** Optimum arousal
- **D.** Social connection

Question 2 (6 marks)

Access the **Building Mental Fitness — Aquatics & Recreation Victoria** weblink in the Resources panel. **Evaluate** how programs such as this can help individuals participate during the access and inclusion phase of their involvement in physical activity and sport.

Question 3 (3 marks)

Explain why physical health is an important component of mental fitness in the participation phase of physical activity.

10.6 Key skills

Key skills

- explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport
- collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media
- propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport
- prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue
- analyse the historical, current and future implications of the selected issue

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

10.6.1 Tell me

To address these key skills, it is important to remember the following:

- understand that intrapersonal issues relate to those that come from within the individual themselves, rather than those around them
- understand how physical activity and sport can be tailored to alleviate some of the barriers to participation and performance caused by these intrapersonal issues
- ensure that you provide information in relation to how the issues affect all levels of involvement, from inclusion and access to participation and performance
- provide examples of strategies that have been implemented to enhance the contemporary issue in question
- ensure that you look at how the issue has changed over time and how it is likely to affect future involvement in physical activity and sport.

10.6.2 Show me

Practice question (5 marks)

KEY

- **green** identify the action word
- blue key concepts
- *purple* key terminology
- light orange marks/marking scheme

The government of South Australia's campaign 'I'm an Athlete. Period' aims to decrease the stigma and taboo around menstruation in sport.

a. **Outline** the physical and psychological impacts that *menstruation* can have on a female athlete. (2 marks)

b. **Explain** how campaigns such as 'I'm an Athlete. Period' can help to promote *higher rates of female participation*. (3 marks)

Decode the question

Strategies to decode the question

- **Identify the action words:**
  Outline — general description, but not in detail
  Explain — provide detail to show the relationship between concepts
- **Key terminology** — *Menstruation*
- **Key concepts** — Promotional campaign and/or strategy, physical, psychological
- **Marking scheme** — 5 marks — always check the marking scheme for depth of response required, linking to key information highlighted in the question.

Sample responses and marking scheme

a. *Menstruation* can affect female involvement in physical activity due to a combination of physical and psychological. Many females experience physical symptoms, such as *cramps and headaches, which can reduce comfort and performance* during exercise. Psychologically, feelings of *self-consciousness and anxiety* about potential leaks or managing menstrual hygiene in public settings can *deter females from engaging in sports or exercise.*
Award 1 mark for outlining the physical impact of menstruation.
Award 1 mark for outlining the psychological impact of menstruation.

b. Campaigns such as 'I'm an Athlete. Period' are important to promoting *higher rates of female participation* in physical activities because they directly address these issues. These campaigns aim *to normalise menstruation and break down the associated stigma* through *increasing awareness*. By *promoting open discussions* about menstrual health, they help to *create a more inclusive and supportive environment* for female athletes. Educational components of these campaigns provide valuable *information on managing menstrual symptoms* effectively, such as the use of appropriate menstrual products and strategies for alleviating discomfort, thus empowering females to maintain their physical activity levels.
Additionally, 'I'm an Athlete. Period.' advocates for better facilities and policies that accommodate menstrual health needs, such as access to menstrual products in sports venues and providing adequate private spaces for changing. This advocacy helps to ensure that females *feel more comfortable and supported in their athletic pursuits*. By creating a culture of acceptance and understanding, these campaigns encourage females to participate in sports confidently and without hesitation, leading to *increased overall participation rates and promoting gender equity in physical activity*.
Award 3 marks for explaining how campaigns such as 'I'm an Athlete. Period.' help to increase female participation in physical activity and sport.

10.6.3 Let me do it

Question 1 (7 marks)

Many high-level athletes and sports teams are equipping themselves with a range of psychological skills in order to improve performance.

a. **Identify** one psychological skill used by an athlete or team and explain its role in improving performance in high-level sports. **(2 marks)**

b. **Explain** how the development of psychological skills can help to improve access and inclusion within physical activity and sport. **(2 marks)**

c. **Identify** how the importance of psychological skills in sport has altered over time and explain the impact of this change on participation in sport. **(3 marks)**

10.7 Review

Hey students! Now that it's time to revise this topic, go online to:

Review your results

Watch teacher-led videos

Practise exam questions

Find all this and MORE in jacPLUS

10.7.1 Summary

Intrapersonal factors affecting access, inclusion, participation and performance

- Intrapersonal issues are those which arise from within an individual rather than from those around them.
- There are many intrapersonal factors that affect access to, and inclusion, participation and performance in, physical activity and sport.
- These issues have changed and will continue to change over time.
- There are differing local, national and global perspectives on each of the identified issues.
- Programs and strategies have been developed to combat some of the issues negatively affecting physical activity levels.
- Research and data on these issues continues to be gathered and will inform future policy and intervention on a local, national and global scale.
- Support for mental health is one of the largest growing areas of wider public health.

Hormonal considerations

- Scientific research into the effects of hormonal changes on sporting performances is limited.
- Most research so far has focused on the physiological effects rather than the psychological and sociological effects of hormonal changes in women and girls.
- There are key hormonal differences at different stages of the menstrual cycle.
- The Female Athlete Triad is a growing concern among high-level athletes.
- There has been a stigma around conversations about menstruation, especially within professional sport.
- Period poverty is an issue which negatively affects many female participants in sport.
- Athletes are now more commonly talking openly about the issues regarding competition and their menstrual cycle.

Injuries

- Physical activity-related injuries make up around $764 million of the Australian public health budget.
- Concussion is becoming the predominant issue in youth sports injuries due to the long-term health problems it can cause.
- Injury can lead to a number of psychological issues related to exclusion from activities and time away from sport.
- Injury/poor health has been identified as the biggest single barrier to participating in regular physical activity.
- There are a number of steps that coaches and sports teams can take to reduce injury risk for participants (e.g. injury assessment, strength and conditioning programs, equipment and clothing).

Psychological skills

- The use of psychological skills is becoming common among sportspeople at all levels.
- The key tools include sleep optimisation, confidence, optimal arousal, concentration and motivation.
- Many sports have a social aspect, which makes them appealing to those wanting social connection.
- Intrinsic motivation can be found from activities through enjoyment, satisfaction and self-improvement.
- The tracking of sleep through new technologies has now made it easier for athletes to maintain their sleep hygiene and allow effective recovery to take place.

Mental fitness

- Mental fitness components include cognitive functioning, a positive mindset, social connection, stress management, physical health and emotional resilience.
- Poor mental fitness can have a dramatic effect on sports participation at the beginner stage.
- Mental fitness teaching is now becoming more popular in schools as well as in sports teams and organisations.
- Stress-management techniques are often used by high-level athletes to control anxiety relating to their performance.

10.7.2 Key terms

amenorrhea the absence of menstruation, often attributed to low body weight, excessive exercise, disordered eating and other causes
hormones chemicals that help to control many functions in your body. Hormones circulate through your blood to your organs, skin, muscles and other tissues.
intrapersonal factors describes factors affecting individuals that come from within themselves, such as attitudes, self-esteem, self-regulation and decision-making
menstruation monthly process in which the female body sheds the lining of the uterus. This results in bleeding from the vagina, typically lasting between 3–7 days.
mental fitness the ability to maintain psychological wellbeing and resilience in the face of challenges. It involves creating emotional stability and effective coping strategies to support mental health.
period poverty the lack of access to menstrual products, sanitation facilities and adequate education surrounding menstruation
resilience the ability to adapt to and recover from stress, adversity and challenging situations
stressor any external event or circumstance that triggers stress responses in an individual. These can range from academic pressures and relationship conflicts to financial difficulties or major life changes.

10.7 Exam questions

10.7 Section A — Multiple choice questions

Question 1 (1 mark)

What is the impact of mental fitness on physical activity?

A. Mental fitness has no impact on physical activity.
B. Developing mental fitness can prevent potential mental-health issues.
C. Mental fitness decreases physical performance.
D. Mental fitness only affects professional athletes.

Question 2 (1 mark)

Identify which of these is an impact of injury on an athlete in a team-sport environment.

A. Increased team spirit
B. Improved performance
C. Sense of inclusion
D. Feeling of exclusion

Question 3 (1 mark)

How can concentration affect an individual's participation in physical activity and sport?

A. It can hinder relationships with teammates.
B. It leads to decreased communication.
C. It encourages individualism.
D. It helps build effective relationships.

Question 4 (1 mark)

Identify the primary reason given in the AusPlay 2023 report for the increase in injury among young athletes.

A. Lack of coaching quality
B. Advanced safety equipment
C. Increased athlete speed and strength
D. Decrease in impact intensity

Question 5 (1 mark)

How can social connection through physical activity help mental fitness?

A. It has no impact on mental fitness.
B. It increases demotivation.
C. It creates a sense of belonging.
D. It decreases energy levels.

Question 6 (1 mark)

Which of the following does not make up part of the Female Athlete Triad?

A. Menstrual disturbance
B. High blood pressure
C. Energy deficient
D. Low bone mass

Question 7 (1 mark)

Which of these is a benefit of taking part in exercise with a friend?

A. Likelihood of success in goal achievement
B. Increase in boredom
C. Decrease in commitment
D. Lack of new exercise ideas

Question 8 (1 mark)

Identify which of the following is NOT a recommended strategy to reduce injury risk for participants.

A. Strength and conditioning programs
B. Overtraining
C. Proper nutrition and hydration
D. Coaching of correct technique

Question 9 (1 mark)

Which of the following is NOT a strategy used to reduce injuries in sport and physical activity?

A. Warm up and cool down
B. Adequate rest/recovery
C. Head-injury protocol
D. Reduction in resting heart rate

Question 10 (1 mark)

How can effective cognitive functioning benefit an athlete during performance?

A. It leads them to make more mistakes during play.
B. It leads to confusion.
C. It allows for clear thinking and problem solving.
D. It decreases decision-making skills.

10.7 Section B — Short answer questions

Question 1 (4 marks)

Discuss how hormonal considerations affect the participation rates of girls and women in sport and physical activity.

Question 2 (3 marks)

Select two different sports and answer the following questions.

a. What are the most common injuries? **(1 mark)**
b. What rules are in place to reduce the likelihood of injury? **(1 mark)**
c. Is there any specific safety/protective equipment? **(1 mark)**

Question 3 (4 marks)

In recent years many professional sports events have changed their schedules to increase TV audiences, resulting in late start times and early morning finishes. **Discuss** the impact of these changes on the performance of athletes taking part in these events.

Question 4 (4 marks)

Discuss how stress-management techniques contribute to maintaining consistent involvement and performance in physical activities. Support your answer with relevant examples from sport.

Question 5 (2 marks)

Explain how the Female Athlete Triad can affect female performance.

Continue to build your exam skills

Access the Unit 2 Area of Study 2 Review at the end of Topic 11. This includes:
- Practice extended response
- Practice examination
- Practice school-assessed coursework

11 Interpersonal issues

11.1 Overview

Hey students! Bring these pages to life online

Watch videos

Engage with interactivities

Answer questions and check results

Find all this and MORE in jacPLUS

LEARNING SEQUENCE

11.1 Overview
11.2 Geographic location
11.3 Coaching
11.4 Sports technology and the media
11.5 Institutional and structural inclusion and equity
11.6 Gender equity
11.7 Key skills
11.8 Review

11.1.1 Introduction

Interpersonal factors are the elements that shape relationships between people and how they communicate and interact with one another. In this topic we will explore the following interpersonal issues: geographic location, coaching, sports technology and the media, institutional and structural inclusion, and gender equity. Each of these factors has an impact on access and barriers to participation in sport and physical activity. For effective change to occur in these areas, we must not only understand current and historical perspectives but also global perspectives.

This topic links closely to topic 10, in which we took an in-depth look at the intrapersonal issues affecting contemporary physical activity and sport in Australia.

The contemporary intrapersonal issues covered in topic 10 relate to those that affect the individual, while these issues relate to how an individual's involvement in physical activity and sport is influenced by those around them and wider society.

FIGURE 11.1 Interpersonal factors can influence the amount of physical activity that is available to an individual and potential barriers to participation.

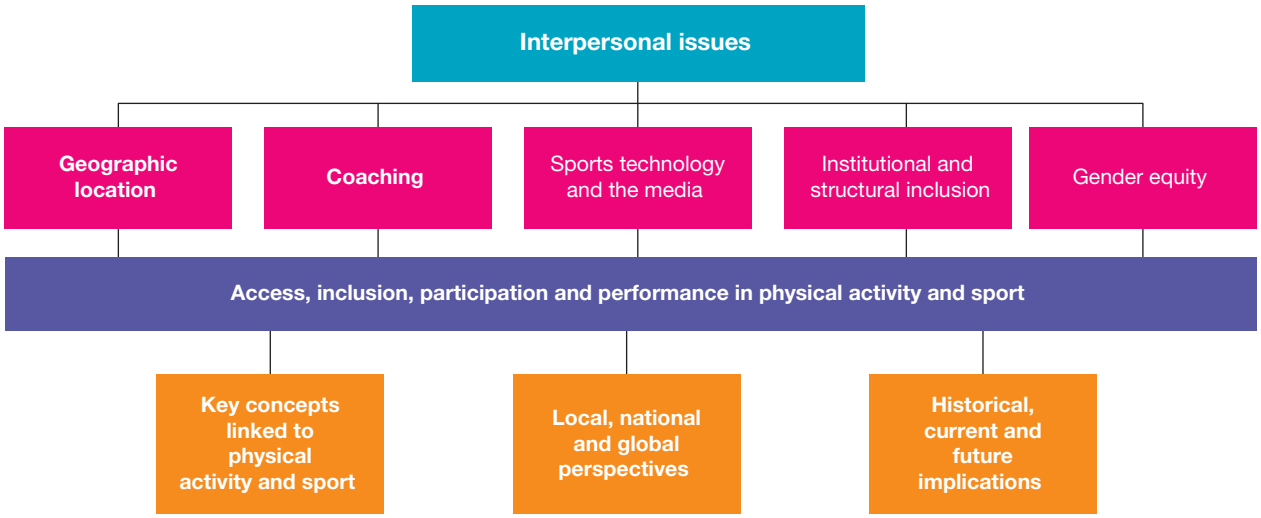
interpersonal factors social influences and relationships that affect a person's behaviour, emotions and development. These factors include interactions with family, friends, teammates and wider society.

11.1.2 Key knowledge and Key skills

Key knowledge	Key skills	Subtopic
• interpersonal issues that influence access to, and inclusion, participation and performance in, physical activity and sport, such as: – geographic location (rural and urban) – coaching (styles, planning/program design and ethical behaviour, such as safeguarding athletes) – sports technology and the impacts of media on beliefs and behaviour – institutional and structural inclusion and equity in sport (for Aboriginal and Torres Strait Islander Peoples, and in consideration of cultural diversity, physical and intellectual diversity, and gender and sexual diversity) – gender equity, such as pay gap, and representation in coaching positions and decision-making bodies at the local, national and global levels	• explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport	**11.2** **11.3** **11.4** **11.5** **11.6**
• key concepts within the selected contemporary issue linked to participation in physical activity and/or sport in society	• collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media	
• local, national and/or global perspectives on the selected issue	• propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport	
• historical, current and future implications of the selected issue	• prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue	
	• analyse the historical, current and future implications of the selected issue	

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

11.1.3 Topic overview



11.2 Geographic location

Key knowledge	Key skills
• interpersonal issues that influence access to, and inclusion, participation and performance in, physical activity and sport, such as: – geographic location (rural and urban) – coaching (styles, planning/program design and ethical behaviour, such as safeguarding athletes) – sports technology and the impacts of media on beliefs and behaviour – institutional and structural inclusion and equity in sport (for Aboriginal and Torres Strait Islander Peoples, and in consideration of cultural diversity, physical and intellectual diversity, and gender and sexual diversity) – gender equity, such as pay gap, and representation in coaching positions and decision-making bodies at the local, national and global levels	• explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport
• key concepts within the selected contemporary issue linked to participation in physical activity and/or sport in society	• collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media
• local, national and/or global perspectives on the selected issue	• propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport
• historical, current and future implications of the selected issue	• prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue
	• analyse the historical, current and future implications of the selected issue

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

11.2.1 Geographic location and its impact on physical activity

The most significant influence of an individual's geographic location on their participation in physical activity depends on whether they live in an urban or a rural environment. In Victoria, and the rest of Australia, geographic location has one of the greatest impacts on participation in certain recreation and sporting activities.

The higher population density of urban areas means that more is spent on public and private leisure facilities, which means greater numbers of facilities. Urbanised areas also tend to have better transport infrastructure, which means that people are able to travel more easily to access physical activity facilities.

FIGURE 11.2 Whether you live in a rural or urban environment can be one of the biggest determining factors determining your level of access to physical activity facilities.

There are, however, a number of different factors linked to geographic location that can also affect the type, quality and amount of physical activity opportunities available. These include the following:

Geographical location factor	Barrier	Enabler
Air quality 	Poor air quality may negatively affect an individual's cardiovascular health and ability to exercise. It can lead to issues such as high blood pressure and chronic obstructive pulmonary disease (COPD). It can also lead to decreased participation rates, as people feel less motivated to exercise in these unpleasant environments.	Indoor sports facilities in urban areas create a healthier environment in which to exercise. Many urban areas also provide parks and green spaces, where people can exercise without being affected by poor air quality. Apps that monitor air quality are now available. This enables the individual to identify the best time to exercise.
Socioeconomic status 	In rural areas, the socioeconomic status is often lower, which can mean that certain activities are too expensive. Some also require a much higher initial and ongoing cost (e.g. horse riding).	Subsidised and community programs have been created to allow certain groups to take part in activities that would normally be too expensive.
Terrain 	Gaining access to the specific terrain needed for certain activities can be difficult. For example, the hilly terrain needed for mountain biking or skiing can be hard to find in low-lying areas. Those wanting to participate in water-based activities, such as surfing, need the correct environment to be able to participate.	Artificial facilities can be built in urban environments to offer an alternative experience (e.g. ski-domes and URBNSURF). Trails and walking networks can make areas more accessible.
Climate 	Certain climates are required for particular sports (e.g. skiing and snowboarding). Average daytime temperature and hours of daylight can also affect participation, because individuals living in colder, darker places are less likely to be involved in as much regular physical activity as those in warmer locations.	Artificial facilities can also provide the necessary environment for some of these activities. Urban planning and design can include street lighting to make it easier and safer for people to exercise when daylight is limited.
Cultural and social influences 	Some communities do not value and prioritise exercise and this can reduce the likelihood of someone exercising regularly. During the teenage years, the impact of peers can also have a dramatic effect on whether an individual continues to participate in physical activity.	Education plays a large part in ensuring people understand the long-term physical, mental and social benefits of exercise. Programs aimed at teenagers should aim to highlight the social benefits of exercise. Physical activity programs must be flexible and offer choices to keep young people involved.

11.2.2 Access and inclusion

In Australia, because of the remoteness of some communities, geographical location is still one of the biggest influences on access to and participation in regular physical activity. The AusPlay research data from the Australian Sports Commission in figure 11.3 highlights the difficulties that Australian health and sport policy-makers have ensuring access for all people regardless of their location.

FIGURE 11.3 AusPlay Data from the Australian Sports Commission

PARTICIPATION - 2018 TO 2022

Estimated **sport-related** participation [12, 13]

Children (0-14) - organised outside-of-school hours sport-related activity at least once a week
Australians (15+) - sport-related activity at least once a week

	Children 0-14	Australians 15+	Boys 0-14	Girls 0-14
Major cities	**1,650,000** (49%)	**6,211,000** (42%)	**876,000** (50%)	**774,000** (47%)
Inner regional	**409,000** (45%)	**1,441,000** (41%)	**215,000** (46%)	**194,000** (43%)
Outer regional	**169,000** (41%)	**631,000** (40%)	**91,000** (43%)	**78,000** (39%)
Remote or very remote	**34,000** (37%)	**123,000** (40%)	**18,000** (36%)	**16,000** (37%)

The data shows that, for most youth age categories, those people living in remote or very remote areas make up the lowest percentage of the population taking part in regular, out-of-school physical activity. In 2024, out of the total population of Australia, 28 per cent lived in regional and remote areas.

CONCEPT CONNECTOR

Using figure 11.3 and any relevant data that you can find, discuss in small groups the possible barriers and enablers to participation for young people in regional and remote areas.

Write your barriers and enablers on to a mini-whiteboard or the class whiteboard. How many different factors can you identify as a group?

FIGURE 11.4 The Deadly Active Sport and Recreation Program prioritises initiatives targeting physical activity needs identified by First Nations communities. These projects aim to enhance participation in quality, culturally relevant physical activities.

There are a number of state programs around Australia that aim to ensure people in remote communities have fair access to sports facilities and coaching. Figure 11.5 outlines some of these programs.

FIGURE 11.5 Programs encouraging regional and remote sport and recreation

Queensland
- *The Game Plan*: A 10-year plan for organised sport and active recreation in the Central Highlands region. Outlines the goals and aspirations for sports clubs, facilities and programs.
- *Regional School Sport*: Aims to provide, foster and develop sport within state schools, colleges, and non-government affiliated schools.

Western Australia
- *Active Regional Communities Grants*: Ongoing grant program that provides opportunities for regional people to participate in sporting and active recreational activities.
- *Sport and Recreation WA*: Government department that works with providers to ensure that sport and recreation decisions provide for regional communities.

Northern Territory
- *Remote Sport Program*: Funds sport and recreational activities in remote areas of the Northern Territory.

Victoria
- *Regional Sport Partnership (VicHealth)*: This is a partnership between VicHealth and nine regional sports assemblies. The assemblies work with local sports clubs and associations, active recreation providers, local councils, recreation facilities and other community grassroots organisations to deliver physical activity and social connection opportunities for young people.
- *Regional Community Sports Infrastructure Fund*: The fund aims to deliver new and upgraded community sports infrastructure across four streams: Indoor Stadiums and Aquatic Facilities, Community Facilities, Women and Girls' Facilities and All Abilities Infrastructure.

New South Wales
- *Regional Sport and Active Recreation Plans*: Individual plans for nine areas of New South Wales which aim to improve access and participation as well as develop pathways for potential and elite athletes from the regions.

11.2.3 Participation and performance

Sports organisations and teams must ensure ongoing participation as well as the development of high-performing athletes from different geographic locations. The aim is to ensure that people are not negatively affected by their regional or remote location. This can be accomplished in a number of ways, which are listed below.

- Regional training hubs provide athletes from regional areas with access to specialised coaching, training facilities, sports science support and performance services. These serve as centralised training bases for athletes from regional areas, reducing the need for travel to metropolitan areas.
- Regional development pathways are pathways specifically tailored to the needs of athletes from regional areas. This includes providing access to high-quality coaching, training facilities and competition opportunities closer to home.
- Talent identification programs actively seek out promising athletes in regional areas. This can involve partnerships with schools, local sports clubs and community organisations to identify and assess athletic potential.
- Scholarship programs offer scholarships and financial support to talented athletes from regional areas to help cover the costs associated with training, travel, accommodation, equipment and other expenses related to elite-level sports participation.
- Partnership and collaboration can be fostered between state sporting organisations, local governments, schools, sports clubs, community organisations and private sector stakeholders to support elite-athlete development in regional areas.

on Resources

Weblinks Australian and state policies, programs and supporting structures
Regional Community Sports Infrastructure Fund Guidelines

11.2.4 Local, national and global perspectives

The issue of remote community support in Victoria is a priority for policy-makers and sports organisations. Regional sports partnerships have been created to deliver sports and physical recreation facilities, activities and connection opportunities for young people in these communities. The Victorian government has also created an infrastructure fund that aims to deliver new and upgraded community sports facilities.

FIGURE 11.6 Upgraded facilities aim to encourage participation in regional areas.

Federal government and sports governing bodies have also created programs to reach those disadvantaged by their geographic location. An example of this is Athletics Australia's Athletics for the Outback program, which is focused on engaging remote communities through youth athletics clinics, team development, event development, teacher upskilling and athletics carnivals.

FIGURE 11.7 Athletics Australia's Athletics for the Outback program is making significant positive change for individuals in remote areas throughout Australia.

Globally, there are many countries that have developed programs to support remote and regional communities. The United States, which has a similar urban/rural split to Australia, offers its potential athletes travel assistance and scholarships to help cover the expenses related to transportation, lodging, equipment and competition fees. Recent developments in technology have also enabled the creation of online coaching and training programs that link athletes in remote areas to experienced coaches and specialists using videoconferencing, online platforms and virtual training equipment.

11.2.5 Historical, current and future implications

Historically, there has been a considerable sport and recreation funding gap between metropolitan and regional/remote areas in Australia. This is partly due to the greater allocation of financial resources to areas with a higher population density (metropolitan areas). There has also been a gradual movement of the population over the past 100 years to the country's bigger cities, which has meant that rural populations have declined. This movement was due mainly to decreasing job opportunities in regional areas.

More recently, funding has been directed towards remote communities, particularly First Nations communities. Both federal and state governments have recognised that these communities have been underfunded. With the development of facilities and resources in isolated areas, it is likely that there will be an increase in the numbers of people regularly participating in physical activity and sport. This, in turn, will lead to a greater number of high-performance athletes being developed and becoming role models for young people within the same communities.

CASE STUDY

We can use AFL to boost school attendance and improve mental health in Indigenous communities

Indigenous boys living in remote Australian communities have a 20% lower truancy rate if they play AFL. This is one of the findings from our latest study exploring the benefits of Indigenous people's participation in Australian rules football (AFL).

Our report, *After the Siren: The community benefits of Indigenous participation in Australian Rules Football* found Indigenous children who participate in AFL have better physical and mental health than those who don't. Children who played football were 6% less likely to be assessed as having learning difficulties due to health issues.

Conducted by the Bankwest Curtin Economics Centre, the report also showed that 56% of Aboriginal and Torres Strait Islander children who participated in football were assessed as being in excellent health compared to 48% of those who had not participated in any organised sport.

There are both physical and mental health benefits for adults and children who participate in sports. But participation in organised sport is generally higher for people from more advantaged backgrounds, such as those owning a home, people who live in higher socioeconomic neighbourhoods, those who have a car, are better educated and not in financial stress.

Interestingly though, this relationship is absent or even reversed for participation in AFL. This suggests it is a highly accessible sport for children and adults. Our report identifies considerable potential for deriving benefits from greater investment in structured AFL competitions and other sports programs in remote areas.

Aussie rules in Indigenous communities

Indigenous Australians have contributed much to the game of Australian Rules Football (AFL). Great Indigenous players, like Cyril Rioli and Adam Goodes, have enthralled crowds with their skills, athleticism, courage and often uncanny reading of the game. And just like Indigenous Australians have contributed to AFL, so it has offered them many benefits in return.

Sport, and AFL in particular, creates a rare arena in which non-Indigenous Australians unreservedly celebrate Indigenous achievement. Much has been written about the success of Indigenous players at elite levels of the game, and through them football has provided a powerful stage for the nation's conscience to be confronted with the racism endured by Indigenous Australians.

But perhaps the more important story is one of Indigenous participation in grassroots and community football, which includes unique carnivals and festivals. Indigenous people are particularly passionate about AFL. For instance, our report showed football and Indigenous culture were complementary. Children and adults who identified with a tribal or language group were more likely to play AFL.

Using data from the 2014–15 National Aboriginal and Torres Strait Islander Social Survey our report analysed factors shaping Indigenous people's participation — being a player — in organised sport and in AFL. For children, this relates to participation in organised sports outside school hours. We explored the associated outcomes in areas of physical health, psychological well-being and social connection.

The data show an already well known state divide. In the NT, WA, SA, Victoria and Tasmania around 26% of Indigenous males aged four and over had participated in AFL in the year prior to the survey. This was compared to 4% in NSW, Queensland and the ACT where rugby dominates. So our analyses focused on the benefits of participation in AFL in the five 'AFL states'.

FIGURE 11.8 Cyril Rioli has contributed much to the AFL with his impressive athletic skills, while proudly representing First Nations Australians.

Using AFL for good

The report shows two-thirds of men aged 15 to 29 living in remote areas of the AFL states had played AFL in the past 12 months. This highlights the importance of football in remote communities. Indigenous men who played AFL were also found to have more frequent contacts with people outside their immediate household and more likely to feel they have social support to call on.

For men, playing football was associated with better self-assessed physical health, as well as better mental health and higher life satisfaction. This is after controlling for an array of other factors — such as age, level of education, remoteness, marital status and smoking and drinking habits. Generally these effects appear similar in magnitude to participation in football generally. But in a number of cases, including for general health and mental health, they are larger than the effects of participation in sports other than football.

We also conducted interviews with key stakeholders from government, community and football administration in WA who told stories of the way football can bring communities together and be leveraged to achieve non-sport outcomes.

These include 'no school no play' rules for getting kids to school, using football carnivals to undertake health checks and vehicle safety checks with an otherwise difficult-to-access population, and to deliver programs on topics such as domestic violence and foetal alcohol spectrum disorder.

There is considerable potential for such benefits to be widened as female participation in AFL expands, with the introduction of the AFL's Women's League. Greater investment in structured AFL competitions and programs in remote communities, where none currently exist, would significantly improve the wellbeing of people living there.

Source: Michael Dockery, 'We can use AFL to boost school attendance and improve mental health in Indigenous communities', *The Conversation*, 14 September 2017, www.theconversation.com

11.2 Activity

11.2 Quick quiz on | **11.2 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1, 4	3, 7	2, 5, 6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Discuss** the impact of geographic location on access to health and physical activity facilities, considering both rural and urban environments. How do these factors influence participation rates in different regions?
2. **Evaluate** the effectiveness of programs such as Queensland's The Game Plan and Victoria's Regional Sport Partnership in addressing barriers to participation in sports and physical activity for remote and regional communities. What are the key elements these successful initiatives share?
3. **Analyse** the role of socioeconomic status in influencing access to physical activity opportunities, particularly in rural areas. How do subsidised and community programs contribute to addressing this barrier, and what further measures can be implemented?
4. **Identify** two geographical location factors that can affect access, inclusion, participation and performance in sport.
5. **Evaluate** the impact of climate on participation in sports and physical activities, considering factors such as temperature and daylight hours. How can urban planning and technological advancements mitigate these challenges?

APPLY your understanding

6. **Analyse** the historical funding disparities between urban and rural areas in Australia for sport and recreation. How have recent initiatives aimed at supporting remote communities, particularly those with First Nations populations, addressed these disparities?
7. **Discuss** the implications of programs such as Athletics for the Outback in engaging remote communities in sports activities. How do such initiatives contribute to community development and empowerment in regional areas?

11.2 Exam questions

Question 1 (1 mark)

Which of these is an example of an initiative being run to promote physical activity in remote areas of Australia?

A. Athletics for the Outback
B. Running the Outback
C. Walkabout in the Outback
D. Indigenous Athletics

Question 2 (2 marks)

Explain what is being done to increase participation and performance in regional and remote areas of Australia.

Question 3 (3 marks)

Explain the impact that technological advancements have had on the development of high-performing athletes in regional and remote areas.

11.3 Coaching

Key knowledge	Key skills
• interpersonal issues that influence access to, and inclusion, participation and performance in, physical activity and sport, such as: – geographic location (rural and urban) – coaching (styles, planning/program design and ethical behaviour, such as safeguarding athletes) – sports technology and the impacts of media on beliefs and behaviour – institutional and structural inclusion and equity in sport (for Aboriginal and Torres Strait Islander Peoples, and in consideration of cultural diversity, physical and intellectual diversity, and gender and sexual diversity) – gender equity, such as pay gap, and representation in coaching positions and decision-making bodies at the local, national and global levels	• explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport
• key concepts within the selected contemporary issue linked to participation in physical activity and/or sport in society	• collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media
• local, national and/or global perspectives on the selected issue	• propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport
• historical, current and future implications of the selected issue	• prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue
	• analyse the historical, current and future implications of the selected issue

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

11.3.1 Coaching and its impact on physical activity

Coaching sports clubs and teams involves more than just the basics of improving the sporting performance of those in their care. Coaching encompasses a range of different skills and values that enable all participants to enjoy and flourish within the coaching environment.

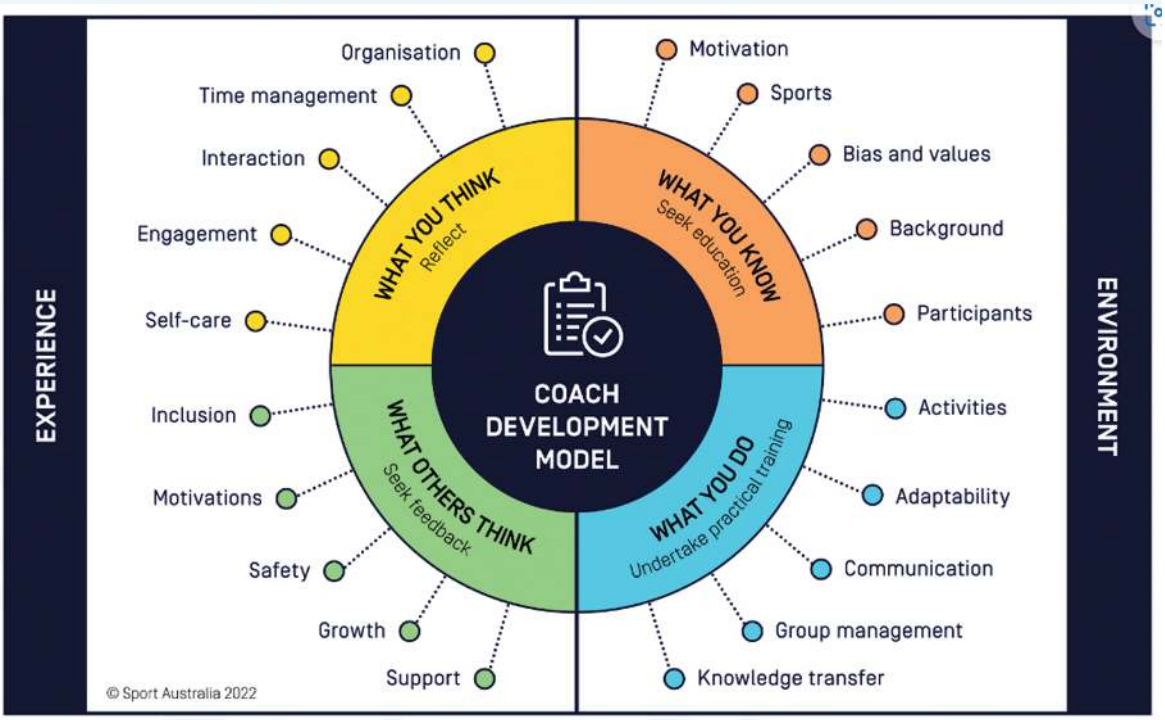
The Australian Institute of Sport (AIS) has created the Coach Development Model to educate sports coaches to ensure they are aware of the multi-faceted requirements of their role.

Coaching styles can vary hugely, and it is vital that the appropriate style is used at various stages of an athlete's skill development and technical ability. Those at the start of their journey in a sport are more likely to need a coach with a positive and encouraging coaching style to motivate them to stay committed to the sport. A negative or overly critical coaching style may demotivate beginner athletes, leading to decreased participation and enjoyment.

Coaching style also influences athletes' enjoyment and satisfaction with their sports experience. A coach who prioritises fun, enjoyment and participation over winning can create a positive and enjoyable atmosphere, enhancing athletes' overall satisfaction with the sport. Equally, a coach who places excessive emphasis on winning and outcomes over process, or who uses authoritarian coaching methods, may detract from athletes' enjoyment of the sport.

FIGURE 11.9 Regular, structured and high-quality coaching can have a dramatic effect on an individual's chances of starting and staying involved in sport and physical activity. However, with recent cases of misconduct and abuse by coaches from a number of sports, do policy-makers and sports organisations need to look at how they are regulating and training coaches?

FIGURE 11.10 AIS Coach Development Model



doc-41970

PRACTICAL ACTIVITY Coaching styles

Goal

To identify how coaching style can affect the enjoyment and engagement within a practical sports setting

Instructions

In a small group of 6–8, complete a short coaching session of two different drills from a sport of your choice. Two members of the group need to act as a coach for a drill. Decide between yourselves who will take a more fun/positive approach and who will lead a more authoritarian/strict session.

Primary data/Reflection

When you have completed the session, discuss what made the two sessions different. How did they make the participants feel? What effect could this have on an individual's (a) enjoyment and (b) likelihood they will improve their skills?

Questions

1. Identify four personal characteristics/values that make an effective coach.
2. What are the advantages of using a more authoritarian coaching style?
3. What are the advantages of using a more positive coaching style?

11.3.2 Access and inclusion

When attending a sport or physical activity for the first time, an individual's first interaction is often with the coach leading the session. Therefore, it is essential that a positive initial relationship is developed to ensure that involvement is continued beyond the first session.

The Play Well Strategy developed by the Australian Sports Commission has identified coaches as a key factor in a participant's experience in sport. The strategy states that modern coaching needs more of a focus on 'providing a safe, fun and inclusive environment' to ensure participation rates stay high, despite the general decrease in physical activity levels among younger generations.

One of the key ways in which coaching education has changed within the youth sports setting is the development of a more inclusive approach. Inclusive coaching is not only about the adaptations necessary for athletes with a disability or impairment but also the belief that everyone should be able to use the same facilities, take part in the same activities and enjoy the same experiences.

Being an inclusive coach also involves:

- appealing to a wider range of possible participants
- acquiring new inclusive coaching skills and practices
- improving athlete retention between sessions
- allowing participants to become the best versions of themselves and achieve their potential
- helping to combat bias and stigma in relation to certain groups and individuals.

on Resources

Weblinks What is inclusion? Your guide to becoming a more inclusive coach
The 7 Pillars of Inclusion

11.3.3 Participation and performance

As the level of proficiency in a sport or activity increases, so does the participants' need for effective coaching and support. However, this is also when some of the more problematic coaching issues have occurred. The pressure to succeed for both the athlete and coach has led to controversial practices being used, which have compromised the safety and health of the athlete. Many sports organisations and clubs have introduced coaching programs, codes of conduct and safeguarding policies to try to reduce the occurrence of coach misconduct.

FIGURE 11.11 Effective coaching is crucial to ensure athletes are adequately supported.

These education programs highlight the responsibility of a coach to maintain a safe and protective environment and ensure that the following prohibited behaviours do not occur:

- *verbal abuse*. Examples include coaches yelling, screaming, or using derogatory language towards athletes.
- *sexual misconduct*. Inappropriate sexual behaviour or coach–athlete relationships, especially with minors, breach trust and can cause significant psychological harm.
- *bullying and harassment*. Coaches who engage in bullying, intimidation or harassment tactics towards athletes create a toxic environment that can negatively affect the athletes' mental health and performance.
- *excessive pressure and control*. Coaches who impose excessive pressure, control or unrealistic expectations on athletes may contribute to stress, anxiety and burnout among athletes.
- *favouritism and discrimination*. This involves coaches showing favouritism towards certain athletes or discriminate against others based on factors such as race, gender or ability.
- *lack of safeguarding measures*. Coaches who fail to implement adequate safeguarding measures to protect athletes from harm, such as ignoring allegations of abuse or turning a blind eye to inappropriate behaviour, are failing in their duty of care.
- *failure to respect boundaries*. Coaches who disregard the personal boundaries of athletes, such as invading their privacy or crossing professional lines, demonstrate a lack of respect and professionalism that can erode trust and lead to harmful situations.
- *unethical behaviour*. Coaches who engage in unethical practices, such as cheating, doping or encouraging athletes to engage in dishonest behaviour, compromise the integrity of the sport and set a poor example for their athletes.
- *lack of professionalism*. Coaches who show up late to practices, fail to communicate effectively with athletes and parents or do not fulfill their responsibilities are displaying unprofessional behaviour.

11.3.4 Local, national and global perspectives

As well as providing the safeguarding rules that need to be followed by all adults working with children, the Victorian government has also developed a number of policies that focus on the specific relationships and circumstances which exist in the coaching and leading of sports teams.

These include, but are not limited to:

- *Working with Children Checks*. These were introduced in 2006 to help protect children and young people from physical and sexual harm by preventing those who pose a risk from working with them.
- *VicSport Child Safe help desk.* This is available to any sport and recreation organisation that needs support in any child safety issues.

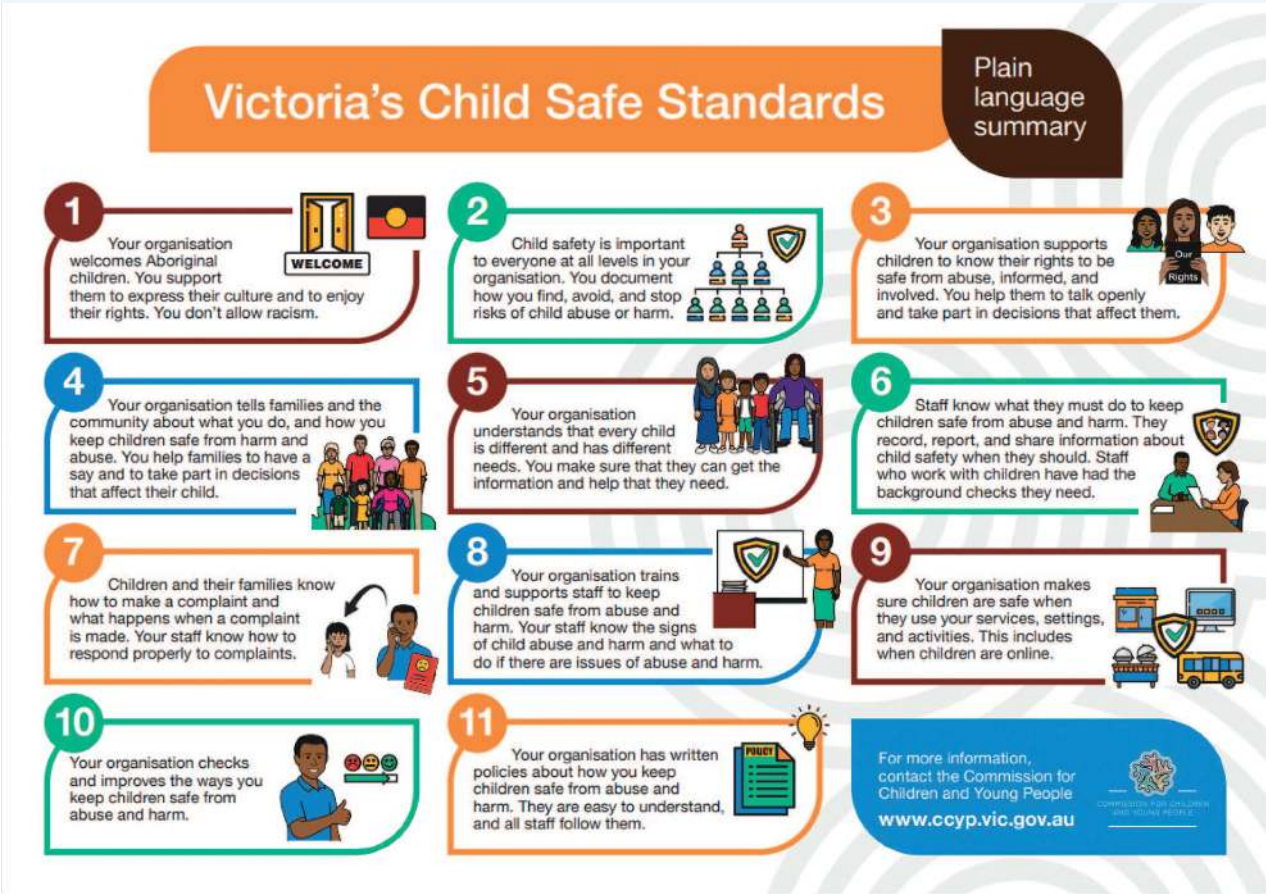
- *Victorian Child Safe Standards.* Introduced in 2016, these are 11 standards that all organisations working with children must comply with to ensure safe and appropriate management of staff and facilities to enable child safety and wellbeing.

CONCEPT CONNECTOR

Access the **7 Pillars of Inclusion** weblink in the Resources panel and download the document. Divide the class into the seven different pillars and think about how a coach can ensure that they uphold each of these pillars. You can also watch the video on your chosen pillar to help get you started.

Write your ideas down on a mini-whiteboard and share your thoughts with the class to identify key inclusive practices.

FIGURE 11.12 Victoria's Child Safe Standards



Disclaimer: This document is a summary of the Child Safe Standards. It does not include the full wording of the Standards or all the things that must be done to comply. For more information go to the Commission for Children and Young People website at www.ccyp.vic.gov.au.

Source: Victoria's Child Safe Standards. © State of Victoria (Commission for Children and Young People). Retrieved from https://ccyp.vic.gov.au/assets/resources/New-CSS/Victorias-Child-Safe-Standards-Plain-language-poster-10.02.2023.pdf.

There have also been well publicised examples from other countries where coaches from all levels of sport have failed in their duty of care to their athletes.

CASE STUDY

Toughen up snowflake! Sports coaches can be emotionally abusive — here's how to recognise it

Sports coaches have been in the headlines recently for all the wrong reasons. At the end of 2018, the University of Maryland investigated a football coach for intimidation, humiliation and verbal abuse. This followed a player dying of heat stroke after a training session on a 41°C day. Earlier that year, UK swimmer Karen Leach revealed the long-term impact of what she said was sexual, mental, physical and emotional abuse inflicted on her by a former Olympic coach when she was a young swimmer. And US Olympic swimmer Ariana Kukors filed a lawsuit against a former coach for sexual abuse.

FIGURE 11.13 Abuse from coaches has been reported in many sports. Abuse can come in many forms, including verbal, physical and emotional abuse.

Studies show nearly 50 per cent of athletes suffer from a mental health issue such as depression or anxiety.

Athlete abuse includes physical abuse, sexual abuse and emotional abuse. A study of 12 former child athletes in the United Kingdom showed most had been frequently threatened and humiliated — part of emotional abuse. These were former athletes across several sports including diving, football, gymnastics, hockey, netball, and track and field athletics. So, what does emotional abuse in sport coaching look like, and why does it happen?

Signs of emotional abuse

Many youth sportsmen and women will be familiar with one or more coaching behaviours that are considered emotionally abusive. Emotional abuse involves deliberate, prolonged, repeated non-contact behaviours that occur in unbalanced relationships of power such as between a coach and an athlete. Researchers suggest emotional abuse by coaches can include belittling, humiliating, shouting, scapegoating, rejecting, isolating, threatening and ignoring. These forms of abuse can be subtle and hidden in accepted coaching practice.

Coaching that uses such methods can contribute to psychological distress and cause emotional breakdown in athletes. In youth sport, participants who suffered emotional abuse reported a range of emotions including feeling stupid, humiliated and depressed.

Why some coaches may be abusive

Organised sport in Australia has been described as a focal point for community engagement, pride and achievement. Australia has well-developed coach-education programs to support such values in sport. These programs focus on skill development and fun.

But research has found coaches value the knowledge of admired or experienced coaches more than that of formal coach education. This may result in coaches recycling practices seen as accepted, but which may include abusive or harmful methods. Formal coach education also uses mentors to help develop beginning coaches. But use of mentors has been shown to shape practice so old ideas are valued and acceptance of more senior, and perhaps 'old-school' coach's ideas encouraged.

Coaches have been shown to use emotionally abusive behaviours when trying to develop mental toughness. Methods include extreme training environments and practices such as humiliation, intimidation and forced physical exertion. Talking about a program where female cyclists are trained for a competition in Europe, ex-professional cyclist Rochelle Gilmore said: 'They've got together to work out how they are going to mentally

and physically break these girls down and get them to their breaking point, and that's pretty much what the camp wants to do. It wants to see these athletes — see how they respond to things under pressure, under really, really severe fatigue.'

Why do athletes accept this?

Emotionally abusive coaching can sometimes be difficult for athletes and parents of athletes to recognise. Research shows parents can also become socialised into sporting cultures and become bystanders to abuse. The motivation to ignore abuse can be as simple as wanting their child to reach their full potential.

Some athletes show a willingness to forgo personal safety in the pursuit of results. Some are willing to subject themselves to anything that might assist in achieving success. Athletes can also misinterpret emotionally abusive practices as a sign their coach is interested in their improvement.

In one study of abuse in elite sport, a female gymnast said: 'My coach would scream at me, but I knew she cared about me. I knew that she wasn't screaming at me just to make me feel like I was nothing. There was an ulterior motive and that was to make me the best.'

Respect for the coach and an expectation this behaviour is normal can encourage the behaviour to continue. Research also shows media, including films, can contribute to the normalisation of abusive coach–athlete relationships. And elite athletes who misrecognise potentially abusive practices can steer public opinion when sharing of stories of extreme practices through social media. For instance, swimmer Michael Phelps once discussed in a Facebook post a training set he was proud of that brought him 'pain'.

What can be done?

Building toughness and resilience through exposure to challenging situations and training loads is an appropriate way to boost performance. But athletes need to be aware of the ethical boundary — the line between tough and abusive. Finding this line is the challenge of education. Most coaches believe they are acting in the best interest of the athletes under their guidance. But coaches must be better educated in the kinds of methods that, even with the best intentions, can result in abuse.

Sporting organisations, coaches, athletes and parents need to understand what constitutes abuse. Gender and power imbalances between coaches and athletes that are central to abuse also need to be highlighted in coach education. It should be remembered that coaching practice in elite contexts is not always transferable to junior sport. Parents and sports participants need to think critically about the practice of trusted coaches and make informed decisions about what we think is acceptable.

Source: Chris Zehntner, 'Toughen up snowflake! Sports coaches can be emotionally abusive — here's how to recognise it', *The Conversation*, 25 February 2019, www.theconversation.com.

11.3.5 Historical, current and future implications

The historical view of coaching, especially in the high-performance sphere, has generally been an 'at-all-costs' approach to winning. A coach could do whatever it took to get the best out of their athletes, no matter the physical, psychological or emotional consequences. This is a viewpoint that has also been popularised through films and TV programs, which have normalised the bullying and/or abusive methods coaches used to get results from their athletes. These abusive practices were then taught to younger coaches through mentoring, which continued these poor coaching practices.

Recent adaptations to coach education and training have included an increased focus on child safety and the need to support athletes' mental health and wellbeing. Historical abuse in sport is now being reported and investigated, and this has led to a more child/athlete-centered approach to coaching. This approach emphasises communication, shared decision-making and the development of trust between the athlete and coach.

It is likely that future changes will continue to focus both on the development of an athlete's wellbeing and their performance. This includes development of their mental skills (as discussed in topic 10). There will also likely be an integration of more technology and artificial intelligence (AI) in coaching. It is now easier than ever to record whole matches and training sessions and use this data to create individualised training programs for athletes and teams. With the development of inclusive practices, it is also likely that there will be a move towards encouraging those from diverse backgrounds to take up coaching roles within sport.

11.3 Activity

11.3 Quick quiz on | **11.3 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
1	2, 4, 7	3, 5, 6

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Describe** the importance of coaching in promoting access to and inclusion in sports and physical activity.
2. **Discuss** the significance of different coaching styles in influencing athletes' participation in physical activity. Provide examples of positive and negative impacts of coaching styles on participation.
3. **Analyse** the role of coach education and training in preventing misconduct and abuse in sports. How do policies and training programs contribute to creating a safe and supportive environment for athletes?
4. **Discuss** the impact of emotional abuse by coaches on athletes' mental health. What signs indicate emotionally abusive coaching, and how can it be prevented?
5. **Explain** the historical evolution of coaching practices, highlighting shifts towards prioritising athlete wellbeing and safety. How have historical views influenced contemporary coaching approaches?

APPLY your understanding

6. Read the article 'Toughen up snowflake! Sports coaches can be emotionally abusive — here's how to recognise it'. **Evaluate** why abusive coaching practices have been common in sport.
7. **Discuss** how Victoria's Child Safe Standards Framework can help to ensure fair access and inclusion to physical activity and sport.

11.3 Exam questions

Question 1 (1 mark)

Which is NOT a behaviour linked to abusive coaching practices?

A. Bullying and harassment
B. Excessive pressure
C. Inclusive training methods
D. Lack of professionalism

Question 2 (5 marks)

Identify the future trends and developments in coaching and explain their impact on the performance stage of sport and physical activity.

Question 3 (3 marks)

Outline the impact of abusive coaching practices on access to and inclusion in physical activity.

11.4 Sports technology and the media

Key knowledge	Key skills
• interpersonal issues that influence access to, and inclusion, participation and performance in, physical activity and sport, such as: – geographic location (rural and urban) – coaching (styles, planning/program design and ethical behaviour, such as safeguarding athletes) – sports technology and the impacts of media on beliefs and behaviour – institutional and structural inclusion and equity in sport (for Aboriginal and Torres Strait Islander Peoples, and in consideration of cultural diversity, physical and intellectual diversity, and gender and sexual diversity) – gender equity, such as pay gap, and representation in coaching positions and decision-making bodies at the local, national and global levels	• explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport
• key concepts within the selected contemporary issue linked to participation in physical activity and/or sport in society	• collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media
• local, national and/or global perspectives on the selected issue	• propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport
• historical, current and future implications of the selected issue	• prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue
	• analyse the historical, current and future implications of the selected issue

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

11.4.1 Sports technology and the media and their impact on physical activity

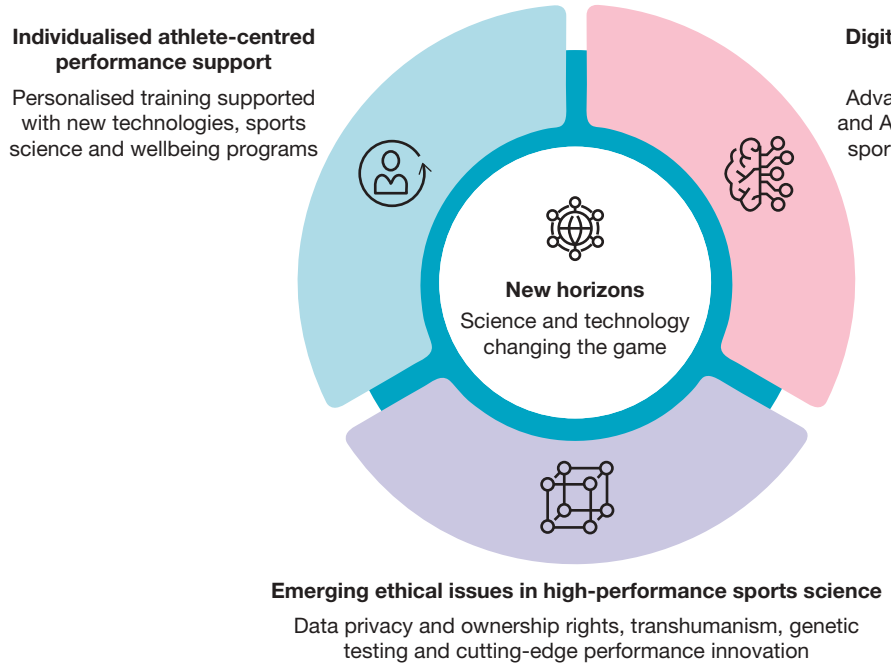
The impact of technology on the world of sport is growing every year. Many technologies that in the past were only available to the most privileged and highest-level sports people, such as heart-rate tracking and GPS units, are now available to everyone.

The Australian Sports Technology Network (ASTN) has estimated the Australian sports technology industry to be worth around $4.25 billion per year. This constitutes over 10 per cent of the total spend on the sports industry. Victoria is currently the leader in this market — the state is the base for around 40 per cent of all sports technology businesses in the country.

FIGURE 11.14 As technology has advanced in the past three decades, so has sedentary behaviour. Sports technology aims to use these innovations to boost participation and performance.

The Australian Sports Commission's Future of Australian Sport report has also highlighted the growth of sports as one of its key 'megatrends'. The Commission has highlighted three main areas for development in this sector, which are shown in figure 11.15.

FIGURE 11.15 Infographic from the ASC 'Future of Australian Sport' report highlighting the three areas of development that have been predicted for this sector



11.4.2 Access and inclusion

One of the biggest impacts of technology and the media on the sports industry in recent years has been to make sports and activities more accessible. The rise of online and app-based fitness programs has encouraged many who were intimidated by exercising in a large group to get active. These platforms offer individuals the flexibility and convenience to exercise at home. This is also a more affordable option, as there is often no need for an expensive club membership or specific equipment.

CONCEPT CONNECTOR

If you're appy and you know it

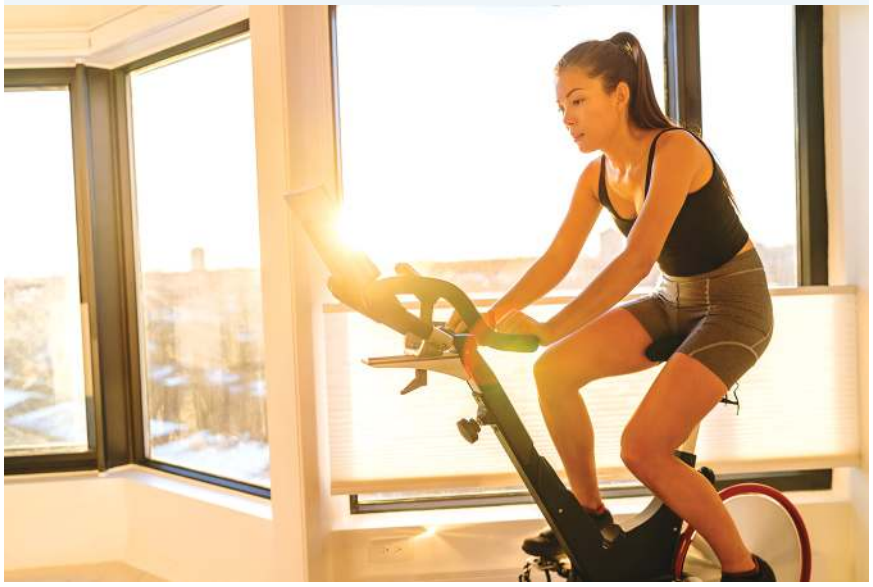
Search for fitness-related apps on a mobile phone app store or through an internet search engine. In a small group, discuss which you think are designed for beginner, intermediate or elite-level sports people.

Choose two apps and answer the following questions about each one.

1. Who is the app aimed at?
2. Is it free, or does it have a cost/membership? (If so how much?)
3. Is it aimed at someone who currently exercises or someone sedentary?
4. Does the app use any tools to keep people exercising regularly?
5. Identify the strengths and weaknesses of the app.

The streaming of exercise classes has also grown in the past decade, with platforms such as Peloton allowing participants to join classes from around the world and access a range of trainers that would otherwise not be available to them. The live aspect of these classes also allows for some of the social-connection benefits of exercise, because they often allow interaction between class members and instructors.

FIGURE 11.16 At-home training platforms reduce some of the barriers to participation for individuals.



on Resources

Weblink The Future of Australian Sport report

Technology has also encouraged the development of a greater range of inclusive exercise and activity sessions. Programs have been developed for individuals with specific requirements, such as low-impact/seated exercise for older people and adaptive equipment for people with disabilities.

Many sports technology providers have also used a gamified approach to fitness, where there is competition built in to the apps and programs. This has encouraged many people who may not have otherwise exercised regularly to participate by challenging family and friends.

Similarly, the growth in sports media coverage has meant that there has been greater coverage of the health benefits of exercise and the promotion of an active lifestyle. Social media has also highlighted fitness trends and community events, which can inspire more people to incorporate exercise into their daily routine.

FIGURE 11.17 The sport of Padel has increased in popularity in recent years due to effective use of social media.

With more media coverage than ever before, sports that may have received little coverage previously are now being noticed. An example of this is the rapid growth in popularity of the sport of Padel. Positive social media coverage and celebrity role models and endorsements have promoted the niche sport to a wider audience.

11.4.3 Participation and performance

Sports technology and the media have also had a significant impact on the levels of participation and performance in sport and physical activity. Many clubs and sports organisations are able to use technology to communicate with their members more easily; this can improve participation levels and commitment.

The growth in online resources has also made it much easier for people to access the information they need to participate regularly, such as class information, team training schedules and rules, regulations and training methods.

These online systems also make it easier for people to register for activities through payment portals, digital registration and scheduling. This takes away some of the logistical barriers to participation that may have existed previously.

One of the biggest developments in sports technology that has occurred in recent years is the growth in wearable technologies. These devices now monitor, record and analyse data to give real-time feedback about activity levels, recovery and sleep. This technology has become more user-friendly and allowed it to move from the elite performer sphere to the everyday. Most recently, analytics based on the data measured by these devices can provide an individual with their recovery/tiredness score. This information can help athletes avoid putting themselves at risk of injury through continued participation. Most wearables calculate scores based on a combination of activity, heart rate and sleep data.

Technological advancements such as live streaming have also allowed a greater range of activities to be completed at home and for more people to be able to participate in physical activity regularly. Not only do these technologies allow for active participation, but they also allow individuals to access support from professional coaches and instructors.

Media coverage, including the rise of social media, has also allowed for the development of role models and sports stars to act as inspiration for future participants and athletes. More sports events than ever are being shown live and on-demand, which means that audiences are able to watch more high-level sports performances than ever before. Content streaming platforms such as Netflix and Amazon Prime have also created a new form of interaction between sports and viewers with the creation of documentaries, which give new insights into the world of elite sports.

FIGURE 11.18 Advancements in materials used in helmets has reduced the number of head injuries in professional cycling.

CONCEPT CONNECTOR

Conduct some research into the wearable technologies that are available currently to individuals and sports teams.

Create a table that shows the costs, strengths and limitations of each technology.

Discuss as a class how effective each technology is in increasing (a) participation and/or (b) performance.

Sports technology has helped push the boundaries of elite athletic performance in recent years. Developments in running shoe technology and the use of carbon insoles has led to a number of long-distance records being broken. The most famous recent example was when Eliud Kipchoge ran a marathon in under two hours in 2019, setting an unofficial marathon record.

Advancements in clothing and materials technology have also meant that athletes can be safer while training and competing. For example, the technology used in cycle helmets is now reducing the number of head injuries and concussions among professional and amateur cyclists.

Technological advancements are also assisting elite athletes in their recovery and rehabilitation. Cryotherapy, compression technology and wearable recovery monitors allow accelerated muscle recovery, reduced inflammation in high-impact sports and the alleviation of muscle soreness. This, in turn, allows athletes to recover faster and maintain peak performance for longer periods of time.

FIGURE 11.19 Professional sports teams and athletes are now using cryotherapy treatment to promote recovery from training and injury.

CASE STUDY

Nike Vaporfly ban: Why World Athletics had to act against the high-tech shoes

Kenyan runner Eliud Kipchoge last year became the first person to run a marathon distance in under two hours. But instead of being a pure celebration of human performance, the achievement (though not technically an official world record) led to criticism of Kipchoge's shoes, an advanced design of the Nike Vaporfly. It represented an intensification of concern that the Vaporfly design was turning the humble trainer into an unfair form of performance enhancement.

Now Kipchoge's Vaporflys have been banned from competition in a recent move by running's governing body, World Athletics. Despite this, other versions of the shoes will still be legal. The new rules also set a maximum sole thickness and a limit to the number of internal carbon plates that are used to help manage the runner's energy. In addition, any new design of shoes has to be made available for anyone to buy four months before they can be used in competition.

FIGURE 11.20 Technological advancements in footwear have led to the breaking of many middle and long-distance running records in the past few years.

These amendments are arguably a balanced and pragmatic approach that addresses some of the problems that new technology can pose to competitive sport. In this case, all of running's world records will remain, but a firmer line has now been drawn before footwear design advances further.

But this outcome could still be criticised because Nike's competitors now only have until spring to respond to the Vaporfly's design, otherwise their shoes will not be legal for the upcoming Tokyo Olympic and Paralympic Games. Either way, it will likely still affect the sport at both a professional and amateur level.

We know that the kind of technology that the Vaporfly incorporates can give runners an advantage. A study published in 2017 demonstrated that such shoes were 4 per cent more efficient than several of their competitors.

But the influence of any new form of sports technology should still ensure that the sport remains fair and accessible to everyone. A review published in 2015 proposed that sports technology could be considered inappropriate if people can't access it, afford to purchase it or safely use it.

These kinds of issues have occurred before in several other sports. In 2009, the world of athletics debated whether Paralympian Oscar Pistorius could (and should) compete against able-bodied runners because it was argued that his prostheses were performance enhancing. (He eventually ran in the 2012 Olympic Games.)

Likewise, once full-body and specially textured swimsuits started rapidly rewriting swimming's world records, their adoption was challenged and eventually outlawed. In that case (like that of Kipchoge's Vaporflys), athletes

who couldn't get hold of the swimsuits were left at a competitive disadvantage if they had sponsorship or endorsement with brands that didn't produce the equipment.

There are other concerns too. Some athletes can also feel coerced into using new technology — whether it is optimal or not — for fear of being left behind. Likewise, a sport can be deskilled or somehow made easier by allowing new technology. This was why the unique string pattern on tennis rackets known as 'spaghetti stringing' was ultimately banned in the 1970s because it made it easier to control and create spin on the ball.

Impact on amateurs

All of these ethical concerns require consideration when competitive rules are constructed and work together with any scientific measurements to ensure the most robust regulations are created. Yet, while this debate usually centres on elite athletes, Nike's Vaporflys could also profoundly change what recreational runners will be able to achieve themselves.

While running shoes now have functional limits placed upon them for major competitions, the rules will be unlikely to apply to amateurs who run or race for mere enjoyment. It's not inconceivable that the gap between amateur and professional could narrow slightly if elites cannot use the same shoes as everyone else.

This situation could already hypothetically occur, in that a recreational jogger with a lower-limb amputation could use a highly effective bionic limb to run. Yet a Paralympian can't use much more than a composite spring when racing under current International Paralympic Committee rules.

Ultimately, the proposed gains of the Vaporfly shoes will not suddenly turn recreational donkeys into racehorses. But at an elite level it is possible for a top athlete to suddenly become uncompetitive if they don't keep up with the kind of innovation Nike has demonstrated. Irrespective of the World Athletics decision, running has moved from being a footrace to an arms race.

Source: Bryce Dyer, 'Nike Vaporfly ban: why World Athletics had to act against the high-tech shoes', *The Conversation*, 6 February 2020, www.theconversation.com.

11.4.4 Local, national and global perspectives

As discussed earlier, Victoria is home to a large proportion of Australia's sports technology development industry. This is due to the proximity to professional sports teams and world-class venues located within the state. The Victorian government also recognises the importance of the sports technology industry and ensures that the state maintains a calendar of major sports events. It also invests in the Australian Sports Innovation Centre of Excellence (ASICE) facility and accompanying programs.

CASE STUDY

Statement from the Premier of Victoria in 2019 discussing new support for Victorian sports tech companies

Victoria is the nation's dominant sporting state and the Andrews Labor Government is making sure that pre-eminence extends to the burgeoning sports tech sector. The Labor Government today announced new support to give Victorian sports technology companies a leg up, to help innovators and developers reach their full potential.

SportsTech has been identified as a key emerging sector, valued at US$27 billion globally in 2018 and expected to grow to US$93 billion by 2027. Australia is an important player on the world stage and, as home to more than 110 start-ups, Melbourne is the nation's sports tech capital.

FIGURE 11.21 The Victorian premier promised support for companies such as Catapult, which developed a wearable tracking device for elite athletes.

Victorian success stories include companies working in sport analytics, wearables, broadcasting tech, fan engagement, facilities technologies, eSports and event technologies. The government, via its start-up agency LaunchVic, is continuing to support this fast-growing sector and today confirmed funding of $350 000 for the Australian Sports Technologies Network (ASTN). ASTN will deliver four accelerator programs to scaling start-ups focused on human performance and sports technology.

A KPMG report commissioned by LaunchVic acknowledges that with an internationally renowned events calendar, elite sporting precincts and globally recognised strengths in health and wellbeing, Victoria was well placed to secure a substantial slice of the ever-expanding SportsTech pie.

Source: Premier of Victoria, 'SportsTech funding gives Victoria the winning edge', 23 August 2019, www.premier.vic.gov.au.

The Australian Institute of Sport (AIS) engineering team supports sports, athletes and coaches through the development of customised technology and equipment. This equipment, which is not for sale to the public, is personalised to suit individual athletes. There is also specific support for Paralympic athletes who need adapted equipment for training and competition. Below are some of the examples of technologies that have been designed by the AIS engineering team:

- wheelchair for tennis and basketball athlete Dylan Alcott
- knee-joint adapters for world champion sprinter and long jumper Vanessa Low
- seats for rowing, wheelchair tennis, rugby and wheelchair basketball
- aerobar extensions for triathletes
- 'grips' for shooting and archery.

FIGURE 11.22 The AIS engineering program creates custom equipment to give its athletes a competitive advantage.

Technology has helped to bring the world of sports to more people than ever before through the invention of streaming and communication platforms. Many sports have developed virtual-reality and simulation platforms that allow athletes to compete against people from all over the world in immersive, real-time scenarios and environments.

International sports organisations are also having to react to changes and developments in technology to ensure that sports remain fair and equal. There will always be those who look to use technology to gain an unfair advantage over their competitors. Sports rule-makers keep a close eye on all technology and try to ensure that it does not unbalance the playing field too much. Like the full-body swimsuit, many technological developments have had such a significant impact on their sport that governing bodies have changed rules to allow or disallow their use in competition.

on Resources

Weblink Controversial technology in sport

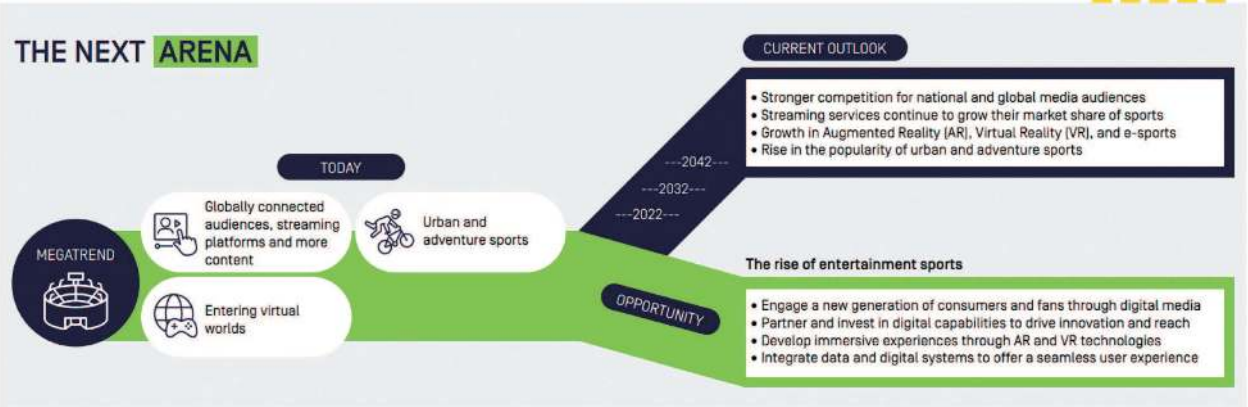
11.4.5 Historical, current and future implications

Since their very conception, all sports have had to move with the technological changes of the day, whether that be in the way they are played or the ways they are viewed by the public. Early technological developments in sport focused on clothing and equipment; for example, the development of the tennis racket over the past 50 years has included numerous material changes alongside adaptations to its size, shape and string technology to allow greater power, control and spin for modern players.

Now that physiological monitoring devices have become so commonly used, current trends in sports technology focus on how the data produced can be used to improve training and performance. This includes the use of AI technology and algorithms to interpret large quantities of data and turn it in to usable data and strategies for athletes and their coaches.

With the decreasing influence of traditional television viewing, there is a push for prominence among streaming and other content providers. This is leading to new forms of sports viewing experiences, which allow a more engaging experience for audiences. This includes behind-the-scenes coverage and in-depth player profiling to help audiences form relationships with athletes and teams.

FIGURE 11.23 Infographic from the AIS 'Future of Australian Sport' key findings document highlighting future trends in sports technology and viewing



Like many other industries, the sports technology sector is looking to develop its use of AI to improve the sporting experience for participants, coaches and viewers. Many sports teams and professionals are investigating the use of AI to analyse past performances in the hope of using machine learning to gain an advantage over their opponents. For example, Formula 1 teams are using AI-powered simulations to model potential race outcomes to determine which conditions they can create to maximise their chances of success in any particular race.

Another factor that will continue to be prominent is the advancement of fan engagement and experience. Sports venues are being equipped with high-tech amenities that will allow virtual reality and augmented reality for fans to bring them closer to the action and their favourite sports teams or athletes.

FIGURE 11.24 Virtual reality interactions with sport are likely to increase as the technology becomes more affordable.

11.4 Activity

11.4 Quick quiz on

11.4 Exercise

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
2, 5	1, 3, 6	4, 7

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Discuss** the impact of technology on the accessibility of sports and physical activities. Consider the impact of online fitness programs and app-based technology.
2. **Describe** the relationship between sports technology, media coverage and the development of niche sports such as Padel.
3. **Discuss** the impact of sports technology, such as the development of running-shoe technology, on accessibility to sport and elite athlete performance.
4. With reference to a specific sports technology, **explain** how it can increase access to physical activity.
5. **Identify** possible future trends in sports technology and media and explain their impact at the access and inclusion level of physical activity and sport.

APPLY your understanding

6. **Discuss** whether sports governing bodies should control technological developments to keep sports fair and equal.
7. With reference to a specific sporting example, **explain** the role that the media has had on participation.

11.4 Exam questions

Question 1 (1 mark)

Which of these is NOT a traditional form of media?

A. Television
B. Radio
C. Newspapers
D. Social media

Question 2 (4 marks)

Access the **The Future of Australian Sport report** weblink in the Resources panel. Read the document and then **identify** and **explain** any two trends/opportunities that could have a positive impact on participation in physical activity and sport in the future.

Question 3 (2 marks)

Describe two recent technologies that have helped to improve athlete recovery.

11.5 Institutional and structural inclusion and equity

Key knowledge	Key skills
• interpersonal issues that influence access to, and inclusion, participation and performance in, physical activity and sport, such as: – geographic location (rural and urban) – coaching (styles, planning/program design and ethical behaviour, such as safeguarding athletes) – sports technology and the impacts of media on beliefs and behaviour – institutional and structural inclusion and equity in sport (for Aboriginal and Torres Strait Islander Peoples, and in consideration of cultural diversity, physical and intellectual diversity, and gender and sexual diversity) – gender equity, such as pay gap, and representation in coaching positions and decision-making bodies at the local, national and global levels	• explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport
• key concepts within the selected contemporary issue linked to participation in physical activity and/or sport in society	• collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media
• local, national and/or global perspectives on the selected issue	• propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport
• historical, current and future implications of the selected issue	• prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue
	• analyse the historical, current and future implications of the selected issue

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

11.5.1 Institutional and structural inclusion and its impact on physical activity

In sports and physical activity, the historical impact of institutional and structural inequity is as stark as it is in any other aspect of Australian life. Although there have been many famous First Nations sportspeople, there are still far too many differences between the experiences of those from culturally diverse backgrounds in sport at all levels compared to those from other societal groups.

To ensure that barriers to participation are removed, it is vital that the views and opinions of all groups are taken into consideration. This is not possible if those groups are marginalised from the decision-making process and not given a fair voice in sporting and governmental institutions. This subtopic will examine how improving equity in this area can promote access to physical activity. We will also examine how it has changed over time in Australia and the rest of the world.

FIGURE 11.25 Every individual regardless of their background needs to have equal access to sport and be given a voice.

FIGURE 11.26 First Nation Peoples' involvement in Australian sporting life

An estimated **2.9%** [13,000] of First Nations individuals aged 18+ participated as sport and recreation administrators or committee members annually. [8]

Approximately **1.9%** [9,000] First Nations individuals aged 18+ participated as team managers or coordinators annually. [8]

An estimated **8.6%** [41,000] of First Nations individuals aged 18+ were sport and recreation coaches, instructors, trainers, or teachers, annually. [8]

Approximately **4.7%** [22,000] of First Nations individuals aged 18+ were officials annually. [8]

First Nations men are more likely to coach [**10.8%**] than First Nations women [**6.7%**]. Women are slightly more likely to be team managers or coordinators and participate at around equal rates as officials and administrators/committee members. [8]

60 Olympic and **16** Paralympic First Nations athletes have represented Australia at the Olympic and Paralympic Games since the 1960's. [9, 10]

on Resources

Weblink AFL Indigenous Player Map 2023

Inequity in the AFL exists for many First Nations people. This is despite the fact that their representation at the top levels of the game outweighs their representation within the general Australian population. For example, in the 2020 AFL season, First Nations people made up 11 per cent of the player cohort in the league, whereas the most recent census suggests that First Nations Peoples make up less than 3 per cent of the total Australian population.

inequity lack of fairness or justice in the distribution of resources, opportunities and treatment among people. It occurs when groups are disadvantaged compared to others due to factors including race, gender and sexuality.

11.5.2 Access and inclusion

There are a number of actions that sporting organisations and policy-makers can take to address the inequities that people from diverse cultural, physical, intellectual and sexual backgrounds face. These include the following:

- *Outreach and diverse recruitment.* Institutions need to work with diverse community groups to see how they can support and encourage participation. Organisations also need to actively target under-represented groups when recruiting to ensure that there is a balance of opinions and backgrounds when key decisions are made.
- *Diversity-based programming*. Institutions can develop culturally reflective programs which highlight the values and interests of diverse groups.
- *Resource allocations.* The allocation of resources needs to encourage the creation of facilities, equipment and programs that are specifically aimed at under-represented and marginalised groups.

FIGURE 11.27 Adam Goodes has been one of the AFL's finest players and an advocate for First Nations Peoples by speaking out against the racism he faced during his career.

- *Policies and practices*. Institutions can adopt inclusive policies and practices that promote diversity, inclusion and accessibility. This includes implementing non-discriminatory admission policies, providing reasonable accommodations for individuals with disabilities and offering flexible programming options to accommodate diverse needs and preferences.
- *Education and awareness*. Institutions can run educational workshops and seminars, and create other materials that break down barriers and dispel myths and misconceptions about sports participation for individuals from diverse backgrounds.
- *Collaborative partnerships*. Institutions can foster partnerships and collaboration with community organisations, government agencies and other stakeholders to leverage resources, expertise and networks in support of equitable access to physical activity and sport.

FIGURE 11.28 Sports organisations and institutions must ensure they have policies that promote equitable access as well as anti-discriminatory practices within their governance. In 2017 Netball Northern Territory formed the first representative netball team, the Dragonflies, for females with an intellectual disability.

11.5.3 Participation and performance

To ensure people from diverse groups participate regularly in physical activity and sport, clubs and organisations must give fair representation to these groups in their management structures. This will ensure that the opinions and views of diverse members are taken into account when opportunities for participation are designed and offered to the community.

Many sports governing bodies and community sports organisations have programs and policies to promote **equity** among their users. These include the following:

Organisation	Description
AFL Northern Territory: Remote Projects	Designed to inspire, educate, empower and unite communities through AFL. The goal of each project is to build the capacity of community members to drive the direction and oversee local football initiatives.
PrideCup	An organisation designed to challenge homophobia and transphobia within sporting clubs, making them more welcoming for LGBTIQ+ fans, players and officials. It offers education sessions that aim to empower sports leaders to become beacons for inclusivity and diversity within their communities.
Northern Territory Netball — Dragonflies Netball Team	The first representative netball team for females with intellectual disabilities. The team gives participants the chance to learn netball in a safe and inclusive environment and provides education in a range of life skills, including social skills, teamwork, positive behaviour and leadership.
Victorian Sport Rainbow Roadmap	A roadmap to assist sports organisations in achieving the PROUD 2 Play Rainbow Ready status. The aim is for all Victorian sports associations to provide safe, inclusive and affirming opportunities for LGBTIQ+ people to enjoy sport and active recreation.

11.5.4 Local, national and global perspectives

In a state with over 100 separate sporting organisations and 16 000 sports and recreation clubs, inclusion and equity must be included within the leadership structure of these groups. Sport and Recreation Victoria has developed a number of policies and programs that highlight the steps that can be taken at a leadership level in order to promote diversity among all groups of people. These include the following:

- *Universal design*. This ensures that all new sports facilities and venues are designed to be accessible for all people, regardless of their gender, sexual orientation, age, ability or cultural background.
- *Access for all abilities*. The program supports inclusive sport and recreation opportunities for people with disabilities.
- *Aboriginal Sport & Recreation Program*. This program aims to create a sport and recreation sector that is accessible and inclusive to all First Nations people in Victoria by increasing awareness of how the sector can be more inclusive and creating links between organisations and First Nations communities.
- *Equity and Inclusion Community Consultation Group*. This group aims to increase the participation opportunities of key priority groups (First Nations Peoples, CALD, LGBTIQ+, older people, women and girls). They have created a working group to devise ways to improve participation as part of the wider Active Victoria 2022–2026 framework.
- *Victorian Aboriginal Sporting Partnership*. This is a working group designed to ensure that Aboriginal voices and experiences are heard and respected, empowering the community to create change that will positively impact Aboriginal Victorians.

equity a process or adjustment that considers an individual or group's unique needs to generate equal outcomes and provide fair access to opportunities

on Resources

Weblink Inclusion and Diversity — Vic Sport

National sports organisations have also implemented processes to prioritise institutional and structural inclusion and equity. The Australian Sports Commission includes a number of diversity, equity and inclusive initiatives in its own structure. This ensures that the organisation has diversity at its core, which means it is at the forefront of any decisions that are made.

FIGURE 11.29 Infographic from the Australian Sports Commission highlighting its diversity, equity and inclusion initiatives

The Australian Sports Commission also works with initiatives such as the Pride In Sport Index, which is the 'first and only benchmarking instrument designed specifically to assess the inclusion of LGBTIQ+ people in Australian sport and sporting organisations'. This program provides data on the inclusiveness of organisations and determines what makes good inclusion practice.

There are also global initiatives and organisations that aim to create a level playing field for people from diverse communities. The International Olympic Committee has been committed to making the Olympics an open and inclusive event for decades. However, it was not until Paris 2024 that, for the first time, there was a 50/50 split between male and female athletes across the Olympic and Paralympic Games.

Charitable organisations such as Right to Play also aim to use sport to promote inclusion and equity development around the globe. Right to Play's goals were founded on the Millennium Development Goals and aim to use sport to contribute to a more effective global society.

FIGURE 11.30 Infographic from the Pride in Sport highlighting the issues facing LGBTIQ+ people in sport

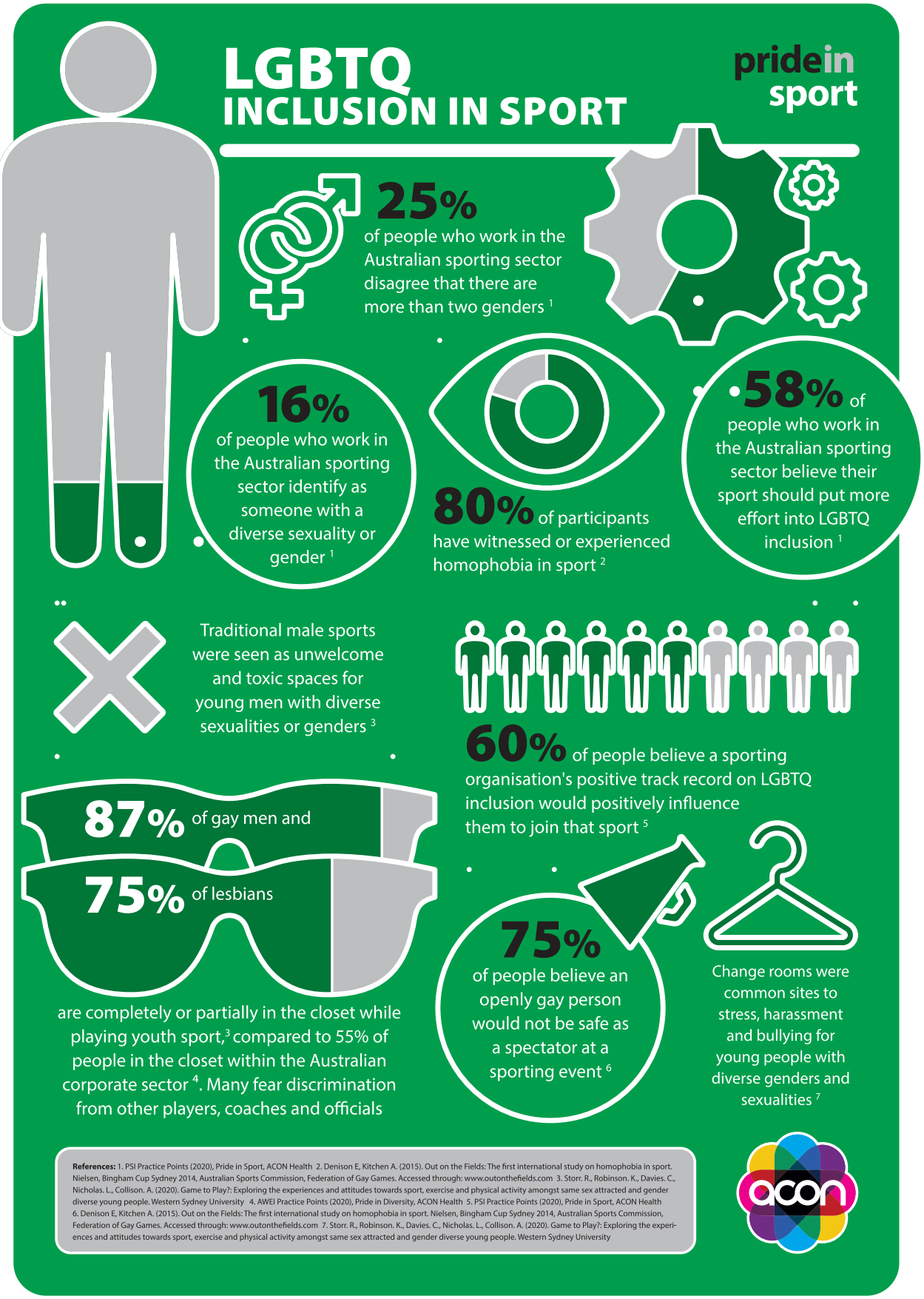
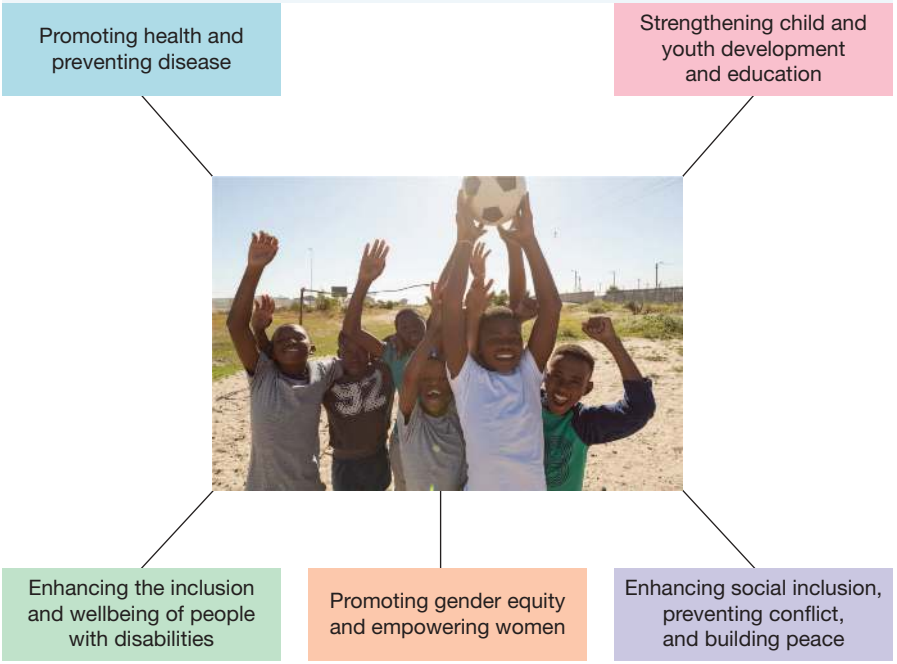


FIGURE 11.31 Organisations such as Right to Play aim to provide equity and inclusion through sport for those who take part.



11.5.5 Historical, current and future implications

Over the past 50 years there have been considerable advancements made in equity and inclusion in structures and institutions within sport and active recreation. However, challenges persist, and there is still a long way to go before sports are truly equitable and inclusive of all individuals.

In Australia the process of **reconciliation** has been one of the major changes that has taken place across all aspects of society. The development of Reconciliation Action Plans (RAP) by organisations has gone some way to addressing the historical injustices against First Nations Peoples. As well as equality and equity, institutional integrity is another of the key pillars on which most action plans are created. The aim is to ensure that the needs and views of First Nations Peoples are taken into account at all decision-making levels in sport and to ensure that they are given equal opportunities to participate in sport and active recreation.

The development of inclusion and equity policies is creating more opportunities for people from diverse communities, but there is still much to be done to combat the racism, homophobia and misogyny suffered by many in sporting organisations. Movements and protests such as Colin Kaepernick's decision not to kneel for the US national anthem have given a forum for those suffering injustice to speak out and have revealed many allegations of historical mistreatment.

reconciliation the process of strengthening relationships between First Nations Peoples and non-Indigenous peoples, for the benefit of all Australians

CASE STUDY

'Felt alienated by the men's game': how the culture of women's sport has driven record Matildas viewership

Wednesday night saw the end of the Matildas' nation-gripping FIFA Women's World Cup pursuit, losing 3-1 to England in the semi-final in Sydney. While it was an emotional finish to Australia's exciting run, the match only

further highlighted the record-breaking audiences experiencing the fan culture of women's football. This fandom has a notably different flavour from traditional men's sports fan culture, and could be the defining legacy of the tournament.

A space for all

Women's football, and most women's sports, allow space for different fan cultures to come together in a safer and more inclusive environment. These cultures have been developed over time by those who have felt excluded by traditional sporting environments that can promote toxic elements of masculinity and require fans to behave in particular ways.

FIGURE 11.32 The crowds that have flocked to the Matildas' games have been described as safer, welcoming and more inclusive.

Fans in many male sporting cultures are expected to have a prior knowledge, understand rules and intricacies of the game, wear particular merchandise and use specific language to show support. If fans don't comply with these set behaviours, they can feel like they don't belong.

Research has shown this is a particularly complicated experience for women. To fit in and feel part of men's sporting fan culture, they have to modify parts of their gender identity. Women's sports create an environment where fans can come as they are, not as who they think they should be. This welcomes everyone to the game, especially people who might have previously looked at sport and thought it wasn't for them.

A history of exclusion

It is no accident these spaces are welcoming, and speaks to the history of active exclusion women have faced in football. Women's international football took off in Australia in the mid-to-late 1970s, with the first recognised game between Australian and New Zealand. Coverage was scarce, and even when it was present, it was often sexist and demeaning. The timing of this growth of the game is no coincidence, aligning with the FA's (English Football Association) lifting of the 50-year ban on women's football in England. The FA didn't have the power to ban women from playing entirely, so in 1921 it ruled that women's games couldn't be played on FA-affiliated grounds. This hindered the development of football not only in the UK, but around the world, as other nations echoed similar positions.

That there was an international team representing Australia in 1979 is credit to the women, and supportive men, who built spaces for women and girls to play. In creating new clubs, teams and competitions, they created environments demonstrating values that were the opposite of those that had previously excluded them.

Fans returning to the sports they love

These welcoming cultures aren't exclusive to football. Many women's sporting clubs in Australia have played key roles in contributing to the growing audiences that elite codes are experiencing today. Women's sporting codes aren't just attracting new fans but are also re-engaging fans formerly lost to sport. Research I conducted into the developing fan culture of the AFLW found many fans came to women's Australian rules football because they were interested in the code but felt alienated by the culture of the men's game.

Fans shared that AFLW offered a more inclusive culture, and they didn't have to navigate how to support athletes accused of domestic violence or sexual assault and fear racist or homophobic language. Fans also felt they could do things such as change teams and support multiple teams. People were fans of the competition more broadly and also wanted to generally support women playing the sport they love.

These findings aren't just bound to Australia. There were distinctly different fan experiences at the men's and women's European Football Championships held in 2021 and 2022. Both finals were played in England and featured the hosts. The men's final was marred by fan violence, altercations with police and racism, while the women's competition presented a safe, friendly and inclusive environment.

Fans of women's sport around the world are rejecting traditional masculine norms of sports fandom, and developing a counter fan culture.

Inclusive supporter groups

Trailblazing volunteers, administrators, coaches and athletes built these spaces for women and non-binary folk to play. But there are also passionate fans on the ground continuing to drive the fan culture. One group bringing the noise this Women's World Cup is Matildas Active Support, which states 'inclusivity is at our core'. The group coordinates meet-ups pre- and post-match, leads chants at the games and brings fans together on social media. The group welcomes everyone to their events, whether that be singing at the top of their lungs or quietly taking it all in. Diverse fan support like this adds to the family-friendly atmosphere at women's football, where families with children feel more comfortable to attend, and women in particular feel safe to attend matches alone.

Fans the legacy of this world cup

It's important women athletes are visible in the media to show the next generation what is possible, and the Matildas are definitely achieving this. But the visibility of fandom and the culture that surrounds women's football is just as crucial to drive women's sport forward.

This Women's World Cup is an opportunity for stakeholders to learn more about the different ways fandom is experienced, and how to connect with diverse fans to continue to grow the audience beyond the tournament and in other women's sports. What's been clear over the last month is that record numbers of women's football fans have rejected traditional masculine forms of sporting fandom for more inclusive, safe and friendly expressions. These fans have been seen. They now must be heard to continue to build on this momentum for women's sport.

Source: Kasey Symons and Paul Bowell, 'Felt alienated by the men's game': how the culture of women's sport has driven record Matildas viewership', *The Conversation*, 17 August 2023, www.theconversation.com.

In future there will likely be continued development of inclusion and equity policies in sport as more individuals from diverse groups are given opportunities and decision-making roles. The aim of these policies will be to close the gap in both access and participation for people in diverse communities as well as remove some of the barriers and historical stigma around their involvement in sport (see table 11.1).

TABLE 11.1 Information from the Australian Sports Commission's 'PlayWell Strategy' which highlights its ongoing plans for equity across Australian sport

Term	Definition
Priority area overview	Prioritising equity and choice to ensure all Australians can access sport
Ambition statement	Our ambition is to create sporting communities where everyone feels welcomed and embraced. To achieve this, we will create a sporting culture that is inclusive, accessible, adaptable, safe and fun for all, and an environment where the individual has choice and control over how they engage in sport.
Narrative	We will ensure everyone who wishes to has equitable access to sport. This provides invaluable benefits to the health and wellbeing of individuals and communities. By prioritising involvement for those with the most barriers, we ultimately benefit everyone.
Priority area objectives	• Prioritise access for those with the most barriers to sport. • Improve retention of people in sport through flexible offerings and safe environments that embrace diversity and inclusion. • Strengthen partnerships with diversity, equity and inclusion (DE&I) experts, not-for-profits, community groups and those who experience the most barriers to sport participation, to guide the sector's work in providing equitable access. • Provide immersive experiences, resources and education on equity, inclusion and cultural safety, to provide greater access to sport.

11.5 Activity

11.5 Quick quiz on | **11.5 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
2, 6	3, 7	1, 4, 5

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Evaluate** the impact of historical institutional and structural inequities on access to physical activity and sport for First Nations Peoples in Australia. Use statistical evidence to support your argument.
2. **Outline** the strategies for promoting equity and inclusion in sport. How effective are these strategies in addressing under-representation and inclusion in sport?
3. **Discuss** the role of policies and practices in promoting diversity, inclusion and accessibility in sporting institutions. Provide examples of inclusive policies and their impact on diverse participation.
4. **Evaluate** the significance of representation from diverse groups within the management structures of sporting clubs and organisations. How does fair representation contribute to the design and offering of participation opportunities?
5. **Analyse** the initiatives of NRL's League Stars Inspire Inclusion & Diversity Program and Pride Cup in promoting diversity and inclusion in sporting communities. How do these programs address the challenges faced by under-represented groups?

APPLY your understanding

6. Consider the statistics in figure 11.30. **Outline** how sports teams and organisations can address accessibility and inclusion for those within the LGBTIQ+ community.
7. **Discuss** the future implications of inclusion and equity policies in sport, focusing on the ongoing efforts to close the gap in access and participation for diverse communities.

11.5 Exam questions

Question 1 (2 marks)

Identify two diverse groups for which sports organisations need to improve access and inclusion.

Question 2 (1 mark)

Identify which programs are in place to increase participation within First Nations communities.

Question 3 (3 marks)

Evaluate how attitudes in sport have changed over time towards people from diverse backgrounds and how this has affected their access to physical activity and sport.

11.6 Gender equity

Key knowledge	Key skills
• interpersonal issues that influence access to, and inclusion, participation and performance in, physical activity and sport, such as: – geographic location (rural and urban) – coaching (styles, planning/program design and ethical behaviour, such as safeguarding athletes) – sports technology and the impacts of media on beliefs and behaviour – institutional and structural inclusion and equity in sport (for Aboriginal and Torres Strait Islander Peoples, and in consideration of cultural diversity, physical and intellectual diversity, and gender and sexual diversity) – gender equity, such as pay gap, and representation in coaching positions and decision-making bodies at the local, national and global levels	• explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport
• key concepts within the selected contemporary issue linked to participation in physical activity and/or sport in society	• collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media
• local, national and/or global perspectives on the selected issue	• propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport
• historical, current and future implications of the selected issue	• prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue
	• analyse the historical, current and future implications of the selected issue

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

11.6.1 Gender equity and its impact on physical activity

Gender inequity in sport directly affects levels of physical activity, with women and girls often experiencing fewer opportunities and resources for participation compared with their male counterparts. Societal norms and stereotypes may also discourage girls from engaging in sports, leading to lower levels of physical activity and fitness.

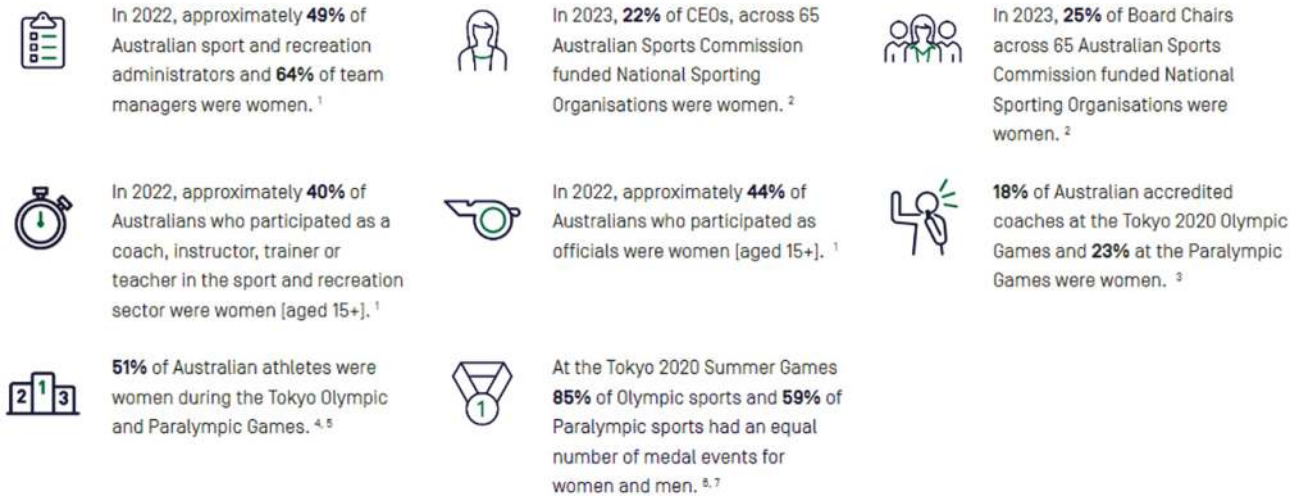
gender the state of being male or female (typically used with reference to social and cultural differences rather than biological ones)

Additionally, unequal access to sports facilities, coaching and funding can further limit women's participation in organised sports and recreational activities. Addressing gender inequities in sport is essential to promoting physical activity among women and girls, fostering healthier lifestyles and empowering them to reach their full athletic potential.

Moreover, gender disparities in sports often result in limited visibility and recognition for female athletes, which can contribute to lower levels of motivation and self-esteem among girls. By promoting gender equity in sport and ensuring equal opportunities for participation and recognition, we can create a more inclusive and supportive environment that encourages women and girls to lead active, healthy lives.

FIGURE 11.33 Despite significant progress in recent years, women and girls continue to face barriers that limit their access to sports programs, resources, and leadership roles.

FIGURE 11.34 Infographic from Clearinghouse for Sport, which highlights how women are not moving into professional and high-performance roles.



11.6.2 Access and inclusion

Gender inequity significantly affects access to and inclusion in sport by creating barriers that limit the participation, representation and opportunities for women and girls. Discriminatory practices, stereotypes and cultural norms often result in unequal access to sports facilities, funding, coaching and leadership positions, particularly at the elite level. These disparities can contribute to lower levels of participation, self-confidence and skill development among women and girls, perpetuating a cycle of exclusion and under-representation in sports. Addressing gender inequity is essential to creating a more inclusive and accessible sporting environment, where individuals of all genders have equal opportunities to participate, lead and succeed.

FIGURE 11.35 The This Girl Can campaign by VicHealth is a program designed to inspire girls and women to take part in sport and physical recreation activities.

There are a number of approaches that can be taken to increase access to sport for women and girls. These include:

- *funding allocation*. Allocate resources, such as funding, facilities, equipment, and coaching, in a manner that ensures equitable access for all individuals, regardless of gender. Implement transparent and fair allocation processes that prioritise the needs of underserved or marginalised groups, including women and girls.
- *inclusive programming*. Develop inclusive sports programs and initiatives that cater to the interests, preferences and needs of diverse participants, including women and girls. Offer a variety of sports options, recreational activities and skill-development programs that are accessible, welcoming and relevant to all individuals.
- *gender-sensitive policies*. Implement gender-sensitive policies that address the unique challenges and barriers faced by women and girls in sports. Enact anti-discrimination policies, gender-equity guidelines and harassment prevention measures to create a safe, supportive and inclusive environment for all participants.
- *targeted outreach and community engagement*. Conduct targeted outreach and engagement efforts to attract and retain female participants in sports programs. Partner with schools, community organisations and women's groups to promote awareness, provide resources and facilitate access to sports opportunities for girls and women.

on Resources

Weblink This Girl Can

11.6.3 Participation and performance

To maximise female participation in sports, organisations must prioritise inclusivity, accessibility and empowerment. This involves offering diverse and female-friendly programs tailored to women and girls' interests and needs, and creating welcoming environments free from discrimination or bias. Providing strong role models, mentors and leadership opportunities can inspire and encourage girls and women to pursue their sporting aspirations.

By addressing barriers such as cost, transportation and cultural norms, sports organisations can ensure that females from all backgrounds have equal opportunities to participate. Collaborating with schools, communities and stakeholders to promote female participation can further foster a culture of inclusion and support, ultimately maximising female involvement and success in sports.

There are also a number of practices that organisations can implement to increase female participation in sport and active recreation. These include:

- *developing female-friendly programs*. Offer a variety of sports options, recreational activities and skill development programs that appeal to girls and women of all ages, abilities and backgrounds.
- *providing role models and mentors*. Showcase female athletes, coaches, officials and leaders as role models and mentors to inspire and empower girls and women to get involved in sport. Highlight the achievements and success stories of female participants to demonstrate the opportunities for growth, development and success within the sporting community.
- *creating inclusive and welcoming environments*. Foster inclusive and welcoming environments in sports organisations, clubs and facilities that promote diversity, respect and belonging.
- *ensuring there are female-only programs and spaces*. Provide female-only sports programs, training sessions and facilities to create safe and supportive spaces for girls and women to participate in sports and physical activity. Female-only programs can help address barriers such as cultural norms, body image concerns and peer pressure, allowing participants to feel more comfortable and confident in their sporting pursuits.

- *offering accessible and affordable options*. Make sports participation more accessible and affordable for females by reducing barriers such as cost, transportation and scheduling conflicts. Offer scholarships, subsidies and financial assistance programs to support girls and women from low-income families or disadvantaged backgrounds to participate in sports.
- *encouraging family and community support*. Engage families, caregivers and communities in supporting female participation in sport by providing resources, education and encouragement. Encourage parents to enrol their daughters in sports programs, volunteer as coaches or mentors, and advocate for inclusive and equitable opportunities for all children within the community.
- *creating skill development, coaching and leadership opportunities.* Provide skill-development and leadership opportunities for female participants to build confidence, resilience and self-esteem through sports. Offer coaching clinics, officiating courses and leadership training programs specifically targeted at girls and women to develop their skills, knowledge, and leadership potential within the sporting community.
- *fostering school and community collaboration.* Partner with schools, community organisations and other stakeholders to promote sports participation and physical activity among females. Collaborate on initiatives such as after-school programs, community sports leagues and outreach events to communicate with girls and women where they are and provide opportunities for them to get involved in sports.

FIGURE 11.36 Although they often have equal access to facilities, women's teams are often given the less favourable pitches, timeslots and officials for their events.

There are also several initiatives in place to increase women's participation in the fields of coaching, officiating and sports leadership. Although figures for participation are fairly balanced, there are still huge discrepancies between men and women in leadership roles in sport. Many institutions have begun to use quotas to increase gender balance at the leadership level. These targets have usually been included as a recommendation, but some organisations have made them mandatory, with sanctions in place for organisations that don't meet the specific criteria.

Programs and institutions involved in the development of opportunities for women in coaching and leadership roles include:

- *Women Leaders in Sport Program (WLIS)*. This is an Australian government initiative that aims to provide development opportunities allowing more women to reach their full leadership potential in the sports industry.
- *AIS Athlete Accelerate Program*. This is an AIS program aimed at retired female athletes that gives them support in their careers post-competition. It provides them with the skills and knowledge needed to navigate a career in sports leadership.

- *Change the Ratio (Australian Sports Technology Network and Women in Sports Tech)*. This program provides education mentorship for women within the sports technology industry.
- *Our Future Females Leaders Program (Bowls Australia)*. This program is tailored for women and helps them join the management, administration, advisory and coaching roles in Bowls Australia.
- *Women's Mentoring Program (Surf Life Australia)*. This is a mentoring program designed to strengthen leadership skills and develop the next generation of female leaders.

FIGURE 11.37 Bowls Australia is one of the many sports governing that have created a program to promote women to leadership positions.

11.6.4 Local, national and global perspectives

As a sporting hub, the state of Victoria has led the way with initiatives that develop the involvement of women at all levels of the sporting continuum. In 2019 Victoria became the first state in Australia to mandate that all state-funded sport and active recreation organisations have at least 40 per cent women on their leadership board.

There are a number of state-wide programs in place to support female involvement in sport and active recreation, which are listed below.

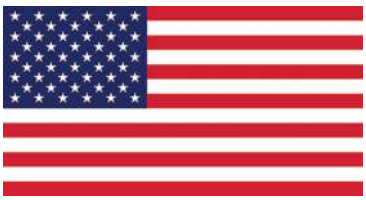
- Change Our Game is an initiative launched by the Victorian government to promote gender equity and diversity in sport and recreation. The campaign aims to increase female participation, leadership and visibility in all aspects of sport, from grassroots to elite levels. Change Our Game provides funding, resources and support for programs and initiatives that empower women and girls to participate, lead and succeed in sports.
- Girls Make Your Move is a national campaign initiated by the Australian government to encourage girls and young women to find their passion for physical activity and sport. The campaign aims to inspire girls to get active in ways that suit their interests and preferences, whether it's dancing, swimming, cycling or playing team sports. Girls Make Your Move provides resources, tips and inspiration to help girls overcome barriers and discover the joy of being active.
- This Girl Can Victoria is part of a global campaign which celebrates and encourages women of all ages, shapes and abilities to get active and participate in sports and physical activity. The campaign features real women and their stories of overcoming barriers to exercise, inspiring others to embrace an active lifestyle.
- VicHealth Active Women and Girls for Health and Wellbeing Program is run by the Victorian Health Promotion Foundation. It runs various programs and initiatives to promote physical activity and wellbeing among women and girls in Victoria. The Active Women and Girls for Health and Wellbeing Program supports community-based initiatives, partnerships and projects that increase opportunities for women and girls to be active, healthy and connected through sport and recreation.

Many of Australia's national sports governing bodies have also created programs that cater to girls and women. The programs cover a range of objectives, including increasing participation, developing coaches and officials, and encouraging more women into leadership positions. Some of these include:

- *The Next Innings (Cricket Australia)*. A program aimed at specifically increasing female participation and supporting clubs who are nurturing the current and future generations of players, coaches, officials and administrators.
- *She Hoops (Basketball Australia)*. An initiative designed to empower women in basketball through visible and attainable pathways, mentoring, connections, insights, participation and education.
- *MyGolf Girls (Golf Australia)*. A program that promotes participation in golf, focused on fun, game-based activities, having a go and making new friends.

- *Learn 2 Lead (Tennis Australia)*. A program designed to build leadership, life skills and confidence in young women through tennis. Learn 2 Lead, developed in conjunction with Plan International Australia and supported by the Australian Sports Commission, is being rolled out nationally and aims to engage young women and gender-diverse people aged between 14 and 18 years in tennis while building their life and leadership skills.
- *She Rides (AusCycling)*. A program encouraging females to start cycling. Participants can choose between programs, with all formats involving face-to-face sessions with an AusCycling accredited coach in a small group environment or one-on-one. Programs generally run for 4–6 weeks, but a number of our coaches are flexible with the structure of their sessions.
- *Women of Winter (Snow Australia)*. A program that supports women to learn through professional development, training and networking opportunities, leading to an increase in the numbers of women working and volunteering in the snowsports industry. This includes encouraging and supporting women to gain employment in the industry and advance their positions in leadership roles.
- *Women's Coach Acceleration Program (AFL)*. A program designed to fast-track the development of women in coaching and assist in their progression to senior coaching roles across both AFL and AFLW programs. All AFL clubs can apply to be awarded one of six available positions as part of the Women's Coach Acceleration Program that sees successful applicants employed by an AFL Club for a minimum t2-year period and provided an opportunity to undertake a coaching role within an AFL or AFLW program.

Globally there are also a number of national and international sports organisations that have female sports development as a key performance target. Some of these include the following:

United Kingdom 	**Women in Sport**: Charity aimed at ensuring that no women are excluded from the joy, fulfilment and lifelong befits of sport and to help create a lasting positive change for women and girls in sport and society. **Female Coaches Program**: Designed to allow female coaches to learn from and be mentored by elite level female coaches. It is designed to address the under-representation of female coaches at all levels of the talent pathway in the UK.
United States 	**Champion Women**: The organisation's mission is to provide advocacy for girls and women in sports through targeted efforts toward equality, accountability and transparency among institutions providing (or not providing) sporting opportunities for girls and women. **Women's Sports Foundation**: Founded by tennis professional Billie Jean King, the WSF is dedicated to advancing the lives of girls and women through sports and physical activity. The WSF works to educate, advocate and organise programs across the United States; it also provides scholarships and supports research.
Canada 	**Fast and Female**: A charity founded with the aim of supporting initiatives that keep girls active and involved in sports and physical activity into their teens. **Canadian Women and Spor**t: An organisation dedicated to creating an equitable and inclusive Canadian sport and physical activity system that empowers girls and women as active participants and leaders through sport. **#MomsGotGame**: A bilingual initiative encouraging, celebrating and supporting moms of school-aged kids to play sport and be active. This is done through partner engagement and digital, radio and television advertisements.

11.6.5 Historical, current and future implications

There has been some progress in improving equity between women and men in certain aspects of the sporting environment in recent years. However, there are other areas, such as officiating and leadership, where work is needed before a level playing field can be achieved.

Over the past 50 years some of the major changes that have aided involvement and attitudes towards women in sport include:

- *greater media coverage.* More visibility in the traditional media as well as newer social media outlets has helped to amplify the voices and achievements of female athletes and teams.
- *increased opportunities for participation.* The establishment of a greater number of women's teams, leagues and competitions has given women more chances to get involved. Also, the development of the health and fitness industry has resulted in an increase in activities tailored and targeted to girls and women.
- *policy change and legislation.* Anti-discrimination laws and gender-equity policies have helped to address some of the barriers to participation in sport and physical activity.
- *elite level success.* The success of high-level Australian athletes on the national and international stage has helped raise the profile of women's sport in general, which should inspire the next generation of female athletes.

FIGURE 11.38 Female athletes such as Mon Conti have become prominent figures and are inspiring young female athletes to pursue careers in professional sport.

The promotion of diversity and inclusion across all groups in sport and active recreation will help to change the stereotypes and stigma of women and girls' involvement in sport. Continued focus from the media on women's sport and female role models in professional sport will also assist. However, this focus should increasingly come from the organisation and administration of sport so that young girls are more able to see the pathway into these roles.

Programs similar to This Girl Can will also help to continue to challenge the gender norms and cultural expectations placed on young girls and women. These programs will also help to change societal perceptions about women's roles and capabilities in sport through awareness, education and advocacy.

CASE STUDY

Albanese has committed $200 million for women's sport — but spending money on infrastructure won't change systemic issues

In the wake of the FIFA Women's World Cup, the federal government has announced A$200 million for women's sport. The money will go towards improving sporting facilities and equipment for women, making women's sport available on free-to-air television and supporting grassroots initiatives to recruit and retain women and girls in sport.

There is much to celebrate in funding commitments dedicated specifically to women and girl's sport. Modernising facilities can provide a short-term excitement and uplift, but it's their management over the long term that will influence whether women and girls participate.

The framework for distributing the $200 million has not yet been drawn up. While the government has indicated there will be grant opportunities for grassroots initiatives, we wonder how much money will be left — after facility builds and the free-to-air policy implementation — to deliver on such initiatives.

To achieve sustainable change and meaningful outcomes at the grassroots, government policy needs to encourage community sport clubs to look at what they have already got and think about doing sport differently to make facilities and club culture safe and inclusive for women and girls.

Barriers to participation

Women and girls encounter a range of barriers to sport participation, including:

- lack of access to safe and convenient facilities
- poor perception of skill and fitness levels and experiences of enjoyment among adolescent girls
- sporting codes and clubs not allowing culturally appropriate clothing
- unsupportive community values and attitudes
- lack of women-only environments for culturally and linguistically diverse women.

FIGURE 11.39 Despite increases in funding for women's sport, there are still many issues to address before equity with men's sport is achieved.

Many girls drop out of sport during their teen years. Building facilities and ensuring elite women's sport is on free-to-air TV will go some way to normalising women in sport, but all of these barriers must be addressed to recruit and retain young and amateur female players.

Coaches and volunteers need to recognise the motivations of their players. They must also bring parents along on the journey. Some young women may be motivated by competitive sport, but others might be interested in the social aspects. Any new funding for women's sports should embrace the teenage girls who are there for fun, as much as the teenagers who are interested in the competition.

Social, flexible and fun sports offerings are the most effective way to attract and engage women and girls. One standout example is Football Victoria's Go Soccer Mums. Mothers are invited to an introductory football skills and fitness program running at the same time and place their children train. The program builds confidence and social networks to re-engage women in sport. It provides a new pathway into sport and a foundation for women to transition into competitive offerings if they choose.

The mothers who progressed through Go Soccer Mums had an opportunity to take on leadership roles typically dominated by men. When more women are in leadership positions in grassroots sport, their interests are more likely to be reflected in decision-making. Policy and funding should be directed to encourage strong representation of women and girls in coaching, officiating and leadership roles in sport at the grassroots.

Better access to existing facilities

In traditionally male-dominated sports, there continues to be a gender bias. Boys' and men's participation is privileged over women's and girls'. Men dominate leadership positions. Men's and boys' fixtures often get scheduled first on preferred fields and with the top officials. There's often an expectation women and girls take on organising and support roles.

In this, the issue is not about the provision of facilities but about lack of equitable use of these facilities. These practices go unquestioned and unchallenged in many communities across Australia. If clubs focused on equitable use of existing facilities — with shared access to facilities and time slots — then funding for women's sport could be targeted at other areas of need.

The equitable use of facilities is a target area for the Victorian government under the Fair Access Policy Roadmap. Under this policy, to access infrastructure funding, local councils and sport clubs will need to demonstrate their fair access plans for equitable use of facilities. Implementing this nationally would ensure investment is going towards sport clubs making progress towards gender equity.

Better coaching practices

We also need initiatives that upskill coaches, committee members and volunteers to support women and girls. Women's and girls' sport is different to men's and boys' sport. These players sometimes need nuanced approaches to coaching to acknowledge and address those differences. Many coach development courses are based on what we know from coaching men and boys. They often overlook the need for awareness and recognition of female-specific considerations when coaching and training athletes.

A key success factor in coaching women is the ability for coaches to empower and support female athletes. However, many coaches — who are often men — have reported not feeling confident to address things such as body image concerns. Updating coaching courses to integrate specific training for supporting female athletes is an important area the federal government funding should target.

Source: Alana Thompson and Meghan Casey, 'Albanese has committed million for women's sport — but spending money on infrastructure won't change systemic issues', *The Conversation*, 23 August 2023, www.theconversation.com.

CONCEPT CONNECTOR

Read the article about the Australian government's $200 million pledge to support female sport. Discuss the following questions in groups of two or three.

After your discussion, write your group's answers onto three sticky notes and stick them on the board in three columns (one per question) and discuss the similarities and differences in your answers.

1. How will the funding help decrease the impact of the barriers to participation identified in the article?
2. How can access to sports facilities be made more equitable for female athletes?
3. What else could the money be spent on to increase female participation in sport and active recreation?

11.6 Activity

11.6 Quick quiz on | **11.6 Exercise**

Learning pathways

LEVEL 1	LEVEL 2	LEVEL 3
6	1, 3, 4, 7	2, 5

These questions are even better in jacPLUS!

- Receive immediate feedback
- Access sample responses
- Track results and progress

Find all this and MORE in jacPLUS

TEST your understanding

1. **Discuss** the impact of gender inequity on levels of physical activity among women and girls, considering societal norms and stereotypes, as well as access to resources such as sports facilities and coaching.
2. **Analyse** the barriers to sports participation faced by women and girls and propose strategies to address these barriers at both grassroots and elite levels.
3. **Evaluate** the effectiveness of initiatives such as the This Girl Can campaign in challenging gender norms and promoting female participation in sports and physical activity.
4. **Discuss** the significance of providing female-friendly programs, role models and mentoring opportunities in increasing female participation and leadership in sports. Give specific examples of programs or initiatives with this aim.
5. **Analyse** the role of Australian government policies and funding in promoting gender equity in sport.

APPLY your understanding

6. **Outline** the global programs and initiatives that aim to achieve greater gender equity in physical activity and sport.
7. **Discuss** the future implications of gender equity policies and the impact that they will have on female access to sport and physical activity.

11.6 Exam questions

Question 1 (2 marks)

Outline the Australian programs and initiatives that aim to achieve gender equity in physical activity and sport.

Question 2 (2 marks)

Explain how the Women Leaders in Sport (WLIS) program has an impact on the participation and performance of female athletes.

Question 3 (3 marks)

Evaluate how attitudes in sport have changed towards gender equity.

11.7 Key skills

Key skills

- explain contemporary intrapersonal and interpersonal issues associated with access to, and inclusion, participation and performance in, physical activity and sport
- collect information on a range of intrapersonal and interpersonal issues from a variety of resources, such as primary data, and print and electronic media
- propose ethical strategies to enhance access to, and inclusion, participation and performance in, physical activity and sport
- prescribe, participate in and reflect on movement experiences that illustrate different perspectives on the selected issue
- analyse the historical, current and future implications of the selected issue

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission.

11.7.1 Tell me

To address these key skills, it is important to remember the following:

- understand that interpersonal issues are those social influences and relationships that affect a person's behaviour, emotions, and development
- understand how physical activity and sport can be tailored to alleviate some of the barriers to participation and performance caused by these interpersonal issues
- ensure that you provide information in relation to how the issues affect all levels of involvement, from inclusion and access to participation and performance
- provide examples of strategies that have been implemented to enhance the contemporary issue in question
- ensure that you look at how the issue has changed over time and how it is likely to affect future involvement in physical activity and sport.

11.7.2 Show me

Practice question (10 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

The 'This Girl Can' campaign aims to make physical activity and sport more accessible to girls and women through the use of advertising across television and social media platforms.

a. **Identify** and **explain** two *strategies* that can be used by sports teams and organisations in order to increase female *participation* levels. (4 marks)

b. **Evaluate** the impact of *increased TV coverage and media attention* on the performance of high-profile female athletes and sportswomen. (6 marks)

Decode the question

Strategies to decode the question

- **Identify the action words:**
  Identify — determine the key characteristics or features
  Explain — provide detail to show the relationship between concepts
  Evaluate — use the information provided as well as evidence for or against the concept
- **Key terminology** — *participation, TV and media coverage*

- **Key concepts** — Promotional campaign and/or strategy performance
- **Marking scheme** — 6 marks — always check the marking scheme for depth of response required, linking to key information highlighted in the question.

Sample responses and marking scheme

a. One method sporting organisations use to *increase female participation* is through the promotion of positive female role models. The achievements of these individuals can be used to *promote the sport to a wider public and develop the aspirations of young women and girls*. A second strategy that is the development and *advancement of female coaches*. This can help to increase the likelihood of girls and women joining clubs and *also helps create a more inclusive environment*.
Award 2 marks for identifying two strategies.
Award 2 marks for explaining how each strategy can increase female participation.

b. Increased TV coverage and media attention can significantly affect the performance of high-profile female athletes by enhancing *their motivation and providing greater recognition*. This recognition can lead to greater sponsorship opportunities, which can *improve their access to the highest quality training and resources*. However, this increased media coverage can also bring about an *increased pressure to perform* consistently well and *greater public scrutiny*, potentially affecting athletes' mental health and performance. This can also lead to an increased pressure to cheat if the athlete is put under too much pressure to perform. Additionally, the obligations of media appearances and managing their public image can distract athletes from *their core training and recovery*. Overall, while the visibility can be beneficial, it requires athletes to balance the demands and pressures to maintain peak performance.
Award 3 marks for evaluating the positive impact of increased media coverage on female performance.
Award 3 marks for evaluating the negative impact of increased media coverage on female performance.

11.7.3 Let me do it

Question 1 (6 marks)

In recent years there has been huge growth in the development and sale of wearable sports technology and home-based fitness products.

a. **Identify** one of these technologies and explain how they can increase accessibility of physical activity and sport. **(2 marks)**

b. **Discuss** how professional athletes and sports teams use technology to improve their performance. **(4 marks)**

11.8 Review

Hey students! Now that it's time to revise this topic, go online to:

Review your results

Watch teacher-led videos

Practise exam questions

Find all this and MORE in jacPLUS

11.8.1 Summary

Interpersonal factors affecting access, inclusion, participation and performance in physical activity and sport

- There are many interpersonal factors that affect access, inclusion, participation and performance in physical activity and sport.
- These issues have changed and will continue to change over time.
- There are different local, national and global perspectives on each of the identified issues.
- Programs and strategies have been developed in order to combat some of the issues negatively affecting physical activity levels.
- Although steps have been taken to level the playing field, there is still a lot of progress needed in some areas.

Geographic location

- There is a major difference between the sporting experiences of those growing up in urban and rural environments in Australia.
- There are a number of key geographical factors that affect access, including air quality, terrain, socioeconomic status, climate and sociocultural influences.
- Participation rates in remote and regional areas are below those of the major cities.
- Different states have put programs in place to develop regional sport.

Coaching

- Coaching can have a dramatic impact on the likelihood of an individual taking up a sport or active recreation and staying involved regularly.
- Coaching style can affect an individual's enjoyment, development and continued involvement in sport.
- Coaching practices have changed to provide a more athlete-centered approach.
- The importance of the role of a coach as a safeguarding leader has increased due to historical reports of athlete abuse and mistreatment.
- Technology has allowed many coaches to work remotely or online via videoconferencing.
- There is now a greater focus on athlete wellbeing in coaching performers at all levels, but especially at professional level where the pressure on performance is higher.

Sports technology and the media

- Sports technology has changed dramatically over the past decade.
- Although some technological developments have led to people becoming more sedentary, other developments have made physical activity more achievable.
- Technology is now allowing more advanced monitoring of the human body than ever before.
- The development of media technology is changing the way that fans and audiences interact and watch their favourite sports and sportspeople.
- Social media is overtaking traditional print media as the main outlet for news and advertising in sport and active recreation.
- Many technological developments have led to governing bodies changing or modifying rules to allow or disqualify certain advancements.

Institutional and structural inclusion and equity

- Certain groups are still under-represented in sporting organisations in Australia and around the world.
- Key diversity groups include First Nations Peoples, culturally diverse people, physically diverse and disabled, intellectually diverse and gender/sexually diverse.
- Stereotyping and stigma still affect many groups' involvement in sport.
- Equity and inclusion policies and Reconciliation Action Plans (RAPs) are now in place across all sporting and non-sporting organisations in Australia.

Gender equity

- Although there have been improvements, there is still a big gap between male and female involvement in many levels of sport, especially in elite coaching and administration roles.
- Media coverage of female sport has increased but still lags behind coverage of male sport.
- Female-centred programs have been developed across Australia to target young girls and women and increase their participation.
- Access is not always equitable due to the preferential treatment given to men's teams and clubs by facility management.

11.8.2 Key terms

equity a process or adjustment that considers an individual or group's unique needs to generate equal outcomes and provide fair access to opportunities
gender the state of being male or female (typically used with reference to social and cultural differences rather than biological ones)
inclusion proactive and intentional behaviours that create an environment where all people feel a sense of belonging
inequity lack of fairness or justice in the distribution of resources, opportunities and treatment among people. It occurs when groups are disadvantaged compared to others due to factors including race, gender and sexuality.
interpersonal factors social influences and relationships that affect a person's behaviour, emotions and development. These factors include interactions with family, friends, teammates and wider society.
reconciliation the process of strengthening relationships between First Nations Peoples and non-Indigenous peoples, for the benefit of all Australians

11.8 Exam questions

11.8 Section A — Multiple choice questions

Question 1 (1 mark)

Which category in the Australian sports technology industry is currently the largest?

A. Business of Sport and Entertainment
B. Professional/Elite Sport
C. Mass Participation and Active Living
D. Media Coverage

Question 2 (1 mark)

Why might an authoritarian coaching style be beneficial?

A. It is good for beginners who have a low skill level.
B. It demotivates athletes and affects progress.
C. It gives clear instructions and guidance to more able athletes.
D. It causes athletes to lose interest in the sport.

Question 3 (1 mark)

How does gender inequity affect access to and inclusion in sports?

A. It creates barriers that limit participation, representation, and opportunities for women and girls.
B. It provides equal access to facilities, coaching and funding.
C. It promotes diverse and inclusive participation in sports.
D. It enhances self-confidence and skill development among women and girls.

Question 4 (1 mark)

How can engaging families and communities support female participation in sports?

A. By discouraging parents from enrolling their daughters in sports programs
B. By advocating for inequality and exclusion in sports opportunities
C. By providing resources, education and encouragement for female sports participation
D. By preventing girls and women from taking on organising and support roles in sports

Question 5 (1 mark)

What is the purpose of establishing talent-identification programs in regional areas?

A. To decrease opportunities for athletes
B. To limit access to coaching
C. To actively seek out promising athletes
D. To win Olympic medals

Question 6 (1 mark)

Which coaching style is more likely to engage and motivate athletes at the start of their journey?

A. Negative and overly critical
B. Authoritative
C. Fun, enjoyable and accessible
D. Outcome-focused

Question 7 (1 mark)

Why should coaching courses integrate specific training for supporting female athletes?

A. To maintain the status quo of coaching based on male athletes
B. To empower and support female athletes' unique needs
C. To overlook female-specific considerations in coaching
D. To address only male athletes' concerns in coaching

Question 8 (1 mark)

Why was Paralympian Oscar Pistorius's use of prostheses debated in athletics?

A. Performance-enhancement concerns
B. Lack of technological advancements
C. Equality of access
D. No controversy

Question 9 (1 mark)

What is a key identified diversity group in structural inclusion and equity in sports?

A. Elderly individuals
B. Gender and sexually diverse individuals
C. Sporty people
D. Upper-class individuals

Question 10 (1 mark)

In rural areas, what is a common barrier to participating in certain sports or activities?

A. Over-development of facilities
B. Higher population density
C. Lower deprivation level
D. Financial constraints

11.8 Section B — Short answer questions

Question 1 (2 marks)

Explain how the Right to Play initiative helps to increase access to physical activity and sport for children and young people?

Question 2 (4 marks)

Outline two recent technological advancements and examine their impact on access to and/or inclusion in physical activity and sport

Question 3 (2 marks)

Discuss social media's impact on participation levels in physical activity and sport.

Continue to build your exam skills

Access the Unit 2 Area of Study 2 Review at the end of Topic 11. This includes:
- Practice extended response
- Practice examination
- Practice school-assessed coursework

AREA OF STUDY 2 What are the contemporary issues associated with physical activity and sport?

OUTCOME 2

On completion of this unit, the student should be able to explain a range of intrapersonal and interpersonal contemporary issues that influence access to, and inclusion, participation and performance in, physical activity and sport at the local, national and global levels.

Source: VCE Physical Education Study Design (2025–2029) extracts © VCAA; reproduced by permission

REVIEW CONTENT SEQUENCE

U2 AOS2 Extended response — Build your exam skills
U2 AOS2 Practice examination online only
U2 AOS2 Practice school-assessed coursework online only

U2 AOS2 Extended response — Build your exam skills

Tell me

To address these questions, it is important to remember:

- examples of initiatives and strategies that are used to minimise the impact of hormonal factors on female participation in sport
- how these initiatives help to increase the access to sport for female participants
- that the hormonal cycle causes several different effects on the female body
- the female athlete triad can affect women, especially those at the top end of the performance scale
- the female athlete triad is a combination of; energy deficiency, low-bone mass and menstrual disturbances
- period poverty can affect those who do not have sufficient or fair access to the necessary menstrual products.

Show me

Practice question (8 marks)

KEY

- **green** identify the action word
- *purple* key terminology
- blue key concepts
- light orange marks/marking scheme

Campaigns such as 'I'm An Athlete. Period' aim to dispel some of the myths surrounding female sports participation and the menstrual cycle.

Suggest how strategies and initiatives can enhance *access* to physical activity for individuals facing *hormonal considerations*. **Examine** the impact of hormonal changes on *participation* rates and **propose** practical solutions to promote inclusivity and engagement in sports activities. (8 marks)

Decode the question

Strategies to decode the question

- **Identify the action words**.
  Suggest — put forward for consideration a solution, hypothesis, idea or other possible answer
  Examine — consider an argument, concept, debate, data point, trend or artefact in a way that identifies assumptions, possibilities and interrelationships
  Propose — suggest or put forward a point of view, idea, argument, diagram, plan and/or suggestion based on given data or stimulus material for consideration or action
- **Key terminology** — *menstrual cycle* — how does it affect the female athlete, *physical* — how does menstruation impact the female body? *access* — how do the strategies increase access to physical activity and sport
- **Key concepts** — initiatives and strategies — what initiatives and strategies have been used in order to increase access to physical activity?
- **Marking scheme** — 8 marks. Always check the marking scheme for depth of response required, linking to key information highlighted in the question.

Sample responses and marking scheme

To enhance access to physical activity for individuals facing hormonal considerations, it is crucial to acknowledge the impact of hormonal changes on participation rates and performance in sports. Education and awareness initiatives play a key role in this process by providing coaches, trainers, and athletes with information on how hormonal fluctuations can affect an individual's physical capabilities and energy levels. By *increasing understanding of these challenges*, sports professionals can *tailor training programs* to accommodate the varying needs of athletes experiencing hormonal changes, ultimately optimising their performance and *reducing the risk of injury*.

Practical solutions to promote inclusivity and engagement in sports activities for individuals with hormonal considerations include the implementation of flexible scheduling options. By offering adaptable training sessions and competition schedules, *athletes can better manage their energy levels and physical well-being* throughout different phases of their hormonal cycles. Creating a supportive environment within sports teams and organisations is also essential. Encouraging open communication about hormonal challenges and providing resources for managing symptoms *can help athletes feel understood and supported* in their athletic pursuits.

Furthermore, the establishment of inclusive policies that address hormonal considerations is paramount in fostering *diversity and equal opportunities in sports*. By ensuring that individuals facing hormonal challenges are *not discriminated against* and have access to the necessary support and accommodations, sports organisations can promote a *more inclusive and welcoming environment for all participants*. Regular health monitoring programs can also be implemented to track the impact of hormonal changes on physical activity participation, *allowing for personalised interventions and adjustments to training* regimes based on individual needs and requirements.

Marking guide

High range response	• Presents comprehensive and well-developed strategies to enhance access to physical activity for individuals facing hormonal considerations • Clearly articulates the impact of hormonal changes on participation rates and performance in sports • Proposes practical solutions with detailed explanations on how they promote inclusivity and engagement in sports activities • Shows critical thinking and creativity in addressing the challenges and opportunities related to hormonal considerations in sports

Mid range response	• Offers relevant strategies to enhance access to physical activity for individuals with hormonal considerations • Demonstrates an understanding of the impact of hormonal changes on participation rates • Provides practical solutions with some explanation on how they promote inclusivity and engagement in sports activities
Low range response	• Provides basic suggestions without clear explanation or relevance to hormonal considerations • Limited understanding of the impact of hormonal changes on participation rates • Minimal or no practical solutions proposed to promote inclusivity and engagement in sports activities

Let me do it

Extended response question learn on

Question 1 (8 marks)

Many athletes are now regularly using a range of psychological skills in order to help them increase the chances of success in their chosen sport.

Identify 2 key psychological skills which influence an individual's participation in physical activity and sport and discuss ways in which they can be used to maximise athletic performance.

Hey students! Now that you have completed the Extended Response, access the following in learnON

Practice examination

Practice SAC

Receive immediate feedback

Find all this and MORE in jacPLUS

Hey teachers! Now access learnON to assign the quarantined school-assessed coursework

Assign the quarantined school-assessed coursework

Track your students' results

Identify strengths and weaknesses

Find all this and MORE in jacPLUS

GLOSSARY

'all or nothing' principle states that if the nerve impulse meets a certain threshold, maximal action occurs in the muscle fibre. If the stimulation is less than threshold, no muscle action occurs in the muscle fibre.
accelerometer a device that measures the acceleration or vibration of an object
acute injury an injury that occurs quickly and for which pain and loss of function is immediate
acute responses the body's immediate, short-term responses that last only for the duration of the activity and for a short time afterwards (recovery)
aerobic exercise sustained physical effort which increases the rate that oxygen is inhaled and passed from the heart to the bloodstream
aerobic power the maximum rate of energy production from the aerobic energy system
aerobic training training that specifically targets the aerobic energy system and refers to a type of repetitive, rhythmical movement
aerobic energy produced with the presence of oxygen
agonist the muscle that causes the major action (prime mover)
altitude training involves training at levels greater than 1500 metres above sea level to induce physiological changes that enhance the oxygen-carrying capacity of the blood
amenorrhea the absence of menstruation, often attributed to low body weight, excessive exercise, disordered eating and other causes
anaerobic energy produced without the presence of oxygen
anatomical position standing erect, facing forward with arms by the side and palms facing forward
antagonist the muscle that relaxes and lengthens to allow movement to occur
anti-doping codes codes established to eradicate the use of drugs and other illegal performance-enhancing methods in sport
arteries large, thick-walled blood vessels that carry blood away from the heart
arterioles small blood vessels that branch off from arteries and extend to capillaries
arteriovenous oxygen difference (a-VO_2 diff.) the difference between the concentration of oxygen in the arterial blood and the concentration of oxygen in the blood in the veins. This is measured in mL/100 mL of blood.
arthritis a condition characterised by inflammation of a joint, causing pain and stiffness
atria the two upper chambers of the heart. They receive blood from the veins and pump it into the lower chambers (ventricles).
barrier something that prevents progress or makes it difficult for an individual to achieve something
beta blockers drugs that block adrenaline hormones from binding to receptors on nerves, reducing the effect they have on the heart and blood vessels
blood doping the process of infusing extra human blood (red blood cells) into an athlete's body prior to performance
blood vessels a transport network of arteries, capillaries and veins that carries nutrients and waste around the body
blood the fluid circulated by the heart around the body. It consists of plasma, red and white blood cells, and platelets.
caffeine a drug that acts on the central nervous system (CNS) to stimulate the release of adrenaline and alters perception of effort and fatigue
calcium a mineral found mainly in the hard part of bones and is essential for healthy bones. It is also important for muscle contraction, nerve transmission, enzyme activity and blood clotting.
capillaries tiny blood vessels in the cardiovascular system between the ends of the arterioles and the venules. They are the site for the exchange of gases between the cells and the cardiovascular system.
carbohydrate loading the manipulation of training and nutrition prior to endurance events to maximise muscle glycogen (carbohydrate) stores

cardiac cycle the movement of blood through the heart in one heartbeat. It consists of alternate systole and diastole of the atria and the ventricles.

cardiac output ($\dot{Q}$) the amount of blood ejected from the left ventricle of the heart per minute. It is the product of stroke volume (SV) multiplied by heart rate (HR), so $\dot{Q} = SV \times HR$, and is measured in litres per minute (L/min).

cardiovascular system the heart and blood vessels circulate blood throughout the body, delivering water, oxygen and nutrients to cells, and removing waste products such as carbon dioxide

cartilage a tough, fibrous connective tissue located at the end of bones and between joints. It protects bones by absorbing the impact experienced in movements such as jumping.

chronic injury an injury that recurs due to weakness or insufficient rehabilitation

chronic muscular adaptations the long-term responses of body systems developed in response to a training program

concentric contraction when the muscle length shortens as the force is being produced

continuous training continuous, submaximal (70–85 per cent HR max) activity lasting longer than 20 minutes

cool down low-intensity activity completed at the end of a training session or competition that allows the body to recover faster by increasing the breakdown of metabolic waste products, such as lactic acid, and preventing venous pooling, gradually returning the body to its resting physiological state

coronary arteries the arteries that supply oxygen and nutrients to the cardiac muscle (heart)

creatine a naturally occurring compound found in skeletal muscles that assists in the regeneration of ATP in the muscle cells

CRISPR-Cas9 a gene editing tool that allows scientists to selectively modify the DNA of living organisms. It makes it possible to switch genes on and off and correct errors in the genome.

demographics the physical characteristics of a population, such as age, gender, ethnicity, family size, job status and education.

deoxygenated oxygen-poor (carbon dioxide-rich) (blood)

deoxyribonucleic acid (DNA) molecule that carries genetic information for the development and functioning of an organism

diastole a relaxation of the heart muscle

diffusion the movement from a higher concentration to a lower concentration

direct injury an injury caused by external force

diuretic causes increased production and excretion of urine from the body

doping the use by, or distribution to, an athlete of certain substances or methods that could have the effect of artificially improving the athlete's physical and/or mental condition and enhancing their performance

eccentric contraction when the muscle length lengthens as the force is being produced

enabler something that makes it possible for a particular thing to be done

epiphyseal plates (or growth plates) the growth centre of developing bones

equity a process or adjustment that considers an individual or group's unique needs to generate equal outcomes and provide fair access to opportunities

erythropoietin (EPO) a naturally occurring hormone secreted by the kidneys that stimulates the production of red blood cells. Can also be produced synthetically.

expiration the movement of air out of the lungs to the external environment (breathing out)

fartlek training continuous training involving changes of intensity to work both the aerobic and anaerobic energy systems

flexibility training training that moves a joint through its range of movement; it can be static or dynamic.

flexibility the range of movement around a joint

Functional Movement Assessment (FMA) involves observing the participant through a variety of movements to inform the design of a physical activity plan

gender the state of being male or female (typically used with reference to social and cultural differences rather than biological ones)

gene doping the use of substances or techniques to manipulate cells or genes to improve athletic performance

glycaemic index is a ranking of carbohydrates on a scale from 0 to 100 according to the extent to which they raise blood glucose levels after eating

growth hormone a synthetically produced drug that mimics the effect of the hormone human growth hormone (HGH)
haemoglobin a substance found in red blood cells that transports oxygen around the body
heartbeat one contraction and relaxation of the heart muscle
high-intensity interval training (HIIT) training that involves repeated bouts of high intensity efforts followed by varying periods of complete rest or recovery at a lower intensity
homeostasis a constant internal environment for optimal functioning of the body and its systems
hormones chemicals that help to control many functions in your body. Hormones circulate through your blood to your organs, skin, muscles and other tissues.
hyperthermia a rise in the body's core temperature above 37.5–38.3 °C
hypothermia a reduced core body temperature below 35 °C
hypoxic low levels of oxygen are available
inclinometry the measurement of angles, slope and tilt as well as elevation and/or depression
inclusion proactive and intentional behaviours that create an environment where all people feel a sense of belonging
indirect injury an injury caused by internal force
inequity lack of fairness or justice in the distribution of resources, opportunities and treatment among people. It occurs when groups are disadvantaged compared to others due to factors including race, gender and sexuality.
insertion usually attached to the bone that moves most when the muscle contracts. It is further (or distal) from the body's midline.
inspiration the movement of air from the external environment into the lungs (breathing in)
intrinsic motivation an individual's inner drive to perform a certain action or behave in a specific way. Examples include doing something for pleasure or believing a specific action is the correct thing to do.
interpersonal factors social influences and relationships that affect a person's behaviour, emotions and development. These factors include interactions with family, friends, teammates and wider society.
intersectoral different sectors working together
interval training training that consists of intervals of work followed by intervals of rest or recovery
intrapersonal factors describes factors affecting individuals that come from within themselves, such as attitudes, self-esteem, self-regulation and decision-making
involuntary control refers to having no conscious control of the muscle
isometric contraction when a force is developed but there is no change in the muscle length
lever a rigid structure that rotates around a fixed point
ligament a strong fibrous band of connective tissue that holds together two or more moveable bones or cartilage
liquid-meal supplements supplements typically containing a carbohydrate-rich, protein-moderate, low-fat powder formula that can be mixed with water or milk
long-interval training training that consists of intervals of work followed by equal intervals of rest or recovery to develop the aerobic energy system
maximum oxygen uptake (VO_2 max) the maximum amount of oxygen per minute that can be taken in, transported to and used by the working muscles to produce ATP (adenosine triphosphate)
menstruation monthly process in which the female body sheds the lining of the uterus. This results in bleeding from the vagina, typically lasting between 3–7 days.
mental fitness the ability to maintain psychological wellbeing and resilience in the face of challenges. It involves creating emotional stability and effective coping strategies to support mental health.
METs (metabolic equivalents) commonly used to express the intensity of physical activities. A MET is the ratio of a person's working metabolic rate relative to the resting metabolic rate. Your MET level would be 1 if you were generally sedentary (e.g. lying down, reading or sitting and talking). Participation in an activity of moderate intensity would result in a MET level of 3–6.
minerals inorganic substances in the body required for adequate functioning of the body; they are important components of bone, muscle, skin and blood.
motor unit consists of one motor neuron and the muscle fibre it stimulates. (Each neuron may stimulate a number of muscle fibres.)

muscular endurance the ability of a muscle or group of muscles to sustain repeated or sustained contractions against resistance for an extended period
muscular strength the peak force that a muscle can develop
musculoskeletal injury any damage that occurs to the structures of the muscular or skeletal systems of the body
myofilament individual protein filaments of myosin (thick filament) and actin (thin filament) that make up a myofibril
nucleic acid analogues compounds that are structurally similar to naturally occurring DNA
nucleic acids nucleotides that are the building blocks of DNA
nutritional supplements food or preparations ingested in excess of those consumed in a normal diet to supplement or increase the amount of nutrients available
objective judgement that is based on something that can be measured by units of time, distance or some other measurement/units
origin the fixed point of attachment that is closer (or proximal) to the body's midline
osteoporosis a condition in which the bones become weak and thin, and therefore brittle
overtraining when an individual trains in a way that does not allow their body to recover sufficiently; symptoms can include a decrease in physical performance, increased fatigue, persistent muscle soreness, mood disturbances and a feeling of being 'burnt-out'
overuse injury an injury caused by excessive and repeated use of the same muscle, bone or joint
oxygenated oxygen-rich (blood)
performance-enhancing includes methods, devices or substances that improve athletic performance
period poverty the lack of access to menstrual products, sanitation facilities and adequate education surrounding menstruation
permitted officially allowed
physical activity any movement of the body produced by skeletal muscles, resulting in energy expenditure
physical inactivity a lack of involvement in physical activity during an individual's leisure time
physiological adaptations the physical changes of the body's cardiovascular, respiratory and muscular systems due to regular exercise, over a period of time
physiological considerations relate to the physical state and function of the participant, such as age, weight, fitness levels and health conditions, and which may influence the FMA
plyometric training training that aims to increase muscular power by first stretching a muscle then contracting it in the shortest time possible
precapillary sphincters one-way valves that control blood flow within capillaries
proprioception the ability of the muscles, tendons and joints to receive and process stimuli about their position
protein supplements nutritional supplements used by many athletes to aid in the growth and repair of muscle tissue and cells
psychological considerations relate to the mental and emotional state of the participant, such as motivation, confidence and self-efficacy
pulmonary circulation the arteries and veins that feed blood from the heart to and from the lungs where blood is oxygenated
pulmonary diffusion the movement of oxygen and carbon dioxide from a high concentration to a low concentration between the alveoli and the surrounding capillaries
reciprocal inhibition the process of one muscle contracting (agonist) while the other muscle relaxes (antagonist) to create movement
reconciliation the process of strengthening relationships between First Nations Peoples and non-Indigenous peoples, for the benefit of all Australians
rehabilitation the process of returning to optimal functioning as well as reducing the chance of re-injury
resilience the ability to adapt to and recover from stress, adversity and challenging situations
resistance training training that aims to build muscular strength, muscular power or muscular endurance by exercising muscles or a group of muscles against a resistance
respiratory rate (RR) the amount of breaths per minute

respiratory system the lungs and associated structures responsible for gas exchange in the body, bringing air into the body and removing waste products
sarcomere the smallest unit of muscle contraction
sedentary behaviour behaviour associated with sitting or lying down, including activities such as watching television, working or playing on the computer, driving or sitting in a car, bus or train. It also includes homework, studying or reading.
sedentary lifestyle when an individual spends six or more hours a day sitting or lying down, without any significant physical movement in their daily life
self-efficacy an individual's belief that they can execute behaviours that can achieve a certain level of success
size principle states that the recruitment of motor units in skeletal muscles starts with small motor units to large motor units
skeletal system a rigid structure made of bones that provides support, protection and sites to which muscles attach to create movement
social-ecological model a framework used to develop, implement and critique health-promotion strategies aimed at improving health by promoting physical activity and limiting sedentary behaviour
sociocultural considerations relate to the interaction of social and cultural elements such as family, peers, community, gender, socioeconomic status, cultural beliefs and traditions
sociocultural relating to the social and cultural norms prevalent in society
socioeconomic status (SES) a term used to describe the social and economic situation of an individual. It incorporates three components: education, occupation and income.
sodium bicarbonate a source of sodium that neutralises acids; it is ingested orally as a capsule or effervescent powder.
sports bar fortified food in a bar form that contains a blend of carbohydrates and protein to provide a large boost of fuel in one serving
sports gel fortified food in a gel form that contains a blend of carbohydrates and protein to provide a large boost of fuel in one serving
sports injury prevention strategies that include any processes completed by a coach, athlete or sports administrator to minimise the risk of injury
stabiliser the group of muscles that ensures that the joint remains stable during movement
stakeholders individuals or groups of people who have a vested interest in a particular issue or outcome
steady state the state in which oxygen supply equals oxygen demand and energy is being supplied aerobically
steroids synthetically produced drugs that mimic the effect of the hormone testosterone
stressor any external event or circumstance that triggers stress responses in an individual. These can range from academic pressures and relationship conflicts to financial difficulties or major life changes.
stroke volume (SV) the amount of blood ejected from the left ventricle with each heartbeat (contraction) of the heart. It is measured in millilitres per beat (mL/beat).
subjective judgement made by an observer with a set criteria
synergist the muscle that assists the agonist to produce the required movement
synovial joint a freely moveable joint that allows movement in one or more directions, and has a joint capsule
systemic circulation the arteries and veins that feed blood from the heart to the whole body and back to the heart again for reoxygenation
systems thinking a framework for understanding the world by the ways that different entities within a system influence one another
systole a contraction of the heart muscle, specifically the ventricles
systolic blood pressure the blood pressure recorded as blood is ejected during the contraction phase of the heart cycle. It is the higher of the two blood-pressure values.
taping the use of strapping tape to limit the range of movement in a joint as part of an athlete's prevention or rehabilitation strategy
tendon a fibrous connective tissue that attaches muscles to bones
thermoregulation the maintenance of core body temperature within a narrow range
tidal volume (TV) the amount of air breathed in and out in one breath

type 2 diabetes a condition that affects how the body uses sugar (glucose) for energy and stops the body from using insulin properly

vasoconstriction a process whereby blood vessels narrow or constrict, causing a decrease in blood flow

vasodilation a process whereby blood vessels increase their diameter, causing an increase in blood flow

veins blood vessels that carry deoxygenated blood and waste products from the body's cells back to the heart

venous pooling a collection of blood in the leg veins when high-intensity activity stops too suddenly

ventilation (V) the amount of air that is inspired and expired during 1 minute

ventricles the two lower chambers of the heart. They receive blood from the atria and pump it to the lungs (right ventricle) and to the body (left ventricle).

vertebrae the 33 moveable and immoveable bones that make up the vertebral column

vertebral column (or spine) the column of irregular bones comprised of three distinct curves that provides the body's central structure for the maintenance of good posture

vital capacity the maximum amount of air that can be expired after a maximal inspiration

vitamins essential components of a balanced diet; they allow normal body growth and maintenance by assisting chemical reactions in the body.

voluntary control refers to having conscious control of the muscle

warm up activities and exercise undertaken at the beginning of a training session with the aim of preparing the body both physiologically and psychologically for the training session that follows

INDEX

A

accelerometers 250, 279, 286
accuracy 217
Achilles tendon problems 81
action
  cardiorespiratory system in 188–9
  levers in 45–6
active recovery 74
acute injuries 60–3, 89
acute responses 153
acute sports injuries 65, 66
adenosine triphosphate (ATP) 176
adequate posture 19
aerobic exercise 200, 214, 230
  on cardiovascular and respiratory systems 201
  regular 202–3
aerobic power 326–7
aerobic training methods 94, 95, 117, 126, 204–7, 214, 230
  benefits and harms 98–9
  and benefits 206
  chronic cardiorespiratory adaptations of 205
  chronic muscular adaptations 97, 98
agonist 40, 52
AIS *see* Australian Institute of Sport
'all or nothing' principle 34–5, 52
altitude training 204, 207–9, 214, 230
  on performance 209
alveoli/capillary interface 177–8
amenorrhea 362, 393
anabolic steroids 118–19
anaerobic training methods 94, 95, 117, 126
  chronic muscular adaptations 97, 98
  interval training 97–8
  plyometric training 96–7
  resistance training 95–6
anatomical movements 15–17
anatomical position 13–15, 52
antagonist 40, 52
arteries 142–4, 164
arterioles 143, 144, 164
arteriovenous oxygen difference (a-VO_2 diff) 158–60, 164, 188
arthritis 66–7, 89
ASADA *see* Australian Sports Anti-Doping Agency
ASICE *see* Australian Sports Innovation Centre of Excellence
assessment reliability 335
ASTN *see* Australian Sports Technology Network
athletes, physical preparation of 73
athletic performance 212
atria 139, 164
Australian Institute of Health and Welfare (AIHW) 66
Australian Institute of Sport (AIS) 102, 364, 406
  Coach Development Model 407
  engineering program 420
Australian Physical Activity and Sedentary Behaviour Guidelines 202, 258
Australian Sports Commission 310, 400, 427
  Future of Australian Sport 415
  PlayWell Strategy 431
Australian Sports Commission AusPlay 2023 369
Australian Sports Innovation Centre of Excellence (ASICE) 419
Australian Sports Technology Network (ASTN) 414
a-VO_2 diff *see* arteriovenous oxygen difference

B

bandages 82
barriers 250, 286
  defined 250
  importance 250
  sociocultural factors 250–7
basic taping techniques 82
beta blockers 214, 230
biceps muscle 10
bicuspid valve 139
blood 141–2, 164
  carbon dioxide 172
blood circulation 143, 146–7
blood doping 217–18, 230
blood flow 157
blood flow redistribution 157–8
blood vessels 142–3, 157, 164
blood volumes 158
body movement 4, 19
bone tissue 5
bone types 7–8
braces 82–4
breathing 173–81
  expiration 174–5
  inspiration 174
  lung volumes 175–6
  maximum oxygen uptake 176–7
  ventilation 173–4

C

caffeine 110, 126
  defined 110
  supplementation 110
calcium 5, 52, 115–16, 126
cancellous bone 5
capillaries 142, 144–5, 164
capillary/muscle interface 178–80
carbohydrate loading 105–6, 126
carbohydrates 104–7
  carbohydrate loading 105–6
  glycaemic index 104–5
  liquid-meal supplements 107
  sports bars 106–7
  sports gels 106
carbon dioxide 172
cardiac cycle 140, 141, 164
cardiac muscle 20
cardiac output 156–7, 164
cardiac response to exercise 156
cardiorespiratory system 188–9
cardiorespiratory system, performance of
  permitted substances and methods 204–12
    ethical and social considerations for 219–27
  prohibited substances and methods 212–19
    ethical and social considerations for 219–27
  regular aerobic exercise 200–4
cardiovascular system 138, 151, 164
  blood 141–2
  defined 138
  heart 139–40
  physical activity 153–60
  respiratory system and 186–8
  structure 138
    and function 138
  thermoregulation in 148–53
cartilage 9, 52
cartilaginous (slightly moveable) joints 9

chronic cardiorespiratory adaptations of aerobic training methods 205
chronic injury 61, 89
chronic muscular adaptations 95, 126
  anaerobic and aerobic training 97, 98
Coach Development Model 407
coaching 406–14
  access and inclusion 408–9
  historical, current and future implications 412
  local, national and global perspectives 409–12
  participation and performance 409
  and physical activity 406–8
  styles 408
common sports injuries 65–6
community 256–7
compact bone 5
compound fracture 62
concentric contraction 38, 52
connective tissue 9–11
continuous training 230
continuous training methods 98
contusion 62
cool down 74–89
coronary arteries 144, 164
CQUniversity 10 000 Steps program 307
creatine 109, 126
CRISPR-Cas9 216, 230
cultural norms 254–6
'culture of cycling' 223
cultures 256

D

Deadly Active Sport and Recreation Program 400
dehydration 107
demographics 286
deoxygenated 139, 164
deoxyribonucleic acid (DNA) 216, 230
diaphragm 170, 184–5
diaries 276
diastole 140, 164
dietary supplements 102
diffusion 177, 183, 194
digital tools 280–1
direct 60
direct injury 60, 89
dislocated shoulder 62
dislocations 62
diuretic 110, 117, 126
DNA *see* deoxyribonucleic acid
doping 117, 126
dynamic stretching 73, 99

E

eccentric contraction 38, 52
electrolyte replacement 107
elite pathways 383–9
emotional benefits, of regular physical activity 246–7
enablers 250, 286
  defined 250
  importance 250
  sociocultural factors 250–7
endomysium 26
environmental factors 256
epimysium 26
epiphyseal plates 8, 52
EPO *see* erythropoietin
equipment 80–1
equity 426, 446
erythropoietin (EPO) 207 213–14, 230
Essendon Football Club supplements saga 223–4
exercise
  arteriovenous oxygen difference during 158
  blood flow redistribution during 158
  cardiac response to 156
  health benefits of 200–2
  in heat 151–2
  respiratory rate and 184
  sweat production during 150
expiration 174–5, 194

F

family 251
fartlek training 205, 230
fasciculi 26
fast-twitch muscle fibres 29
female athletes 439
Female Athlete Triad 362
fibrous joints 9
fitness components 326
FITT principles 339
flat bones 7
flexibility 329–31
flexibility training 94–101, 117, 126
footwear 81
fracture 62
Functional Movement Assessment (FMA) 332
  accuracy 335
  assessment reliability 335
  informed consent 334–5
  physiological considerations 332–4
  psychological considerations 334
  sociocultural considerations 334
  validity 335

G

gaseous exchange 177, 187
  alveoli/capillary interface 177–8
  capillary/muscle interface 178–80
gender 254, 433, 446
gender equity 433–43
  access and inclusion 434–5
  local, national and global perspectives 437–8
  participation and performance 435–7
gender stereotypes 254
gene doping 215–17, 230
geographic location 398–406
  access and inclusion 400–1
  historical, current and future implications 402–4
  local, national and global perspectives 402
  participation and performance 401–2
  and physical activity 398–400
Get Active Victoria's Kids Voucher program 306–7
glycaemic index (GI) 104–5, 126
growth hormone 119–21, 126
growth plates 8

H

haemoglobin 5, 52, 207, 208, 230
hard tissue injuries 62
health benefits of exercise 200–2
health-related fitness components and factors 326–32
  aerobic power 326–7
  fitness components 326
  flexibility 329–31
  muscular endurance 328–9
  muscular strength 327–8
heart
  functions 138
  location 140
  structure 138
  valves 140
heartbeat 164
heart rate (HR) 153–5
heat
  hyperthermia and exercise in 151–2

high-intensity interval training (HIIT) 205, 230
homeostasis 148, 164
hormonal considerations 360–7
  access and inclusion 361
  impact on physical activity 360–1
  local, national and global perspectives 362–4
  participation and performance 361–2
hormones 360, 362, 393
human–environment interactions 303
human growth hormone 119–21
humidity 151
hydration 107–9, 115
hydrogen ions 113
hyperthermia 151–2, 164
hypothermia 152, 164
hypoxic 208, 230

I

inclinometry 279, 286
inclusion 446
Indigenous Marathon Project (IMP) 311–13
indirect 60
indirect injury 60, 89
individual component 294–7
inequity 424, 446
informed consent 334–5
injuries 367–75
  access and inclusion 368–9
  acute 61–3
  causes of 60–1
  current and future implications 373–4
  local, national and global perspectives 370–3
  overuse 63–4
  participation and performance 369–70
  reduction 370
insertion 39, 52
inspiration 174, 194
institutional and structural inclusion and equity 423–33
  access and inclusion 424–5
  local, national and global perspectives 426–9
  participation and performance 425–6
  physical activity 423–4
intrinsic motivation 295, 319
intermediate interval training 97–8
International Olympic Committee (IOC) 117, 378, 427
interpersonal factors 396, 446
interpersonal issues
  coaching 406–14
  gender equity 433–43
  geographic location 398–406
  institutional and structural inclusion and equity 423–33
  sports technology and media 414–23
intersectoral 306, 319
interval training 97–8, 119, 126
intervertebral discs 8
intrapersonal factors 358, 393
intrapersonal issues
  hormonal considerations 360–7
  injuries 367–75
  psychological skills 375–83
intrinsic motivation 295, 296
involuntary control 19, 52
isometric contraction 38–9, 44, 52

J

joints classification 9
  cartilage 9
  connective tissue 9–11
  ligaments 9–10
  tendons 10–11
Jump Rope for Heart 309–10

K

Kids Voucher program 306–7
kinesiology taping 82
knee brace 83
knee joint 10

L

levers 43–4, 52
  in action 45–6
  third-class levers 44
ligaments 9–10, 52
  knee joint 10
liquid-meal supplements 107, 126
locomotive activities 326
long bones 5, 7
long-interval training 205, 210, 230
lung
  inspiration and expiration 175
  structure 171
  volumes 175–6

M

maximum oxygen uptake (VO_2 max) 171, 176, 194, 202, 205, 230
mechanical aids 96
mechanical disadvantage 45
media coverage 417
menstruation 361, 362, 393
mental fitness 383–4, 393
  access and inclusion 384–6
  current and future implications 387–9
  local, national and global perspectives 387
  participation and performance 386
  in physical activity 383–9
mental health and wellbeing 245
metabolic equivalents (METs) 266, 286
minerals 114–15, 126
mineral storage 5
mitral valve 139
mobility 75
motor skills development 295
motor units 34, 52
  activation 35–6
  force production 35–6
  recruitment 35
mouth breathing 171
multiple factors influence behaviour 302–3
muscle action 39–40
muscle contractions 95
muscle control 40–1
muscle fibres 20, 27
  arrangement 25, 31
  characteristics and functions 25–33
  common features of 25
  types 2, 29–32
muscle force 35
muscles
  contraction 39–40
  control 40–1
  insertion 39
  interactions 43–8
  origin 39
  types 19–21
muscle strain 61
muscle tendons 4
muscle tone 28–9
muscular contractions
  activation of 34–6
  concentric contraction 38
  eccentric contraction 38
  isometric contraction 38–9
  reciprocal inhibition 41–2
  types of 38–43
muscular endurance 328–9
muscular strength 327–8

muscular system 23
functions 19
adequate posture 19
body movement 19
major skeletal muscles 21–3
types of 19–21
musculoskeletal injury 59, 89
physiological strategies to prevent 71–8
cool down 74–5
physical preparation of athletes 73
pre-participation screening 71–3
rehabilitation 75–6
warm up 73–4
musculoskeletal system 43
bones to produce movement 43–8
illnesses of 66
injuries 60–1
acute injuries 61–3
common sports injuries 65–6
overtraining 64–5
overuse injuries 63–4
interactions of muscles 43–8
muscle fibre 25–33
muscular contractions 38–43
muscular system 19–25
neural control of muscles 33–8
performance enhancement of 92
aerobic training methods 98–9
anaerobic training methods 95–8
flexibility training 94–101
hormones 117–23
nutritional supplements 101–17
prohibited methods 120
training methods 94–5
physical aids to 78–85
braces 82–4
equipment 80–1
footwear 81
protective equipment 78–80
taping 81–2
skeletal system 4–19
myofibrils 27
myofilament 39, 52
myofilaments 27

N

nasal breathing 171
national and global perspectives 362–4
National Heart Foundation's Jump Rope for Heart 309–10
natural production *vs.* synthetic intervention 214
neural control of muscles 33–8
activation of muscular contraction 34–6
'all or nothing' principle 34–5
size principle 35
normal and arthritic joints 66
nucleic acid analogues 215, 230
nucleic acids 215, 230
nutrition 115
nutritional supplements 101–17, 126
carbohydrates 104–7
defined 101
dietary supplements 114–15
hydration 107–9
performance supplements 109–14
specialised sports foods 104

O

objective 240, 274, 286
optimal mental health 245
origin 39, 52
osteoporosis 67–9, 89
overtraining 64, 89, 205
overuse injury 63–4, 89
oxygenated 138, 139, 164
oxygen uptake 183–4

P

PAR-Q *see* Physical Activity Readiness Questionnaire
pedometer 277–8
peers 252–3
performance-enhancing 94, 126
defined 92
drugs 118
of musculoskeletal system 92
aerobic training methods 98–9
anaerobic training methods 95–8
flexibility training 94–101
hormones 117–23
nutritional supplements 101–17
prohibited methods 120
training methods 94–5
substances 219–20
substances and methods 117–18
ethical considerations of 220–2
performance supplements 102, 109–14
caffeine supplementation 110
creatine 109
protein powders 110
protein supplements 109
sodium bicarbonate 113–14
perimysium 26
period poverty 361, 393
permitted methods 94–101
permitted 207, 215, 230
personalised physical activity plan
creation 337–42
planning 337–9
preliminary information 339
sample 340–1
sedentary behaviour 339
evaluation 342–5
importance 342–3
FITT principles 339
Functional Movement Assessment (FMA) 332–7
health-related fitness components and factors 326–32
physical activity 44–6, 67, 153–60, 238 *see also* regular physical activity, 240, 286
for adults aged 18–64 years 262
assessing methods 273–81
cardiovascular system and 153–60
cardiac output 156
cardiac response to exercise 156
heart rate 153–4
stroke volume 154–6
for children aged 0–5 259–60
for children and young people aged 5–17 260–1
coaching and 406–8
defined 240
geographic location and 398–400
hormonal considerations and impact on 360–1
individual factors 295, 296
influences on 314
injuries and impact on 367–8
institutional and structural inclusion and equity 423–4
maintaining an active lifestyle 244–50
mental fitness in 383–9
objective measures of 277–8
for older adults aged 65+ years 262–3
personalised plan *see* personalised physical activity plan
population-based initiatives 305–16
intersectoral approach 306–13
social-ecological model 305
prevalence and trends in 265–73
psychological skills and impact on 375–6

regular participation 244
respiratory system 181–6
diffusion 183
oxygen uptake 183–4
respiratory (breathing) rate 182
ribcage muscles and diaphragm 184–5
tidal volume 182
ventilation 182–3
and sedentary behaviour guidelines 258–65
and sedentary behaviour levels 265–6
social-ecological model *see* social-ecological model
sociocultural enablers and barriers to 250–7
socioeconomic status and 271
subjective measures of 274–7
types 240–4, 256
Physical Activity Readiness Questionnaire (PAR-Q) 332, 333
physical aids, musculoskeletal system 78–85
braces 82–4
equipment 80–1
footwear 81
protective equipment 78–80
taping 81–2
physical benefits
of regular participation 244
of regular physical activity 244–5
physical environment 299–301
physical inactivity 258, 265–70, 286
physical preparation of athletes 73
physiological adaptations 201, 215, 230
physiological considerations 332–4
plasma 142
Play Well Strategy 408
pleura 170
plyometric training 96–7, 126
policy factor 301–2
positive social media 416
potential harms 214, 217
potential injuries 69
precapillary sphincters 144, 164
precision 217
preliminary information 339
pre-participation screening 71–3
produce movement, bones to 43–8
prohibited methods 120
proprioception 82, 89
proprioceptive 82
proprioceptive neuromuscular facilitation (PNF) stretching 74, 75, 99
protective equipment 78–80
protein powders 110
protein supplements 109, 126
proxy survey 276
psychological considerations 334
psychological skills 375–83
access and inclusion 376–7
historical, current and future implications 381–2
impact on physical activity 375–6
local, national and global perspectives 378–81
participation and performance 377–8
pulmonary circulation 143, 146, 164
pulmonary diffusion 169, 177, 194, 202, 230

Q

questionnaires 71

R

reciprocal inhibition 41–2, 52
reconciliation 429, 446
red blood cell production (RBC) 213
red blood cells 5–6
regional training 401
regular aerobic exercise 200–4
regular participation, benefits of 244
regular physical activity 200
emotional benefits of 246–7
mental benefits of 245–6
physical benefits of 244–5
social benefits of 247
spiritual benefits of 247–9
rehabilitation 75–6, 89
relative humidity 151
resilience 361, 386, 393
resistance training 95–6, 119, 126
mechanical aids to 96
physiological effects of 95
respiratory (breathing) rate (RR) 173, 182, 194
respiratory system 167, 169, 194
breathing and gaseous exchange 173–81
cardiovascular and 186–8
conducting system 170
defined 169
diaphragm 170
functions 169
maximising oxygen uptake 171
organs 169
physical activity 181–6
pleura 170
regular aerobic exercise on 200–4
structure 169–70
ribcage muscles 184–5

S

safety equipment 78
sarcolemma 27
sarcomeres 27–8, 52
scholarship programs 401
sedentary behaviour 258, 265–73, 286
assessing methods 273–81
individual factors 295, 296
levels 265–6
personalised physical activity plan 339
physical activity and 265–73
social-ecological model *see* social-ecological model
trends 267–71
sedentary behaviour guidelines 258–65
sedentary lifestyle 290, 295, 319
self-efficacy 295, 296, 319
SEM *see* social-ecological model
septum 139
SES *see* socioeconomic status
sesamoid bones 7
short bones 7
short interval training 97–8
silent disease 68
simple fracture 62
simulated high-altitude training 209
size principle 35, 53
skeletal muscles 20–1, 40
fibre arrangement 26
major 21–3
structure of 26–9
skeletal system 4, 53
anatomical position 13–15
bone growth and health 8–9
bone types 7–8
defined 4
function of 4–6
body movement 4
framework and protection 4–5
mineral storage 5
production of red blood cells 5–6
joints classification 9
major bones of 6–7
synovial joints 11–13

terms of reference 13–15
vertebral column 8
sliding filament theory 27–8
slow-twitch muscle fibres 29
SMARTER goal 337, 338
SMART goals 274
smooth muscle 19–20
social benefits, of regular physical activity 247
social-ecological model (SEM) 292–305, 319
components of 292–4
core concepts of 302–4
defined 292
individual 294–7
physical environment 299–301
policy 301–2
social environment 297–9
social environment 297–9
societal norms 433
sociocultural 220, 230
sociocultural considerations 334
sociocultural influences, on performance-enhancing 222–5
socioeconomic status (SES) 253, 258, 286
and physical activity levels 271
sodium bicarbonate 113–14, 126
SOFIT 278
soft and hard tissue 61–3
soft elastic bandages 82
soft-tissue injuries 63
SOPARC 278
SOPLAY 278–81
specialised sports foods 102, 104
spiritual benefits, of regular physical activity 247–9
spongy bone 5
sport/activity-specific phase 73
sport and/or exercise 44–6, 148
Sporting Schools 310–11
sports bars 106–7, 126
sports drinks 107–9
types 108
sports gels 106
sports injuries 60
common 65–6
sports injury prevention 71, 89
sports stars 304
sports technology and media 414–23
access and inclusion 415–16
local, national and global perspectives 419–20
participation and performance 416–19
sprain 61
stabiliser 40, 53
stakeholders 305, 319
state-sanctioned doping 224
static stretching 74, 99
steady state 156, 164
steroids 118–19, 126
strain 61
Strava 280
strenuous exercise 150
stressors 386, 393
stretching 74
stroke volume (SV) 154–6, 164
subjective 258, 286
subjective measures 274–7
submaximal exercise 156
SV *see* stroke volume
synergist 40, 53
synovial (freely moveable) joints 9, 11–13, 53
synthetic EPO 213
systemic circulation 143, 146, 164
systems thinking 292, 319
systole 140, 164
systolic blood pressure 156–7, 164

T

talent identification programs 401
taping 81–2, 89
technological advancements 417, 418
tendons 10–11, 53
terms of reference 13–15
thermoregulation 148, 164
cardiovascular system in 148–53
defined 142
during humid conditions 151–2
in physical activity 148
sport and/or exercise process 148–51
role of 148
third-class levers 44
tidal volume (TV) 173, 194
Tour de France's culture clash 223
training methods 94–5, 204
anaerobic 95–8
to improve performance 100
training program 326
TV *see* tidal volume
type 1 muscle fibres 29
type 2 diabetes 270, 286
type 2A muscle fibres 30
type 2B muscle fibres 30–2

U

untrained athlete 154

V

validity 335
valves 139
vascular system 143
vasoconstriction 150, 164
vasodilation 149, 164
veins 142, 145–6, 164
venous pooling 145, 164
ventilation (V) 173–4, 182–3, 194
ventricles 139, 164
vertebrae 8, 53
vertebral column 8, 53
VicHealth Walk to School program 307–8
VicHealth's This Girl Can program 308–9
Victoria's Child Safe Standards 410
vital capacity 175, 194
vitamins 114–15, 126
voluntary control 19, 53
voluntary muscles 19
VO_2 max *see* maximum oxygen uptake

W

WADA *see* World Anti-Doping Agency
warm up 73–4, 89
wearable devices 279–80
World Anti-Doping Agency (WADA) 117, 212