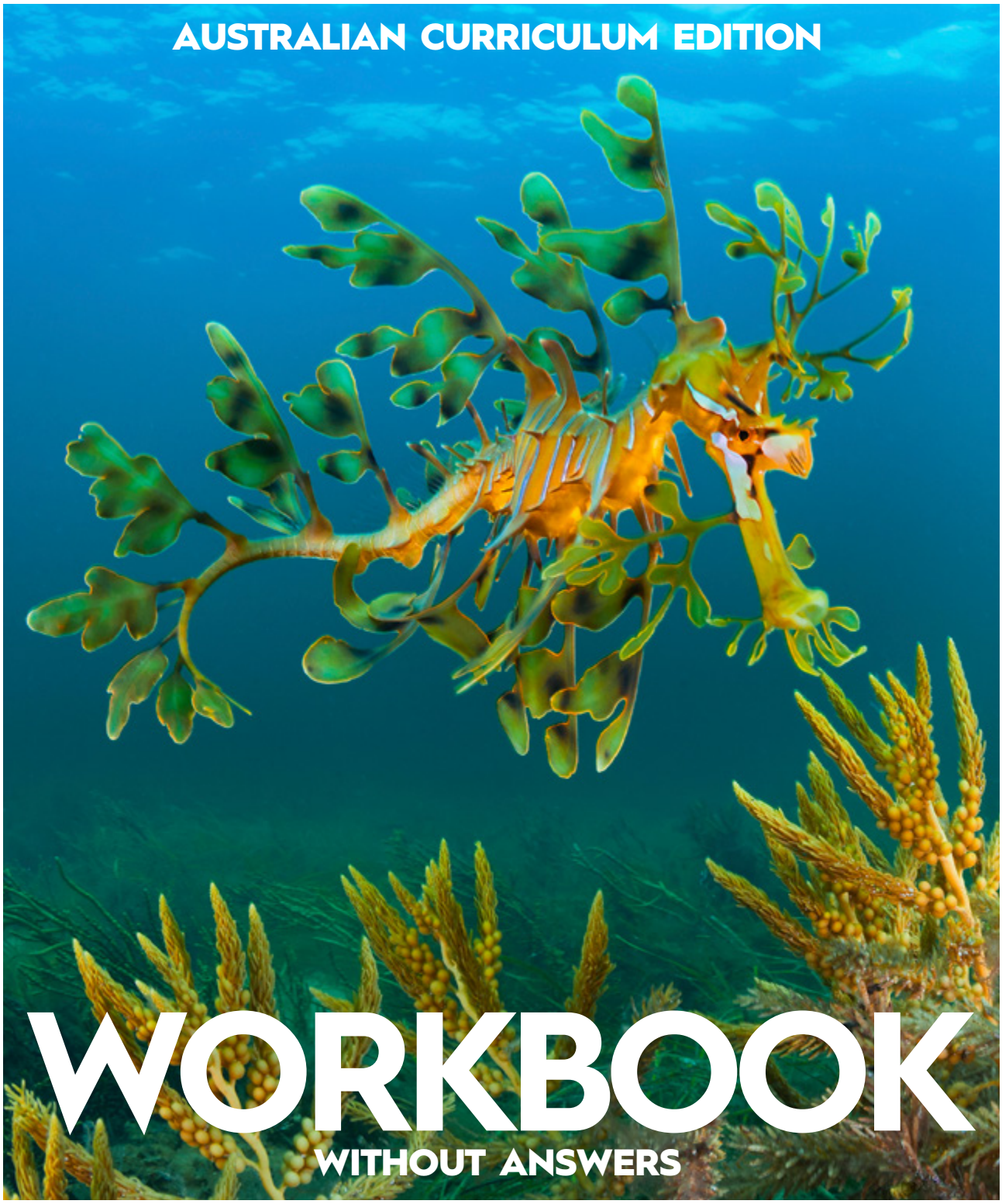
BIOLOGY

LEVELS OF LIFE

AUSTRALIAN CURRICULUM EDITION



WORKBOOK

WITHOUT ANSWERS

BRIAN LECORNU TONY DIERCKS

BIOLOGY

LEVELS OF LIFE

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WORKBOOK

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BIOLOGY: LEVELS OF LIFE WORKBOOK
WITHOUT ANSWERS
AUSTRALIAN CURRICULUM EDITION

First published 2017
Revised January 2018, December 2018, November 2020
New Version January 2024

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ISBN: 978-1-7635294-0-3

Published by Briton Books, ADELAIDE, SOUTH AUSTRALIA
Designed by ApplePi Design, SOUTH AUSTRALIA

PROUDLY PRINTED IN SOUTH AUSTRALIA

Cover Photograph:
Cover photograph © Gary Bell/OceanwideImages.com
A leafy seadragon off the coast of Yorke Peninsula, South Australia
Leafy Seadragons *(Phycodurus eques)* are endemic to Australia and are found from Lancelin WA, to Wilsons Promontory, Vic, but are mostly sighted in South Australian waters and southern WA waters. The Leafy Seadragon is the marine emblem of South Australia.

Contents

To the Student

BIOLOGY: Levels of Life Workbook (Australian Curriculum Edition), written specifically for the Stage 2 Biology subject outline of the SACE Board of South Australia, is designed to assist you as you work through the year and then be used as a resource and reference for final revision.

The questions in this workbook cover all of the Science Understandings that are examinable at the end of the year. There is a section designed to help you to select a topic and plan your Science as a Human Endeavour Investigation. We strongly advise that you seek help from your teacher in making this decision.

You will gain most benefit if you use this workbook in conjunction with its companion textbook **BIOLOGY: Levels of Life (Australian Curriculum Edition).**

As you work through the questions you should check your answers with your teacher. A complete set of Workbook answers is included in the **BIOLOGY: Levels of Life Teaching Notes (Australian Curriculum Edition),** and in the **Teacher Edition of the e-Workbook.**

We hope that you find the study of Biology interesting and enjoyable and that this workbook helps you to achieve success.

Acknowledgements

The authors would like to thank Sonya Johinke for editing the questions and for providing valuable suggestions during the preparation of this workbook. Phil Gibson at ApplePi Design has been extremely helpful in the preparation of the **BIOLOGY: Levels of Life Textbook, Workbook,** and **Teaching Notes.**

Brian LeCornu
Tony Diercks
January 2024

1 Chromosomes and DNA

Subject Outline terms and phrases	**DNA, double-stranded, helical, cytosol, prokaryote, nucleotide, genetic information, eukaryote, chromosome (linear, circular), nucleus**

1. Organisms are made of one or more cells and cells are made of chemicals.
   Define the following chemical terms:

   element:

   compound:

   molecule:

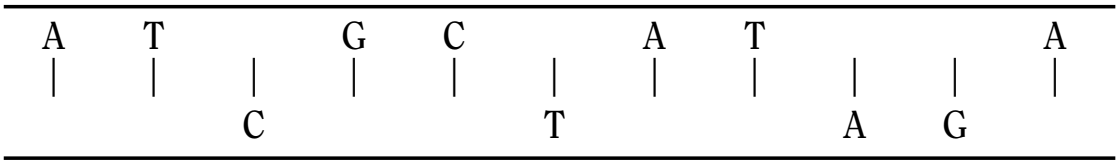
   organic compound:

2. (a) Describe how DNA stores and transmits genetic information.

   (b) DNA functions in the same way in all living things. Explain what this means.

3. (a) Describe a **nucleotide** molecule and name its subunits.

(b) Complete the following diagram of a segment of DNA to show the missing nitrogen bases.



(c) On the diagram in part (b) what has been used to represent the weak hydrogen bonds?

4. State four important features of DNA.

(1)

(2)

(3)

(4)

5. Explain why DNA is a suitable molecule for storing genetic information in organisms.

6. What is the difference between **cytosol** and **cytoplasm**?

7. (a) Describe the structure of a **chromosome** in a eukaryotic cell.

(b) What is the function of chromosomes?

8. Complete the following table comparing chromosomes in prokaryotes and eukaryotes:

	Chromosomes in prokaryotes	**Chromosomes in eukaryotes**
Shape		
Histones present or absent		
Location in cell		
Number per cell		
Introns present or absent (see glossary)		
Where centromere attaches during cell division		

2 The Language of Life

Subject Outline terms and phrases	**genetic information, nucleotide, weak bonds, complementary base-pairing, semi-conservative replication, universal, protein synthesis, gene, transcription, translation, mRNA, tRNA, amino acid, ribosome, codon, anticodon, exon, intron, polypeptide, DNA codon, RNA codon, coding strand, template strand**

1. DNA is generally described as a double helix. Explain what this term means by referring to the structure of DNA.

2. Explain what is meant by 'Base-pairing rules and method of DNA replication are universal'.

3. Refer to the diagram at right.

   (a) On the diagram label a **single nucleotide** [1], the **original DNA strands** [2], the **position of a weak bond between** the **strands of DNA** [3], and a **new DNA strands** [4].

   (b) Why is the replication of DNA called semi-conservative?

(c) Explain why the replication of DNA is necessary for DNA to carry genetic information from one generation to the next.

4. (a) Why is it that some of the information on a DNA molecule must be 'translated into proteins' in order to direct the activities of the cell?

(b) State the structure and function of a gene.

Structure:

Function:

5. Explain why the genetic code must be made up of codons that are at least three bases long.

6. What role does each of the following cell components play in protein synthesis?

(a) mRNA

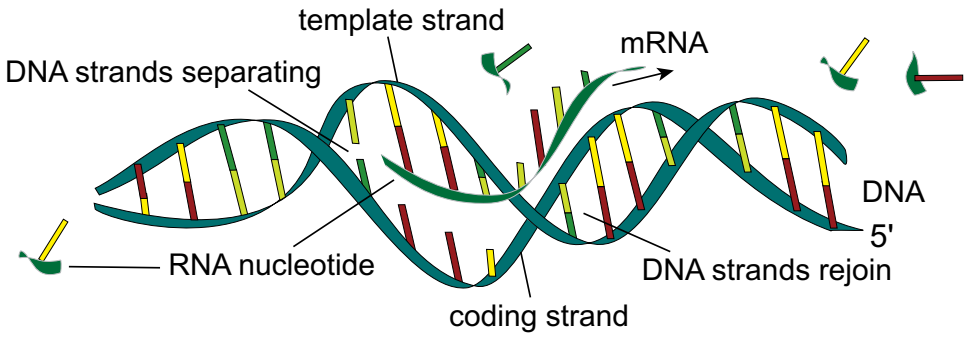
(b) tRNA

(c) ribosomes

7. Write the chromosome number on which the gene is located for the following human genetic diseases. (see textbook chapter 1 and 2)

haemophilia	red-green colourblindness
Huntington's disease	cystic fibrosis
Duchenne muscular dystrophy	retinitis pigmentosa

8. (a) On the diagram label the the coding strand, the template strand of DNA, the mRNA, the weak hydrogen bonds, and the ends of the strands



(b) Explain the meaning of 3' to 5' when referring to DNA.

9. Distinguish between DNA codons, RNA codons, and RNA anticodons.

DNA codons:

RNA codons:

RNA anticodons:

10. Complete the following table showing details of transcription and translation.

Process	Site in eukaryotic cells	Molecules involved	Product
Transcription		(1) (2) (3)	
Translation		(1) (2) (3)	

11. Use the words **gene, chromosome, DNA, bases,** and **protein** to fill in the gaps in the following sentence:

A segment of on a that contains the complete sequence of required to direct the synthesis of a is called a .

12. Use the genetic code (textbook P16) to complete the following table of codons and anticodons.

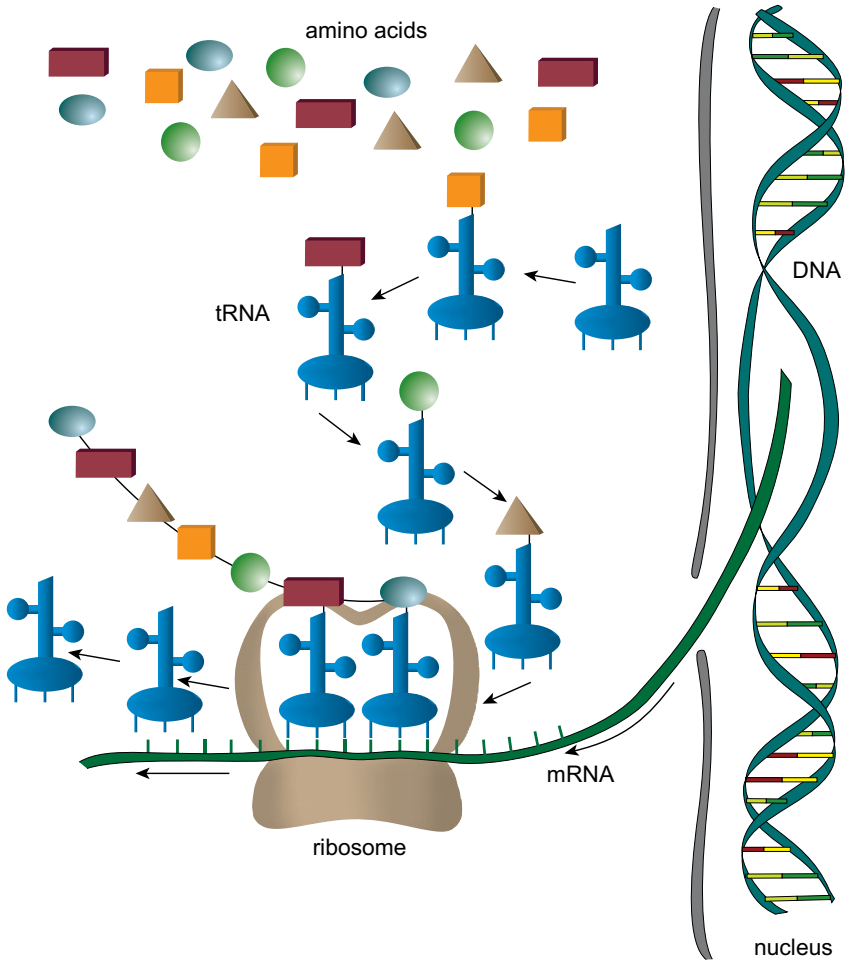
DNA (template)			TTA	
mRNA	CUA			
tRNA		GCC		
amino acid	leucine			glycine

13. How could a protein be affected by a change in the base sequence on the DNA?

14. Complete the following table showing details of nucleic acids. (see Textbook Chapter 1 and 2)

Nucleic acid	Overall shape	Bases present	Type of sugar present	Structure formed	Site in the cell
DNA	double helix				
mRNA					
tRNA					
				ribosome	

15. (a) Label each of the following structures on the diagram below.
amino acids, DNA, mRNA, nuclear membrane, ribosome, tRNA.



(b) In an eukaryotic cell transcription occurs in the

and translation occurs at the

16. (a) Distinguish between an **exon** and an **intron.**

(b) Describe how the RNA transcript is coverted to mature mRNA during the process of transcription.

3 Proteins

Subject Outline terms and phrases	**primary, secondary, tertiary, quaternary, three-dimensional shape, enzyme, hormone, receptor protein, antibody, substrate, induced-fit model, temperature, pH, inhibitors, activation energy**

1. Define the following terms used to describe protein formation.
   Primary structure:

   Secondary structure:

   Tertiary structure:

   Quaternary structure:

2. Explain how the primary and secondary structure of a protein give rise to a unique tertiary structure.

3. Complete the following table for protein function.

Function	Examples
structural	
	antibodies
	hormones
hormone recognition	
catalyse reactions	

4. Explain how the **three-dimensional shape** of proteins plays an important role in their ability to recognise and bind to specific molecules.

5. 'Antibodies are specific to their antigens'.

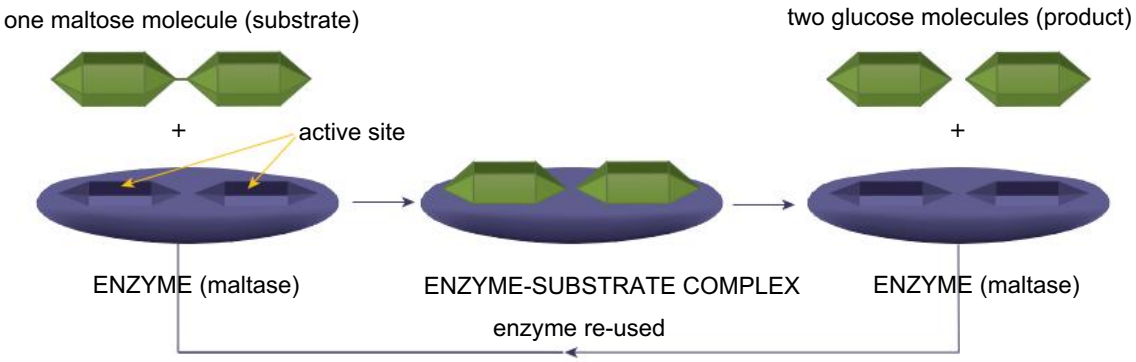
   Explain the statement above by referring to the molecular shapes of antigens and their corresponding antibodies.

6. (a) What is the function of **enzymes**?

   (b) What are enzymes made of and how do they differ from one another?

   (c) Explain the difference between **intracellular** and **extracellular** enzymes.

7. (a) On the diagram below label the **substrate, enzyme, enzyme-substrate complex** and **product.** Indicate the position of the **active site.**



(b) Use the example in the diagram above to explain why an enzyme is specific for its substrate.

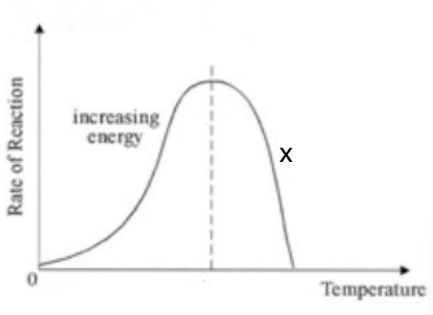
(c) Describe the induced-fit model of enzyme-substrate binding.

8. On the pH scale below label the positions that correspond to **acidic, basic,** and **neutral.**

9. Refer to the graph at the right.

(a) On the temperature axis, label the dotted line.

(b) Explain why the rate of reaction decreases in the region labelled X.

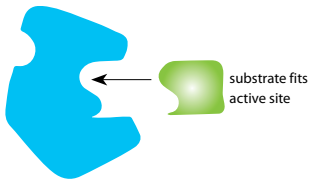


(c) Besides temperature, state two environmental factors that affect the activity of enzymes.

Factor 1:

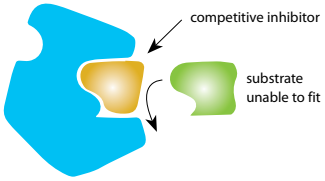
Factor 2:

10. (a) On the diagram at right label the enzyme (E), the competitive inhibitor (C), and the non-competitive inhibitor (NC).

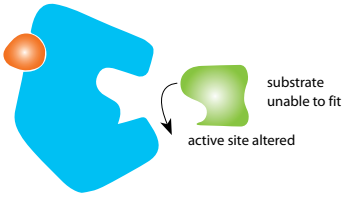


(b) Explain how (i) competitive and (ii) non-competitive inhibitors can affect the function of an enzyme.

(i) competitive inhibitors



(ii) non- competitive inhibitors



11. How do pH and temperature alter the binding of enzyme and substrate molecules?

pH

temperature

12. Explain the change in the rate of an enzyme-controlled reaction:

(a) as the concentration of reactants increases (See Textbook Fig. 3.17)

(b) as the concentration of the enzyme increases (See Textbook Fig. 3.18)

13. (a) What is meant by the term **activation energy**?

(b) What effect do enzymes have on the activation energy required for biological reactions?

4 Genes and Phenotypic Expression

Subject Outline terms and phrases	**phenotypic expression, cellular differentiation, tissue, gene expression, cytosine, methylation, epigenetic, cancer, mutation, cell division, ionising radiation, mutagenic chemicals, viruses, germ cells, somatic cells**

1. What is meant by:
   (a) **phenotypic expression**?

   (b) phenotype?

2. Complete the following table of gene products that influence phenotypic expression.

Gene Product	**Phenotypic expression**
increased EPO	
	diabetes
	increased body size and muscle mass
auxins	
	ripening of fruit
testosterone	
	female secondary sex characteristics

3. Complete the following table of environmental factors that affect transcription and translation, and hence phenotypic expression.

Environmental factor	**Phenotypic expression**
lack of oxygen in humans	
	change in skin colour
lack of iodine in axoltl diet	
	goitre in humans
malnutrition in children	
	increased plant growth

4. (a) What are **transcription factors**?

   (b) State two ways in which transcription factors control gene expression.

   (c) State two factors that affect translation.

5. Define the term cell differentiation, and give four examples of differentiated cells.

6. Explain how **methylation** of the **cytosine** nucleotide of a gene can affect the process of transcription.

7. Describe how **epigenetic** modifications such as changes in DNA methylation can lead to cancer.

8. (a) What is a '**mutation**'?

   (b) Explain what is meant by the idea that mutations can occur spontaneously.

   (c) List three factors that can increase the mutation rate.

9. Complete the following sentence.

   A change in the base sequence of _____ can cause a change in the _____ produced or the failure of a _____ to be produced. This may result in the appearance of new _____ in offspring.

10. (a) Explain the meaning of the term 'genetic disease'.

    (b) State three reasons why mutations that occur in your cells may have no apparent effect on you.

11. Explain why mutation of DNA in a **somatic cell**, such as a skin cell causing skin cancer, does not get passed on to the next generation.

12. Explain why mutation of DNA in a germ cell can lead to changes in the characteristics of descendants. Give three examples.

13. (a) State two examples of genetic and/or chromosomal abnormalities that result in disease in humans.

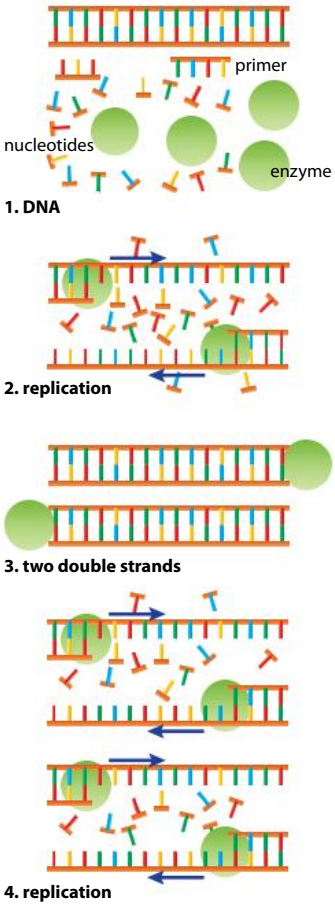
    (b) Describe the effects of these diseases. (see Textbook Chapter 13 for more details)

5 The Use of Genetic Information

Subject Outline terms and phrases	**polymerase chain reaction (PCR), base sequence, primer, heat-resistant enzymes, free nucleotides, electrophoresis, electropherogram, DNA profiling, forensic science, genome**

1. Outline the steps used to extract DNA from a cell.

2. By referring to the diagram at right describe how **PCR** is used to amplify small quantities of DNA. Use the terms heating and cooling, primers, free nucleotides, heat-resistant enzymes.



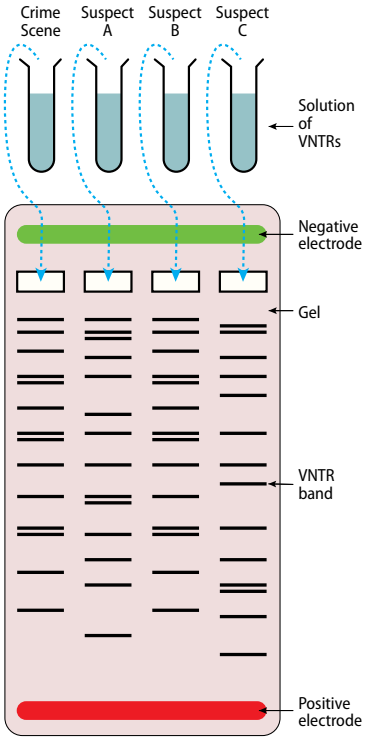
3. Explain how gel **electrophoresis** is used to:

   (a) produce an electropherogram that shows a DNA sequence

(b) separate DNA fragments of different lengths.

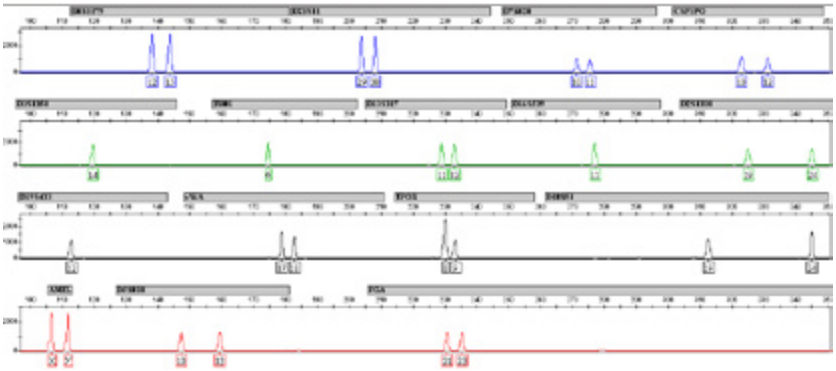
4. Explain why an individual can be identified by analysing their DNA fragments.

5. Refer to the diagram, which shows **DNA profiles** from a crime scene and three suspects. Which suspect's profile matches the DNA from the crime scene? Explain your answer, including why the other suspects' profiles do not match the DNA from the crime scene.



6. Make a list of the uses of the products of the PCR technique under each of the following headings:

forensic science	medicine	scientific research



Locus	Chromosome	STR	Allele values
D8S1179	8	TCTA	12,15
D21S11	21	TCTA	29,30
D7S820	7	GATA	10,11
CSF1PO	5	AGAT	10,12
D3S1358	3	TCTA	14,14
TH01	11	AATG	6,6
D13S317	13	TATC	11,12
D16S539	16	AGAT	11,11
D2S1338	2	TGCC	19,24
D19S433	19	AAGG	12,12
VWA	12	TCTA	17,18
TPOX	2	AATG	8,9
D18S51	18	AGAA	19,24
Amelogenin	X; Y		X,Y
D5S818	5	AGAT	10,13
FGA	4	TTTC	21,23

7. Refer to the diagram above, which shows an electropherogram and matching table of data for a DNA profile.

   (a) How many sites are represented on this electropherogram?

   (b) (i) At site D8S1179 this individual has a reading of 12,15. What does this mean?

   (ii) Why did the '12' and '15' fragments separate during electrophoresis?

   (c) List the sites at which this individual is homozygous.

   (d) What is an STR? Which STR is used at site VWA?

8. The Human Genome Project is one of the most ambitious undertakings by humanity.

   (a) State three benefits and potential benefits resulting from knowledge of the complete human genome.

   (b) State three problems that could arise from this knowledge.

9. (a) State three ethical issues that result from the collection of genetic information.

   (b) State and describe an economic issue that result from the collection of genetic information.

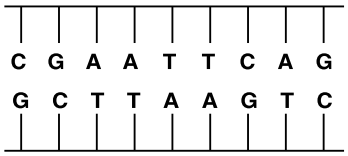
   (c) Explain why the collection of genetic information could be a cultural issue.

6 Biotechnology (Human Manipulation of DNA)

Subject Outline terms and phrases	**biotechnology, plasmid, vector, bacterial transformation, probe (DNA or RNA), restriction enzyme, virus, microinjection, CRISPR, electroporation**

1. (a) Describe the role of restriction enzymes in selecting and removing particular genes from a chromosome.

   (b) The DNA segment below is cut by the restriction enzyme ***EcoR1*** at the site 'AATT'.
   Write the base sequence of the sticky end of the left fragment after the DNA has been cut.



2. State three important features of a DNA or RNA probe.

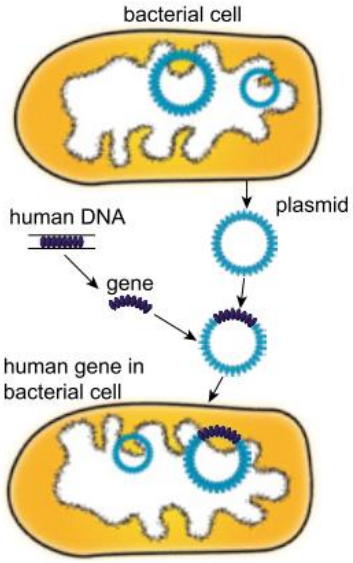
3. Describe how particular genes can be:

   (a) selected, using probes

   (b) removed, using restriction enzymes.

   (c) Name one method, other than DNA and RNA probes, that can be used to select a particular gene.

4. Use the diagram below to explain how a bacterial cell can be used to produce human insulin.



5. State three advantages and three disadvantages of the human manipulation of DNA.
   Advantages:

   Disadvantages:

6. Explain how and why a human gene needs to be altered before it can be expressed by a bacterial cell.

7. Describe how selected genes can be transferred between species using

   (a) **bacterial plasmids**

   (b) **viruses**

   (c) **microinjection**

8. What is meant by the term **transgenic organism**? Give an example to illustrate your answer.

9. Give three examples of chemicals or organisms that can be produced by genetic engineering.

10. Prior to the 1980s the hormone insulin was obtained by extracting it from cattle pancreases. Human insulin is now manufactured as a result of advances in genetic engineering. Discuss advantages and concerns of using genetic engineering to produce human insulin.
    Advantages:

    Concerns:

11. (a) What is **gene therapy**?

    (b) State two methods that are used in gene therapy.

12. (a) Present one argument for and one argument against the genetic manipulation of organisms for food and medicine.

Food:

Medicine:

(b) Discuss possible effects of the genetic manipulation of organisms on the environment.

13. (a) What is the function of the **CRISPR**/Cas9 system in bacteria?

(b) Describe how CRISPR can be used to edit genes.

(c) How can CRISPR be used to investigate the function of genes in embryos?

14. (a) Describe the steps involved in designing and manufacturing a specific protein.

(b) State three uses of designed proteins.

7 Living Things are Made of Cells

Subject Outline terms and phrases	**cell theory, cell membrane, cytoplasm, organelles, fluid mosaic model, prokaryotic, eukaryotic**

1. State six characteristics that together distinguish living things from non-living things.

   (1)

   (2)

   (3)

   (4)

   (5)

   (6)

2. By referring to your answers to question 1, explain why the cell is the smallest independent unit of life.

3. State the four main ideas of the **cell theory**.

4. Define the following terms.

   cell membrane

   cytoplasm

   organelle

5. Describe the structural differences between a lipid molecule and a phopholipid molecule.

6. Describe the fluid mosaic model of the cell membrane.

7. State four functions of the cell membrane.

8. Complete the following table, comparing prokaryotic and eukaryotic cells:

	Prokaryotic cells	**Eukaryotic cells**
Size		
Chromosome shape		
Presence of nucleus		
Organisation		
Membrane-bound organelles		
Number of chromosomes		
Location of chromosome/s		
Composition of cell wall		

9. State three features of prokaryotic cells and eukaryotic cells that are a reflection of their common evolutionary past.

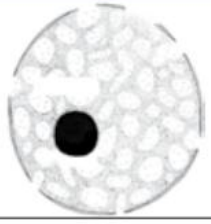
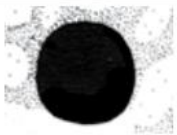
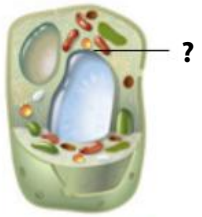
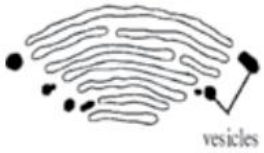
8 Cell Structure and Function

Subject Outline terms and phrases	**organelle, nucleus, nucleolus, mitochondrion, chloroplast, vacuole/vesicle, Golgi body, endoplasmic reticulum(rough and smooth), ribosome, lysosome, cytoskeleton**

1. For each of the following terms, state whether it refers to the **structure** or **function** of a cell:

microscopic	metabolic	cell wall
reproduces	synthesises protein	contains DNA
synthesises DNA	spherical	photosynthesises
respires	cell membrane	

2. Complete the table below which shows features of organelles in eukaryotic cells.

Organelle	Diagram	Function	Distinguishing feature(s)
		controls cell activities	
		rRNA synthesis	
		photosynthesis	
			
			inner membrane folded to form cristae
			

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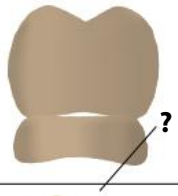
			made of rRNA and protein
		releases digestive enzymes	

3. Describe the following structures, their function, and their location.

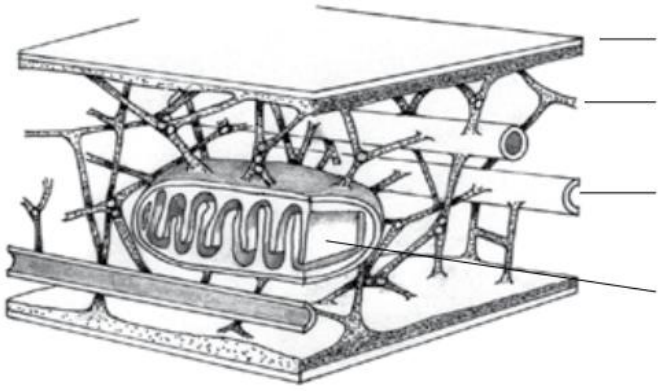
   nuclear envelope

   chromatin

   chromosome

   cristae

4. Label each of these structures:
   microfilament, microtubule, cell membrane, mitochondrion

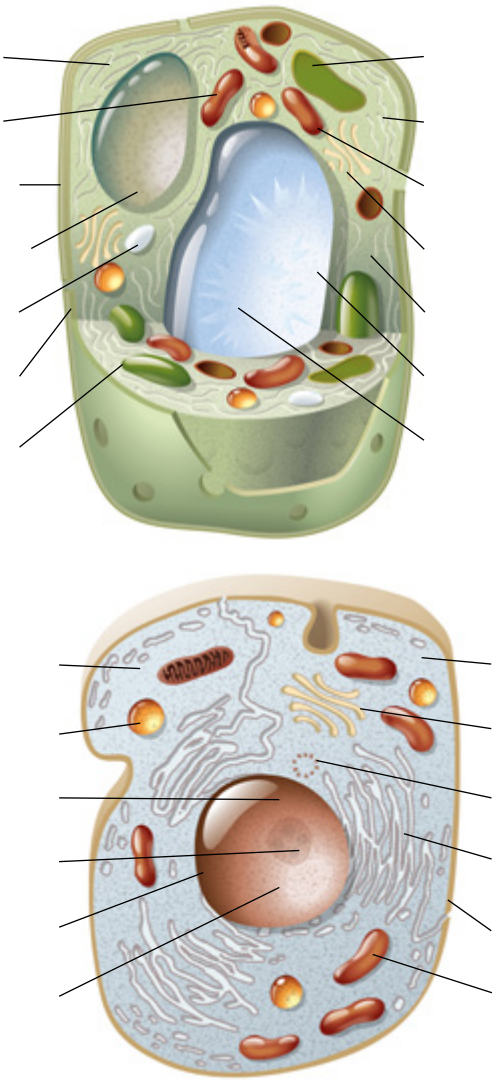


5. State three main functions of the cytoskeleton.

6. Complete the following table which shows the composition, function, and location of components of the cytoskeleton.

Component	Protein component	Description of subunits	Function	Found in
microfilament			intracellular movement	
	tubulin	globular		cilia and flagella
intermediate filament	keratin			skin cells

7. Complete the labelling of the diagrams of plant and animal cells.



8. Complete the following table which compares animal and plant structures.

Structure	Plant cell	Animal cell
cell wall	present	
cell membrane		
nucleus		
nucleolus		
mitochondrion		
chloroplast		absent
vacuole		
Golgi body		
vesicle		
endoplasmic reticulum		
ribosome		
lysosome		
cytoskeleton		

9 Living Cells Need Energy

Subject Outline terms and phrases	**energy, light energy, chemical energy, autotroph, heterotroph, photosynthesis, chlorophyll, energy transformation, chemical bond, ATP, ADP, Pi, metabolic reactions, aerobic respiration, fermentation (anaerobic respiration)**

1. (a) What is **energy**?

   (b) State three reasons why living cells need energy.

   (1) (4)

   (2) (5)

   (3) (6)

2. Complete the following sentences:

   The energy that cells obtain from their environment can be in either or form. Some cells use sunlight, a form of energy, while others must take in , a form of energy.

3. Define the following terms:

   (a) **autotroph**

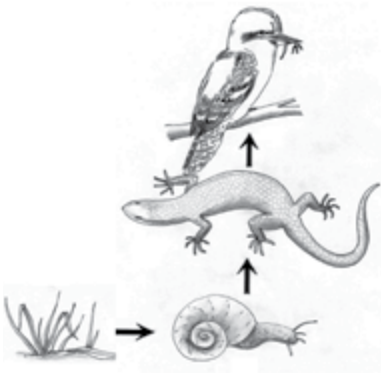
   (b) **heterotroph**

   (c) **photosynthesis**

4. Complete the following table which refers to energy transformations in cells.

Cell	Energy input	Energy output
photosynthetic cell		
muscle cell		
light-emitting cell (e.g. glow worm)	chemical	

5. By referring to the diagram on the right, state the source of organic molecules for each organism.



grass:

snail:

lizard:

kookaburra:

6. (a) What is the main source of energy for life on Earth?

(b) Explain how a heterotroph like yourself is able to obtain energy from this source.

(c) Explain why nearly all life on Earth is dependent on the process of **photosynthesis**.

7. Complete the missing information in the following chemical and word equations for photosynthesis.

$$+ \quad 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light energy}} C_6H_{12}O_6 + $$

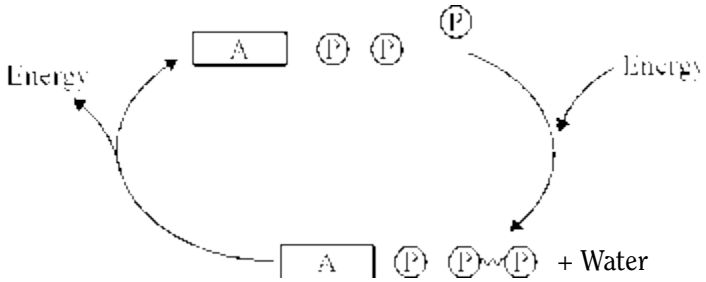
$$+ \quad \text{water} \xrightarrow[\text{chlorophyll}]{\text{light energy}} + \quad \text{oxygen}$$

8. What is the role of chlorophyll in photosynthesis?

9. (a) Explain why certain molecules, such as glycogen, starch, and lipids, are able to be used as stores of energy.

   (b) Energy changes occur when **chemical bonds** are broken and new bonds are formed. By referring to this statement, explain why the breakdown of glucose in the presence of oxygen, to form carbon dioxide and water, releases energy.

10. Use the following diagram of the **ATP** cycle to answer the questions below.



   (a) What is the source of the energy that enters the ATP cycle?

   (b) State three uses of the energy that is released in the ATP cycle.

11. Define the term **cellular respiration.**

12. Some cells provide themselves with energy using a chemical process requiring oxygen, while other cells use a chemical process that does not require oxygen. Certain cells are able to use both processes.

    Name these chemical processes that cells use to provide themselves with energy.

    (1) chemical process requiring oxygen

    (2) chemical process not requiring oxygen

13. Complete the missing information in the following summary equation for **aerobic respiration**.

    $C_6H_{12}0_6$ + ——————> + $6H_2O$

    + oxygen ——————> + water

14. Complete the following sentence.

    Energy that is released as a result of breakdown of glucose in the presence of oxygen is either lost as _____ or is used to make _____ which can be used by the cell for energy-requiring processes.

15. Complete the following table which shows details of the stages of aerobic respiration.

Name of reaction	Site of reaction	Reactants	Products	Net gain of ATP
glycolysis			pyruvate	
phosphorylation	cytoplasm and mitochondria			

16. Complete the missing information in the following summary equations for **fermentation (anaerobic respiration)**.

    In plants and yeasts

    $C_6H_{12}0_6$ ——————> $2C_2H_5OH$ + _____

    glucose ——————> _____ + _____

    In animals

    $C_6H_{12}0_6$ ——————> $2C_3H_6O_3$

    _____ ——————> _____

17. Complete the following table which summarises the main differences between aerobic respiration and fermentation (anaerobic respiration) in eukaryotes.

	Aerobic Respiration	Fermentation
Site of reaction(s)		
Reactants		
Products in animals		
Products in plants and yeasts		
Amount of ATP produced per glucose molecule		

18. (a) State two commercial uses of fermentation.

(b) Under what conditions would a human cell carry out lactic acid fermentation?

19. Explain why much less energy is released through fermentation than through aerobic respiration, even though both processes involve the breakdown of glucose.

20. Human sperms cells contain a large number of mitochondria.
Explain how this relates to their function.

A sperm cell containing mitochondria

10 Movement in and out of Cells

Subject Outline terms and phrases	**transport proteins, channel proteins, aquaporins, carrier proteins, diffusion, facilitated diffusion, osmosis, active transport, endocytosis, exocytosis, surface-area-to-volume ratio, concentration gradient, exchange**

1. Complete the tables below to summarise the differences in inputs and outputs for autotrophic and heterotrophic cells.

Table of inputs

Substance	Autotrophic cells	Heterotrophic cells
oxygen		
carbon dioxide		
nitrates, nitrites		
phosphates		
calcium		
other inorganic nutrients		
organic compounds		

Table of outputs

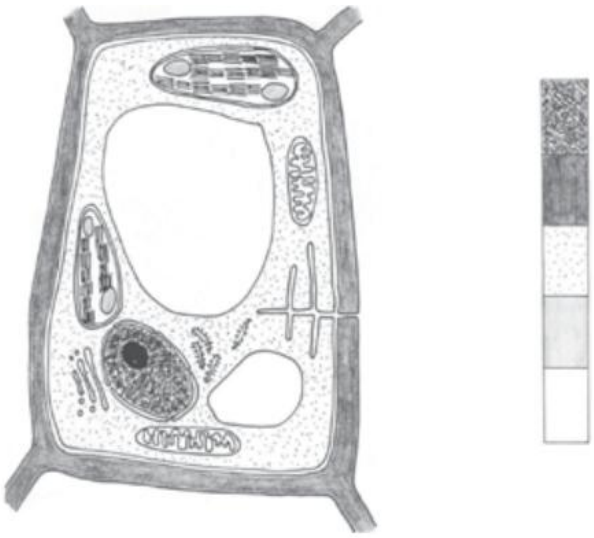
Substance	Autotrophic cells	Heterotrophic cells
oxygen		
carbon dioxide		
lactic acid		
ethanol		
urea		

2. The membrane of a human muscle cell maintains different concentrations of materials inside and outside the cell. Give an example of a substance that has a higher concentration inside a human muscle cell than outside, and an example of a substance that has a higher concentration outside a human muscle cell than inside.

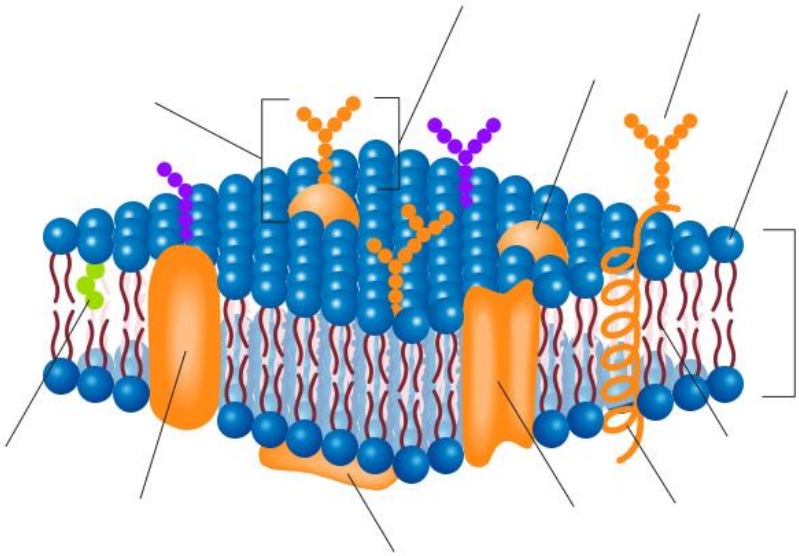
   Substance that has a higher concentration inside

   Substance that has a higher concentration outside

3. Label the key next to the diagram below to show the location of *starch, cellulose, water, protein* and *nucleic acids* in the cell. On the cell diagram label the location of *lipids.*



4. (a) Label the features of the fluid mosaic model of the Cell membrane shown below.



(b) State 3 functions of the cell membrane.

5. Give two examples of transport proteins

6. Define the following terms and give examples.

   concentration gradient

   passive process

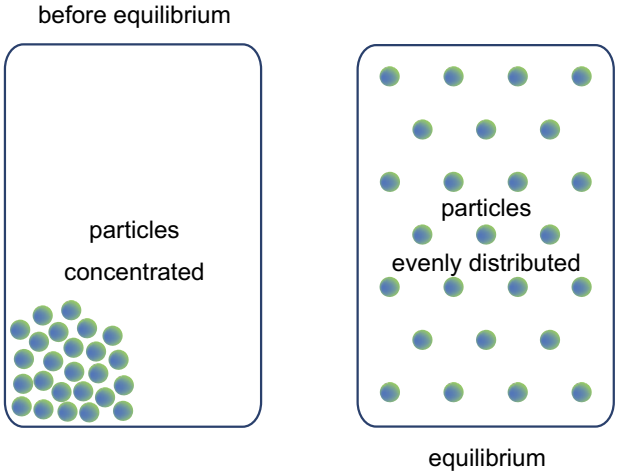
   semi-permeable

   active process

7. Complete the following table which refers to the processes by which substances move across membranes.

Process	Active/Passive	Example of substance moving	Direction of movement
diffusion			
facilitated diffusion			with concentration gradient
	passive	water	
	active	sodium ions and potassium ions	
pinocytosis			into cell
		bacterial cells	into cell of immune system
exocytosis			

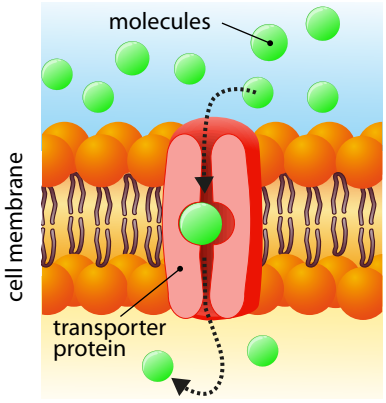
8. The following diagrams represent the position of molecules in a fluid before and after **diffusion** has occurred.



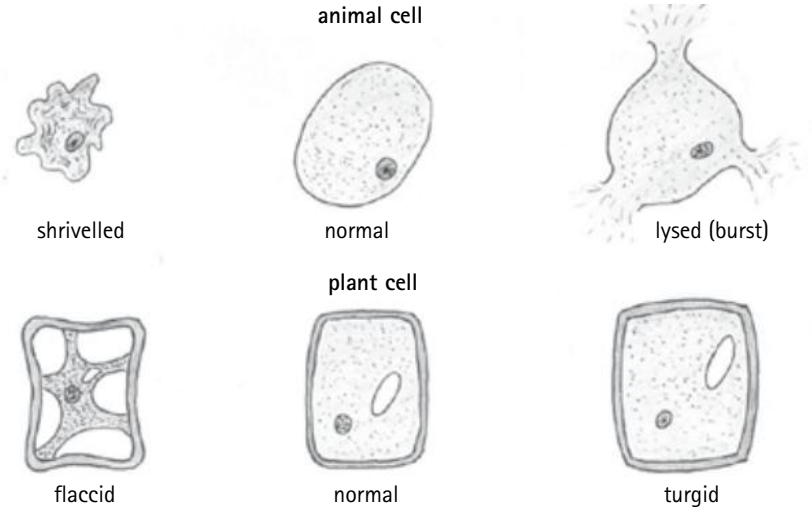
Explain what has happened between the first and second diagram.

9. (a) What is meant by the selective exchange of materials by the cell membrane?

(b) Explain how **facilitated diffusion** works, by referring to the following diagram.



10. The following diagram shows the effects of osmosis on animal and plant cells. In the spaces below the diagram explain what has happened to the flaccid/shrivelled and the turgid/lysed cells.

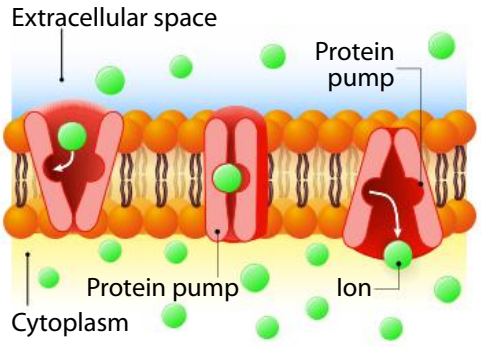


flaccid/shrivelled:

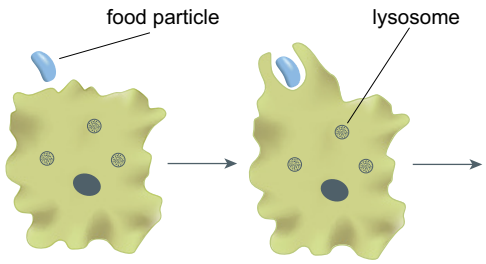
turgid/lysed:

11. Explain why osmosis is considered to be a special case of diffusion.

12. Explain how **active transport** works, by referring to the following diagram.



13. The following diagram shows a cell that is about to engulf a food particle.



(a) Describe the remaining steps in the process

(b) State the name of this cellular process.

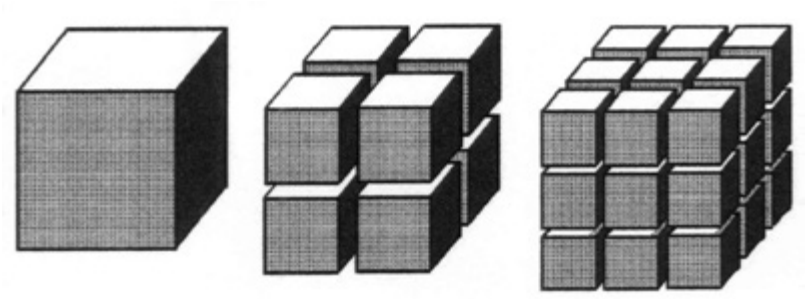
(c) Name two cells that carry out this process.

14. Complete the following table which shows features of some energy-requiring processes that move substances across cell membranes.

Type of movement	Direction of movement	Examples of cells involved	Example of substance moved	Energy supplied by
endocytosis (phagocytosis)	into the cell			ATP
endocytosis (pinocytosis)			fat droplets	
exocytosis		salivary glands		
active transport		human muscle cell		

15. Explain the meaning of the statement 'The cell membrane is a dynamic structure'. In your answer you should refer to the role of the membrane in active transport, endocytosis, and exocytosis..

16. The diagram below shows the change in surface area that occurs when a large cube (6 cm by 6 cm by 6 cm) is divided into eight equally-sized medium cubes or 27 equally-sized small cubes.



(a) Calculate the total surface area of

(i) the 27 small cubes

(ii) the eight medium cubes

(iii) the one large cube

(b) Use your answers to explain how the **surface-area-to-volume ratio** changes as the large cube is divided into smaller pieces.

(c) Explain why the relationship between surface area and volume is an important factor in determining the survival of cells.

17. (a) State two processes that contribute to in an increase in the size of a cell.

(b) Explain why the size of a cell is limited by the change in its surface area to volume ratio as it grows.

18. (a) Explain how the concentration gradient of a substance affects its direction and rate of diffusion across a cell membrane.

(b) Explain why active transport is needed to move some substances across a cell membrane.

19. Explain how the physical and chemical nature of the materials being exchanged affects their movement across a cell membrane

20. Describe the role of the Golgi body in moving substances, such as enzymes and hormones, out of the cell.

11 Cell Metabolism

Subject Outline terms and phrases	**cell metabolism, metabolic pathway, intermediate compound, environmental factor**

1. What is meant by the term **cell metabolism**?

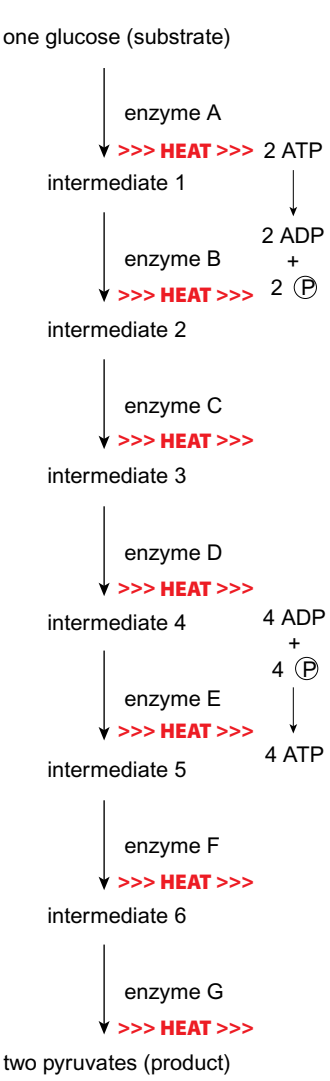
2. (a) Describe the structures of the internal membranes of mitochondria and chloroplasts.

   (b) Explain how the structures of the internal membranes of mitochondria and chloroplasts facilitate some biochemical processes.

3. Explain how biochemical processes in the cell are influenced by the presence of specific enzymes.

4. State three **environmental factors** that influence biochemical processes in the cell.

5. Refer to the diagram at right to answer the following questions.



   (a) Explain why a different enzyme is required for each step in the **metabolic pathway**.

   (b) Explain why the amount of energy in the glucose molecule is greater than the amount of energy in the two pyruvate molecules combined.

   (c) Explain what would happen if enzyme E was inactivated.

6. State four reasons why metabolic pathways in cells involve many small regulated steps.

   (1)

   (2)

   (3)

   (4)

7. (a) Complete the following sentence:

   Poisons are that with cell metabolism.

   (b) State three ways in which poisons can cause this effect on cells.

8. Complete the following table which shows the effects of some chemicals on protein synthesis in prokaryotic and eukaryotic cells.

Chemical	**Effect on prokaryotes**
Chloramphenicol	
	Stops growing peptide moving to new codon
Tetracycline	
	Prevents proper assembly of ribosomes
Rifamycin	
	Effect on eukaryotes
Amanitin	
	Same as chloramphenicol for prokaryotes
	Effect on both
Actinomycin	
	Causes incomplete peptides to fall off the ribosome

9. Complete the following table which shows the effects of some chemicals on cell metabolism.

Chemical	**Effect on cell metabolism**
Carbon monoxide	
	A non-competitive inhibitor
Cyanide	
	Attacks a step in the synthesis of bacterial cell walls
Barbiturates	
	Binds to potassium ion

10. Name the chemicals and provide information about their beneficial use as indicated in the brackets for each of the following categories:

    medical (5 uses):

    agriculture (3 uses):

    food preservation (3 substances)

11. State a harmful effect of each of the following chemicals and explain why the chemical is or was used by humans.

    radium

    mercury

    DDT

    sulfur dioxide

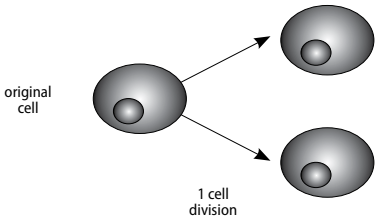
    thalidomide

12 New Cells from Old

Subject Outline terms and phrases	**cell division, somatic cells, gametes, germ-line cells, binary fission, mitosis (mitotic division), asexual reproduction**

1. (a) Where do all new cells come from?

   (b) Refer to the diagram that shows one cycle of cell division. State the number of cells that will be present after three cycles of cell division.



2. The chemical unit of genetic information in most organisms is DNA.

   (a) Explain why the amount of DNA in a cell doubles before cell division.

   (b) What would be the consequence if a cell divided before the replication of DNA occurred?

3. Define the following terms.

   (a) somatic cells

   (b) germ cells

   (c) diploid cells

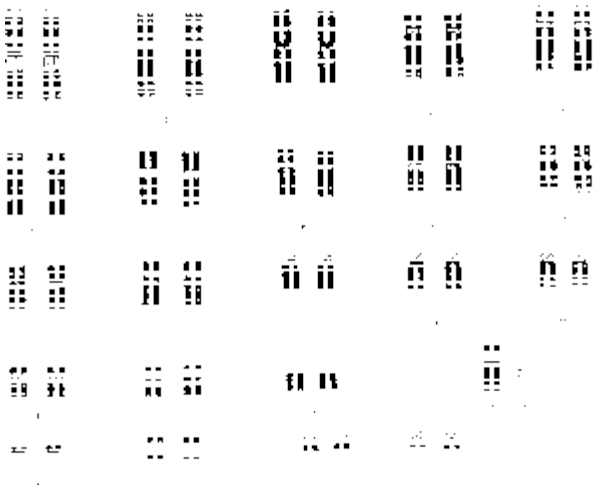
   (d) homologous chromosomes

   (e) haploid cells

   (f) zygote

   (f) germ-line cells

4. Use the human karyotype to answer the following questions. (also refer to Chapter 2)

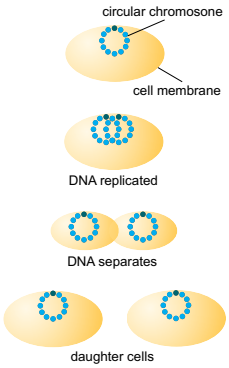


(a) Is this karyotype that of a male or a female? Explain:

(b) How many non-sex chromosomes (autosomes) are in this karyotype?

(c) How could biologists construct a human karyotype like the one shown above?

5. State the name of this process, and describe it using the terms *chromosome, cell membrane, daughter cells*



6. The process of cell division in eukaryotes involves **mitosis**, the precise division of the contents of the nucleus.

   Name the phases of mitosis and describe what happens to the chromosomes at each phase.

   (1)

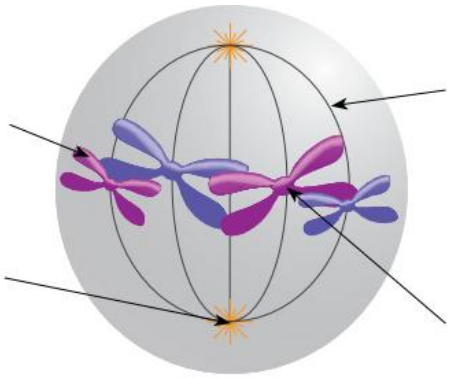
   (2)

   (3)

   (4)

7. The diagram below shows an animal cell that is entering metaphase of mitosis.

   (a) Label the following structures on the diagram:
   chromatid, centromere, spindle fibres and pole.



   (b) How many chromosomes does this cell contain?

8. The two daughter cells that result from a mitotic division contain identical sets of chromosomes. Explain the key events that occur leading up to and during mitosis that produce these genetically identical cells.
   In your answer you should use the following terms:
   replication, condensation, sister chromatids, centromere, spindle fibres, separation

9. Define the following terms.
   (a) asexual reproduction

   (b) budding

   (c) clone

10. (a) State three types of asexual reproduction used by plants.

(1)

(2)

(3)

(b) Name three types of animal that can reproduce asexually.

(1)

(2)

(3)

(c) Name the type of cell division that is involved in asexual reproduction in eukaryotes.

11. (a) Explain why the offspring produced by asexual reproduction are genetically identical to each other and to the parent.

(b) Explain how variation occurs in asexually reproducing organisms.

12. How do the number and type of chromosomes in the daughter cells produced by mitotic division or binary fission compare to those of the parent cells?

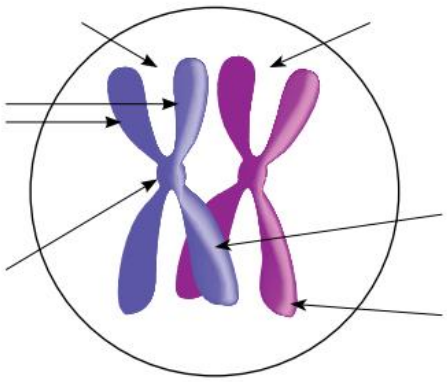
13 Sexual Reproduction and Meiosis

Subject Outline terms and phrases	**diploid, haploid, homologous, meiosis, crossing over, independent assortment, fertilisation, genetic variation, sexual reproduction**

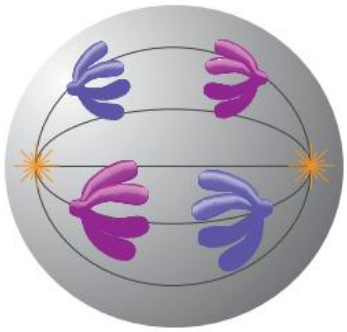
1. (a) How many types of autosome are present in a normal **diploid** human cell?

   (b) How many of each type of autosome are present in a normal diploid human cell?

2. Label the diagram below showing a pair of homologous chromosomes as they would appear while crossing over during late prophase I. Label the following features on your diagram:
   centromere, sister chromatids, chiasma, maternal chromosome and paternal chromosome

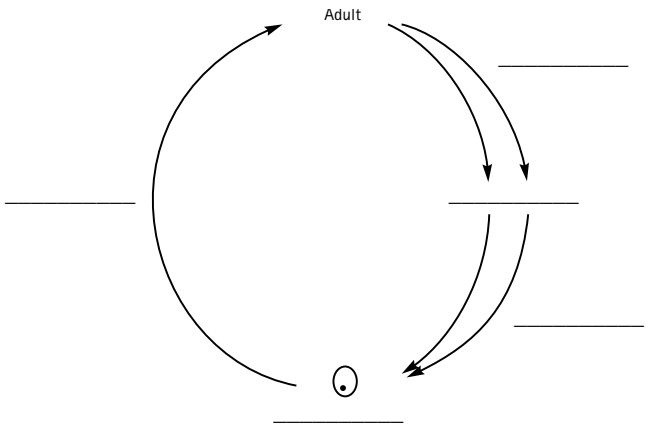


3. (a) Describe what is happening during anaphase I.



   (b) Describe how a second diagram could be drawn (and compared to the diagram in part (a)) to illustrate the idea of independent assortment.

3 (c) Use the following terms to label the diagram below which represents the life cycle of a sexually reproducing organism.
growth and mitosis, gametes, meiosis, fertilisation, zygote



4. Explain how (a) crossing over and (b) independent assortment contribute to genetic variability in the offspring of a sexually reproducing species.

(a) crossing over:

(b) independent assortment:

5. (a) Give an example of a syndrome in humans that is caused by the presence of an extra autosome.

(b) How is it possible for a human to receive this extra autosome?

(c) State one environmental factor that can increase the incidence of this syndrome.

6. Complete the table below to show the differences between **haploid** and **diploid** cells in humans.

	Haploid cell	Diploid cell
Number of chromosomes		
Number of sex chromosomes		
Site of production		
Is further cell division possible?		
Number of autosomes		
Is fusion with another cell possible?		

7. Define the term **fertilisation.**

8. Fill in the missing details in the following description of fertilisation in humans.

SPERM	+	EGG	⟶	ZYGOTE
CHROMOSOMES		CHROMOSOMES		CHROMOSOMES

9. Complete the following table which compares the products of mitosis and meiosis in humans.

	Mitosis	Meiosis
Number of divisions		two
Type of parent cell		germ cell
Number of chromosomes in parent cell		
Type of cell produced	somatic cell	
Number of chromosomes in a daughter cell		
Is product haploid or diploid?		
Number of cells produced in males from one parent cell		

10. Compare the degree of genetic variation in the products of asexual reproduction and sexual reproduction.

11. Complete the following table to show whether the source of genetic variation contributes to the products of asexual and sexual reproduction.

Source of genetic variation	Asexual reproduction	Sexual reproduction
mutation	yes	
crossing over		
independent assortment		
random fertilisation		

12. Explain how fertilisation contributes to the genetic variability of offspring.

14 Control of Cell Division

Subject Outline terms and phrases	**internal factors, external factors, cell cycle, checkpoints, gene products, hormones, carcinogen, regulatory genes, cell culture**

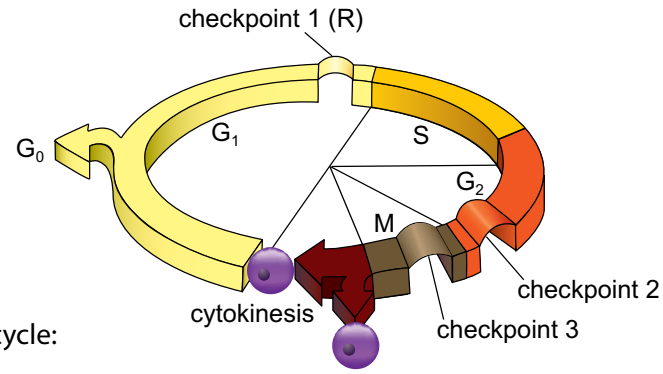
1. State two **gene products** that a cell produces to regulate the **cell cycle**.

2. State two **external factors** that regulate the cell cycle.

3. Complete the following table describing the cell cycle.

Stage	Event(s)	Major Checkpoint (yes or no)
G_0		no
G_1		
	DNA replication	
G_2		yes
mitosis		
cytokinesis		

4. The diagram shows phases of the cell cycle.



(a) State one process that occurs in:

G_1

S

G_2

(b) Explain the roles of each of the following gene products in the regulation of the cell cycle:

growth factors

cyclin

Cdk

MPF

5. Interphase refers to the period in the cell cycle when the cell is not dividing. State three processes that occur in the cell during interphase.

6. What are the two key factors that trigger a stem cell to divide?

7. Plant hormones and growth factors are important in the regulation of cell division. Give three examples of each.

plant hormones:

growth factors:

8. Explain how **carcinogens** upset the normal control of cell division.

   What can happen as a result of this?

9. Complete the following table which shows the most likely cause of mutations that result in different forms of cancer.

Type of cancer	Most likely cause of mutation
skin cancer	
	carcinogens in cigarette smoke
colon cancer	
	high energy radiation (e.g X-rays)
bladder cancer	
	asbestos

10. Humans have been unknowingly culturing cells for thousands of years.
    State three uses for culturing yeast cells and two uses for culturing bacterial cells that humans have been engaged in for centuries.

    uses for culturing yeast cells

    uses for culturing bacterial cells

11. State four contemporary uses of cell culture.

    (1)

    (2)

    (3)

    (4)

12. Cells can be cultured in a number of ways. Provide a contemporary use for each of the following:

    (a) bacterial cell culture on agar plates

    (b) HeLa cells

    (c) animal cell cultures

    (d) plant cell culture

13. (a) State four special provisions required for the growth medium used to culture animal cells.

    (b) State three steps, in the correct sequence, that need to be followed in the technique of plant tissue culture.

14. State two advantages of plant tissue culture over other methods of propagating plants.

    (1)

    (2)

15 Organisms Have Tolerance Limits/

Subject Outline terms and phrases	**internal factors, external factors, cell cycle, checkpoints, gene products, hormones, carcinogen, regulatory genes, cell culture**

1. (a) State five properties of tissue fluid that are kept reasonably constant in humans.

   (1)

   (2)

   (3)

   (4)

   (5)

   (b) Use the concept of **tolerance limits** to explain why it is important that the properties of the tissue fluid that surrounds cells remain reasonably constant.

2. By referring to the diagram below, explain the unique distribution of the trees in the arid outback of Australia.

3. Name a resource whose low level limits the productivity of communities in each of the following locations.

Community location	Resource
Sargasso sea	
an Australian desert	
River Murray	
deep ocean floor	
Mt Kilimanjaro	

16 Homeostasis

Subject Outline terms and phrases	**stimulus, response, stimulus-response model, sensory receptor, effector, homeostasis, internal environment, negative feedback, nervous system, endocrine system**

1. (a) What is meant by the term **stimulus**?

   (b) State four examples of a stimulus.

2. (a) List five main types of **sensory receptor** that are found in humans.

   (b) State five examples of changes in the external environment that humans detect, and to which they respond.

   (c) State two examples of changes in the external environment that humans do not detect, and to which they do not respond.

   (d) Explain why it is important that humans selectively detect and respond to changes in the external environment.

3. Choose one type of sensory receptor found in humans, and explain how the loss of this type of receptor would affect an individual.

4. (a) What is meant by the term **response**.

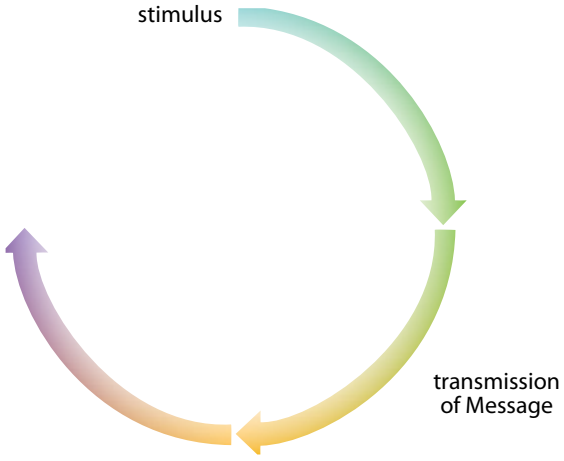
(b) List two types of effector

5. Define the following terms.

homeostasis:

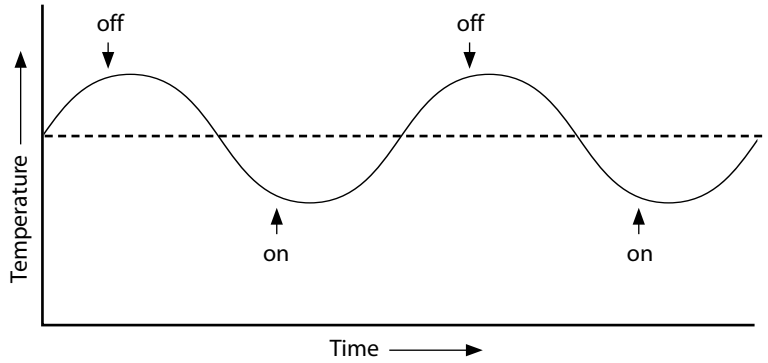
negative feedback:

6. (a) Fill in the missing words to show the five elements of a **stimulus-response model** in the correct sequence.



(b) By referring to the diagram explain the term negative feedback.

7. By referring to the graph below, explain how a homeostatic control mechanism works by responding to a change in the internal environment (such as body temperature), and explain why it cannot keep the factor constant.



8. State two organ systems that are involved in coordination and control in humans.

   (1)

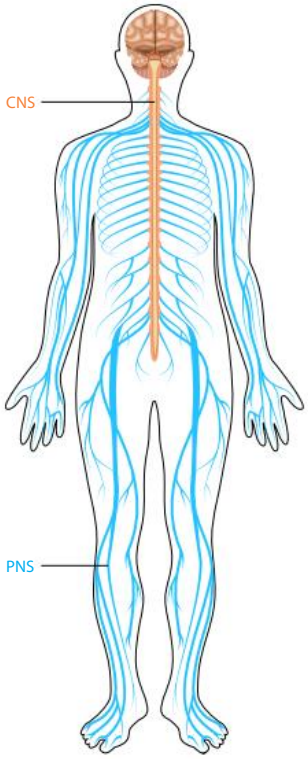
   (2)

17 The Nervous System

Subject Outline terms and phrases	**central nervous system (CNS), peripheral nervous system (PNS), sensory neuron, interneuron, motor neuron, nerve pathway, synapse, neurotransmitter, reflex response**

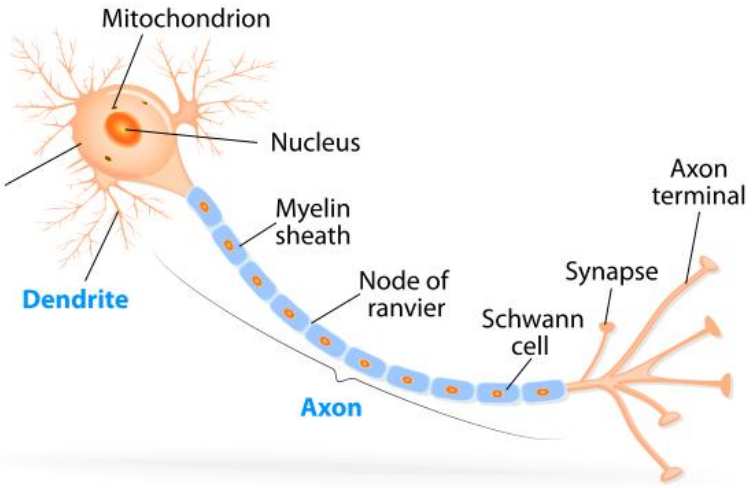
1. (a) On the diagram label the **central nervous system (CNS)** and the **peripheral nervous system (PNS)**.

   (b) State three functions of the CNS.



   (c) Name the two parts of the PNS and state which part of the body each one controls.

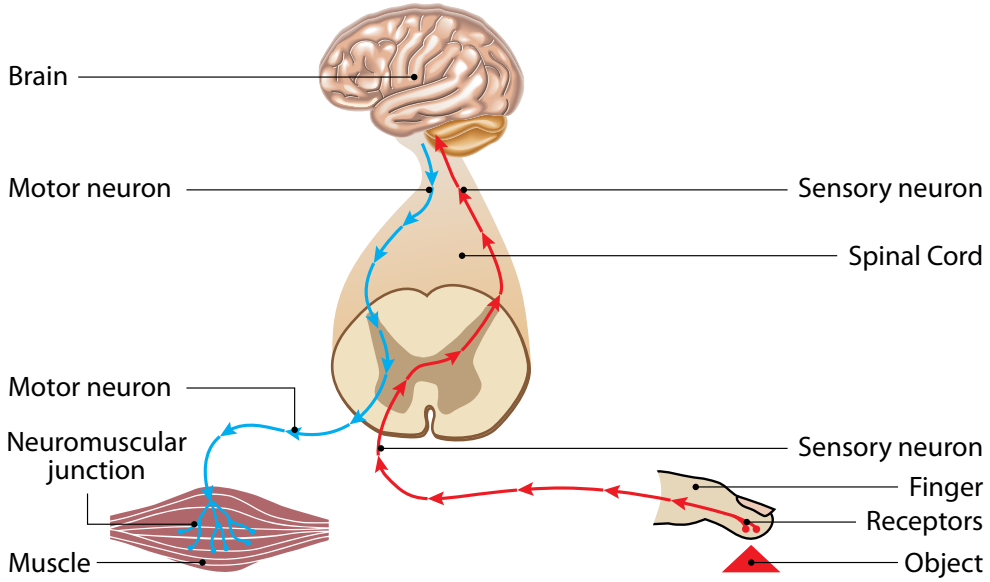
2. On the diagram below, label the following structures:
   cell body, dendrite, nucleus, axon, axon terminal



3. Complete the following table to show the structure and function of **sensory neurons**, **interneurons**, and **motor neurons**.

	sensory neuron	interneuron	motor neuron
unipolar or multipolar			
location	peripheral NS		
main role			
receives signal from	receptor		
sends signal to			

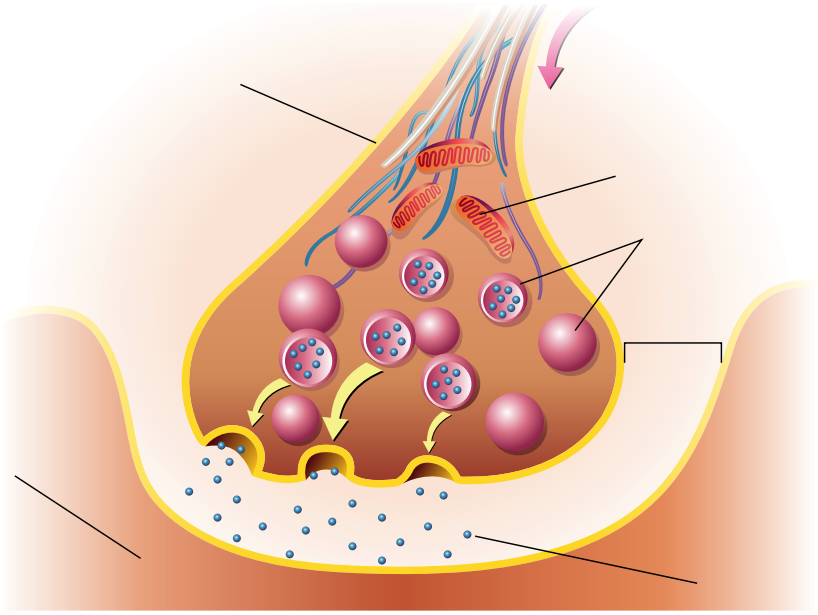
4. Use the following diagram to describe the structure of a **nerve pathway** from receptor to effector:



5. (a) What is a **synapse**?

(b) What is a **neurotransmitter**? Give two examples.

(c) Label the Synapse diagram below with the following: *Nerve Impulse, Mitocondria, Synaptic Cleft, Neurotransmitter, Axon, Vesicle, Dendrite,*



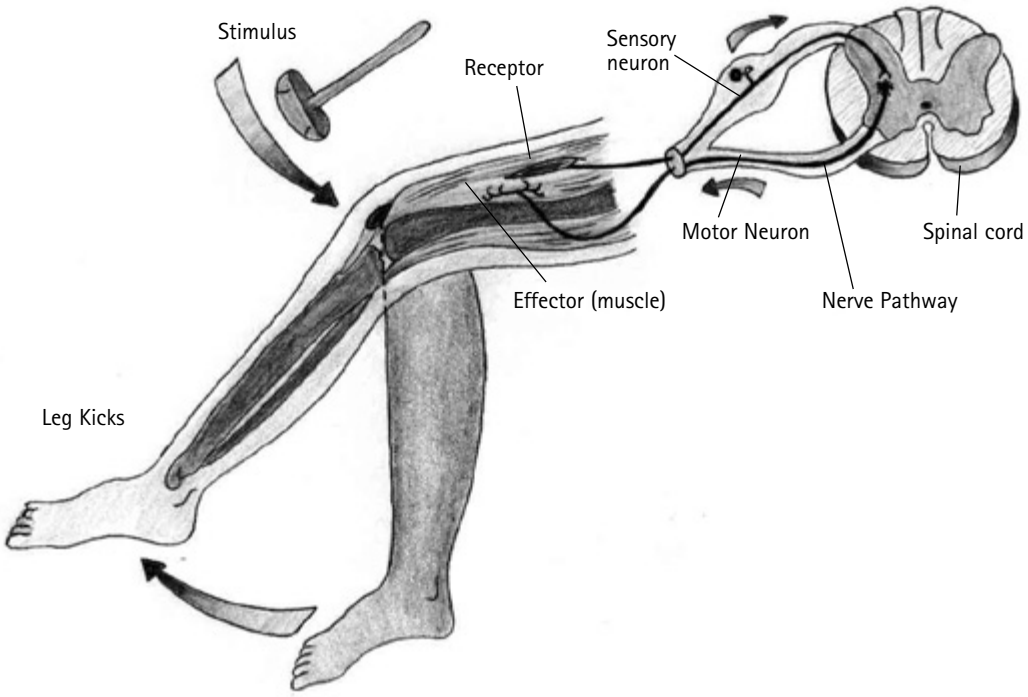
(d) (i) Why is it important that neurotransmitters do not remain in the synaptic cleft?

(ii) How are neurotransmitters removed from the synaptic cleft?

6. (a) What is meant by the term **reflex response**?

(b) State three examples of a reflex response in humans.

7. By referring to the diagram below, describe the sequence of events from the stimulus to the reflex response.



8. What is the advantage to an individual of having the signal from a stimulus, such as heat from a flame, processed directly by the spinal cord, without involving the brain?

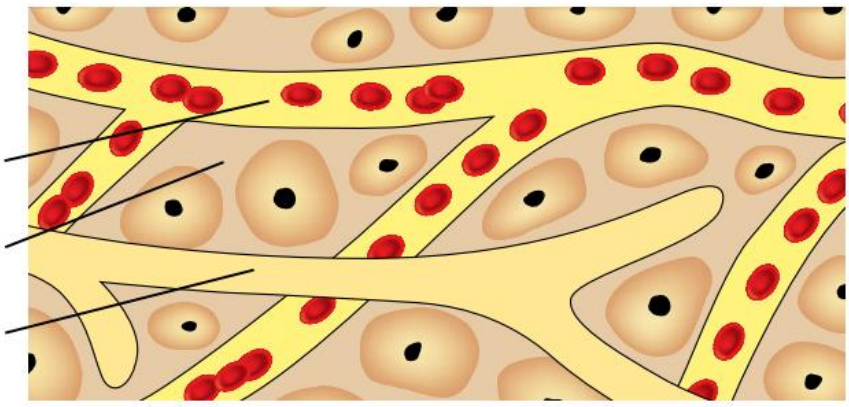
18 The Endocrine System

Subject Outline terms and phrases	**hormone, peptides, amino acid derivitive, steroid, target site, target cell, target tissue, target organ, adrenaline, 'fight or flight' response, thyroid stimulating hormone, thyroxine**

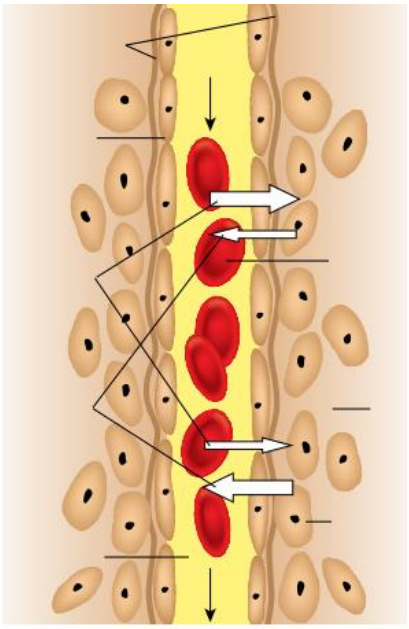
1. Complete the following table which shows different types of hormone.

Type of hormone	Name of hormone	Name of endocrine gland	Target cells, tissues, organs	Effect
	adrenaline			
		adrenal medulla	cardiac muscle, smooth muscle	
				increases oxidative metabolism
	antidiuretic hormone			
				stimulates breakdown of glycogen to glucose, increases blood sugar level
				lowers blood sugar level, increases glycogen storage
	thyroid stimulating hormone (TSH)		thyroid	
	aldosterone			

2. On the diagram, label a *blood capillary, a lymph capillary,* and the *tissue fluid.*



3. (a) Label the following on the diagram below: *red blood cell, plasma, capillary wall, tissue fluid, tissue cells, movement due to osmosis, movement due to blood pressure, direction of blood flow and basement menbranes.*



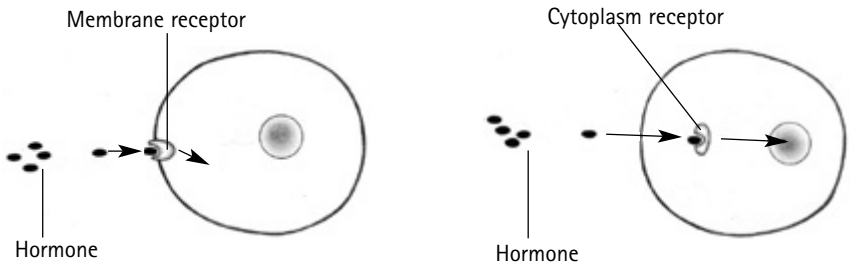
(b) Describe the role of the basement membrance.

4. (a) What is a membrane receptor molecule?

(b) Explain how the distinctive shape of membrane receptor molecules allows cells to recognise other molecules.

5. Explain why a hormone which is present in blood in all parts of the body will only produce an effect on a specific cell, tissue, or organ, and **not** other cells, tissues, or organs.

6. By referring to the following diagrams, explain how water-soluble and lipid-soluble hormones produce an effect on cells.



Water-soluble hormones:

Lipid-soluble hormones:

7. (a) State two examples of hormonal responses that are stimulated by the nervous system.

(b) State two examples of hormonal responses that are stimulated by other hormonal messages.

8. (a) In the **'fight or flight' response**, what do the terms 'fight' and 'flight' mean?

(b) Complete the following table to describe the responses of body structures to adrenaline in the 'fight or flight' response.

Body structure	Response to adrenaline	Effect
smooth muscle around blood vessels of skeletal muscle		increased blood flow
	constrict	redirect blood to the periphery
heart		
		increase air flow to lungs
	increase glucagon secretion	
radial muscles of the iris		

9. Describe the role of **thyroid stimulating hormone** in the production of **thyroxine**, including the importance of negative feedback.

10. Complete the following table which compares the action of the nervous and endocrine systems.

Communication	Pathway	Message	Site of action	Speed of action	Duration
Nervous system					
Endocrine system					

11. Explain why a nerve impulse is more appropriate than a hormonal message for controlling blinking of the eye, but a hormonal message is more appropriate than a nerve impulse for controlling the uptake of glucose from the blood by cells.

12. Explain how the hypothalamus acts as a 'bridge' between the nervous and endocrine systems.

19 Homeostatic Control Mechanisms

Subject Outline terms and phrases	**osmoregulation, anti-diuretic hormone (ADH), blood volume, blood pressure, insulin, glucagon, diabetes mellitus**

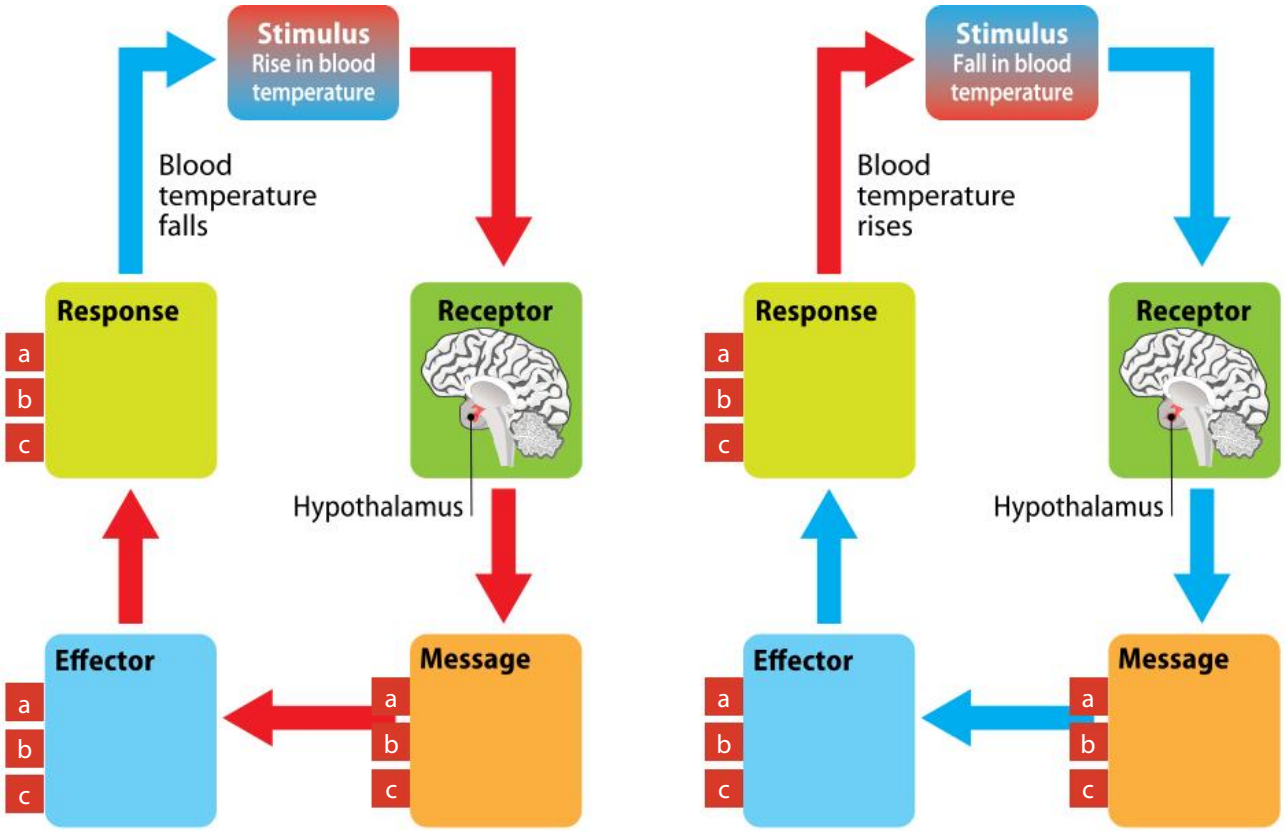
1. Complete the following table to show which body systems are involved in controlling the internal conditions listed.

Internal condition	Nervous system, endocrine system, or both
body temperature	
osmoregulation	
blood sugar level	
pH of blood	

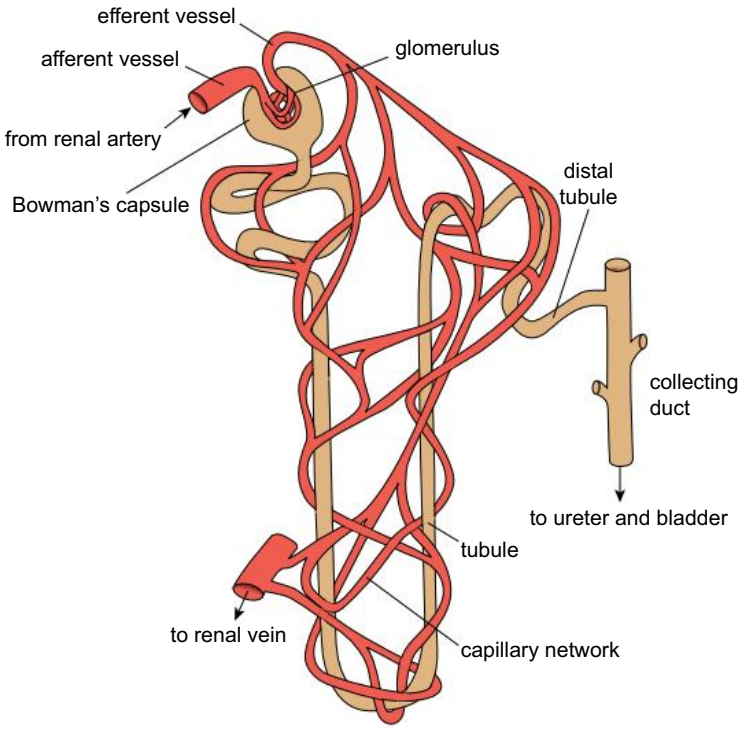
2. Complete the following table for the control of human body temperature.

Stimulus	Receptor	Message transmission	Effector(s)	Response(s)
Body temp. decreases				shivering
Body temp. increases				vasodilation
Body temp. decreases			thyroid gland	
Body temp. increases			sweat glands	
Body temp. decreases		nerve impulse		

3. Complete the labels on the following diagrams to show the **receptor, messages, effectors,** and **responses** involved in regulating human body temperature.



4. Label these structures on the nephron diagram below:
glomerulus, Bowman's capsule, tubule, collecting duct, capillary network, from renal artery, to renal vein



5. Use the terms *filtration* and *reabsorption* to explain how a nephron works.

6. (a) Describe the role of **anti-diuretic hormone (ADH)** in **osmoregulation**, including its effect on aquaporins.

   (b) Explain how the water content of the blood (osmoregulation) affects **blood volume** and **blood pressure**.

7. Complete the table below using the words *higher, lower,* or *same* to describe the concentrations of the following substances in the filtrate and urine, compared to their concentration in the plasma.

	Percentage present in:		
Substance	**Plasma**	**Filtrate**	**Urine**
water	92.0	higher	varies
urea	0.03		
glucose	0.1	same	
inorganic ions	0.72		
protein	8.0		lower

8. Name the kidney structures in the correct sequence to describe the pathway that would be followed by (a) water, and (b) glucose from the time they enter the afferent vessel (from the renal artery).
   (a) water

   (b) glucose

9. (a) What are the main target tissues for **insulin**, and what is the effect of insulin on the cells of these tissues?

   (b) What are the main target cells for **glucagon**, and what is the effect of glucagon on these cells?

   (c) How do insulin and glucagon work together to regulate blood sugar level?

10. Describe how **diabetes mellitus** (type 1 and type 2) can result from a hormonal imbalance.

11. Explain how pH is monitored in the brain to maintain a constant carbon dioxide level in the blood.

20 How Cells Have Evolved

Subject Outline terms and phrases	**evolution, fossil evidence, endosymbiotic event, ribozyme**

1. Explain how **evolution** has resulted in life on Earth diversifying over the last 3.5 billion years.

2. Explain how each of the following pieces of evidence supports the idea that eukaryotic cells did not exist on Earth before prokaryotic cells.

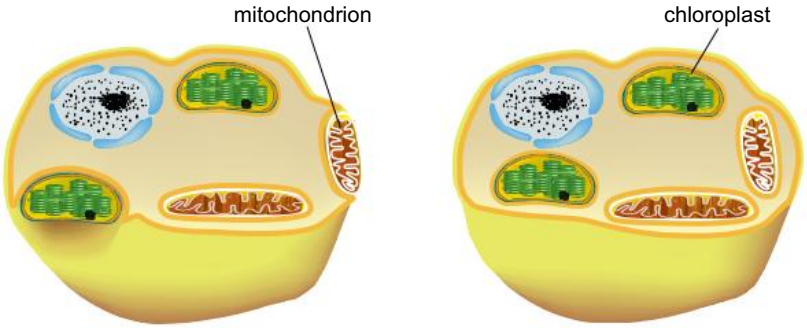
   (1) fossils

   (2) cell complexity

   (3) early Earth's atmosphere

3. (a) What is meant by the term **endosymbiotic event**?

(b) Explain how endosymbiotic events may have led to the formation of the first eukaryotic cells. In your answer you should refer to the following diagram, on which you should put suitable labels.



(c) State four pieces of evidence that support the idea that the first eukaryotic cells were formed by endosymbiotic events.

(1)

(2)

(3)

(4)

4. (a) Explain how the first membranes may have formed spontaneously, eventually giving rise to simple cells.

(b) Describe the possible roles of RNA and **ribozymes** in the first simple cells.

(c) Explain why proteins were not used as enzymes in the first primitive cells.

21 Defining a Species

Subject Outline terms and phrases	**species, mode of reproduction, interbreed, fertile, morphological similarity, biochemical similarity, gene pool, zygote, pre-zygotic, temporal isolation, behavioural isolation, mechanical isolation, gamete isolation, post-zygotic, hybrid, hybrid inviability, hybrid sterility**

1. Define the following terms.
   (a) species

   (b) community

   (c) population

   (d) gene pool

2. A species can be defined using methods based on structural features, biochemical similarity, ability to interbreed to produce fertile offspring, or gene pool. Explain how each of these methods is used to define a species.

   structural features (morphological):

   biochemical similarity:

   ability to interbreed:

   gene pool:

3. (a) List four **pre-zygotic** mechanisms that maintain reproductive isolation of species in a community.

(1)

(2)

(3)

(4)

(b) Explain how each of these pre-zygotic mechanisms helps to maintain reproductive isolation.

(1)

(2)

(3)

(4)

4. (a) List two **post-zygotic** mechanisms that maintain reproductive isolation of species in a community.

(1)

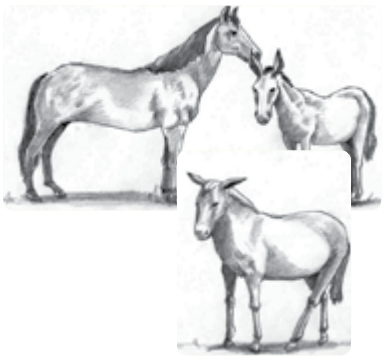
(2)

(b) Explain how each of these post-zygotic mechanisms helps to maintain reproductive isolation.

(1)

(2)

5. Explain why horses and donkeys are considered to be different species even though they are able to produce offspring (the mule).



22 Evidence for Evolution

Subject Outline terms and phrases	**comparative genomics, cytochrome, DNA-DNA hybridisation, DNA sequencing, phylogenetic tree, evolutionary relationships, rRNA gene sequencing**

1. (a) What is meant by 'the universal presence of DNA'?

   (b) Explain how the universal presence of DNA provides evidence for the common ancestry of all living things.

2. (a) Explain the term **mutation**.

   (b) Explain how the sequence of amino acids in a protein is related to the genetic code in the nucleus of the cell. (also see Chapter 2)

   (c) State three factors that can induce mutations.

3. (a) State one piece of evidence that indicates that DNA on Earth has diversified over billions of years.

   (b) State two processes that have brought about this diversity.

4. Explain three sources of genetic variation in a species that reproduces sexually.

(1)

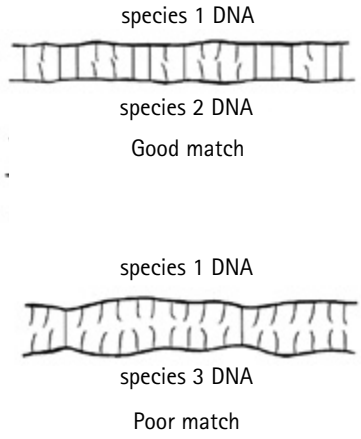
(2)

(3)

5. (a) What is meant by the term **comparative genomics**?

(b) Explain how comparative genomics can help establish the likely evolutionary relationships between different species.

6. Use the information in the following diagram to explain how the degree of matching of DNA strands from two different species in **DNA-DNA hybridisation** provides a clue as to how closely related the two species are.

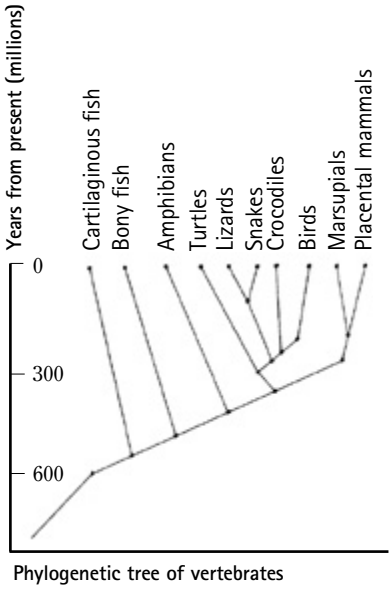


7. Explain how the degree of similarity of the DNA sequences and the degree of similarity of protein sequences in closely related organisms provide evidence for the theory of evolution.

8. (a) Explain why the protein *cytochrome c* is useful for studying the evolutionary relationship between different species.

(b) How can a protein provide this kind of information for comparison?

9. The **phylogenetic tree** below was constructed by comparing the nucleotide sequences of DNA in the different groups. Use the information in the diagram to answer the following questions.



Phylogenetic tree of vertebrates

(a) State which two groups of vertebrates are most likely to have separated most recently.

(b) Which group has DNA which is most dissimilar to that of mammals?

23 Gene Pools and Natural Selection

Subject Outline terms and phrases	**gene pool, natural selection, adapted, selection pressure, frequency of alleles, genetic drift, genetic diversity**

1. Define the term **gene pool**. (review Chapter 21)

2. What reasoning did Thomas Malthus use to show that not all offspring in natural populations survive to reproduce?

3. State why most natural populations of organisms do not increase in size, but remain fairly constant from one year to the next.

4. List four factors that restrict the size of a natural population.

   (1)

   (2)

   (3)

   (4)

5. Explain why genetic variability is an advantage to a population.

6. (a) State one example of a genetically controlled characteristic that may *increase* an individual *human's* chances of survival and reproduction.

   (b) State one example of a genetically controlled characteristic that may *decrease* an individual *rabbit's* chances of survival and reproduction.

7. List the five points that Darwin used to explain the theory of evolution by **natural selection**.

   (1)

   (2)

   (3)

   (4)

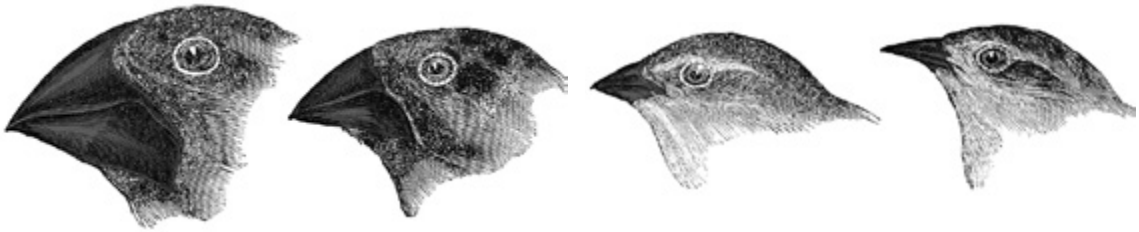
   (5)

8. Explain how a strain of bacterium resistant to the antibiotic streptomycin could evolve by natural selection. In your answer you should use the following terms: *mutation, genetic variation, selecting agent, selection pressure, survival, reproduction, favourable gene, change in the gene pool.*

9. (a) What is meant by a **large gene pool**?

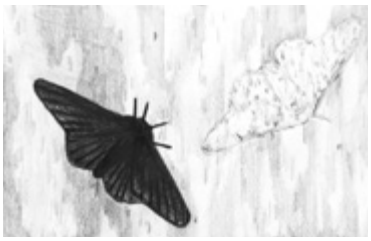
   (b) Explain why a population with a large gene pool is more likely to survive **selection pressures**.

10. In 1831 Darwin sailed on the Beagle as the ship's naturalist. He was particularly fascinated by the distribution of finches on the Galapagos Islands to the west of South America. Darwin found a number of different species of finch and he noticed that each species seemed to be restricted to one island or a small number of neighbouring islands. Differences between the species included such features as beak shape which seemed to be suited to the food available to the particular species. From these observations Darwin began to formulate an idea of how the different species of Galapagos finches could have developed in such a way as to ensure that each species was well suited (adapted) to its own environmental conditions.



Use the example of the Galapagos Island finches to outline the reasoning that Darwin used to explain how the finches developed in such a way as to ensure that each species was well suited (adapted) to its own environmental conditions.

11. One of the classic examples of natural selection involves the peppered moth *Biston betularia*. This moth is found in England in two main shades. One is light with patches of darkness (hence the name 'peppered') and the other is dark in colour. Before the Industrial Revolution almost all the moths were light in colour and dark ones were extremely rare.



Explain how the proportion of darker moths increased and the proportion of paler ones decreased over many generations after the Industrial Revolution.

12. State three processes that could cause the **frequency of alleles** in a population to alter and result in evolutionary change.

    (1)

    (2)

    (3)

13. Explain the term **genetic drift**.

14. Explain how evolutionary changes are affected by factors such as:

    (a) sexual reproduction.

    (b) genetic drift.

24 Speciation and Evolution

Subject Outline terms and phrases	**speciation, geographically isolated populations, allopatric speciation, sympatric speciation, convergent evolution, niche, succession, divergent evolution, adaptive radiation, low genetic diversity, extinction**

1. State three examples of geographical barriers, other than a desert, that could lead to reproductive isolation.

   (1)

   (2)

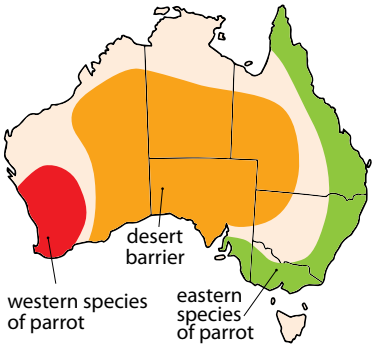
   (3)

2. Geographical isolation (separation) by itself does not lead to **speciation**. What else is needed in order for speciation to occur?

3. Describe the process of allopatric speciation.

4. The habitats of two species of parrot are shown on the map.

   The eastern and western species of parrot have descended from a common ancestor, but have become so different from one another that they are no longer able to interbreed. Use the ideas of **geographical isolation (separation), gene flow,** and **natural selection** to explain how this speciation occurred.



5. State two pre-zygotic and two post-zygotic barriers that maintain reproductive isolation between different species. (revise Chapter 21)

   two pre-zygotic barriers:

   two post-zygotic barriers:

6. Explain what is meant by **convergent evolution**. Give three examples to illustrate your answer.

7. (a) What is meant by **adaptive radiation**? Give an example.

   (b) How does adaptive radiation differ from **divergent evolution**.

8. In the natural community shown below, there could be flood, drought, high temperatures, heavy rain, or fires in the coming year. Choose three of these abiotic factors and describe the changes that they would cause to the populations in this community.

   Factor 1:

   Factor 2:

   Factor 3:

9. Define the following terms.

   (a) succession

   (b) colonisers

   (c) climax community

10. Describe the series of events that could have occurred on each of the following two sites.

   (a) The sand dunes in the south-east of South Australia, after they became exposed due to a fall in sea level.

   (b) The island of Surtsey, after the bare volcanic rock arose out of the sea.

11. (a) What conditions are necessary for primary **succession** to occur?

   (b) How does primary succession differ from secondary succession?

12. (a) Give two examples of species with low genetic diversity, and describe how their genetic diversity was reduced.

   (b) Explain why species or populations that have a reduced **genetic diversity** have a higher risk of extinction.

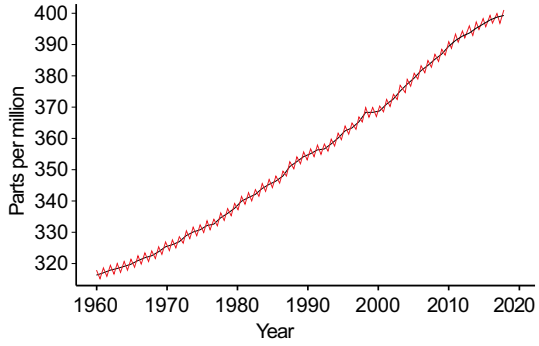
25 Human Impact

Subject Outline terms and phrases	**biodiversity, ethical issue**

1. Complete the table below which shows how human activities have led to climate change, environmental change, or both.

Human activity	Climate change, environmental change, or both	How the change was (changes were) caused
clearing tropical land		
lighting fires		
introducing rabbits to Australia		
altering water courses		
polluting the atmosphere		
burning fossil fuels		

2. (a) By referring to the graph and data below, state the likely trend of carbon dioxide levels in the atmosphere beyond the year 2024.



DATE	CO_2 LEVEL
24/12/2023	421.86 ppm
24/12/2022	419.41 ppm
24/12/2013	397.53 ppm

(b) State the factor that is the most likely cause of this trend.

(c) Explain how this trend could lead to changes in communities on a global scale.

3. (a) State what is meant by the extinction of a species.

(b) State three human activities that have caused animals to become extinct and for each one give an example of a species that was affected.

(c) State three factors, other than human activity, that could cause the extinction of a species.

(d) Explain why maintaining **biodiversity** is an **ethical issue.**

4. The three main arguments for the importance of biodiversity are the human-centred view, the interconnection of life on Earth, and human respect for all living things.

   (a) State the main point of each of these three arguments, and give an example of each.

   human-centred view:

   interconnection of life on Earth:

   respect for all living things:

   (b) Which one of the three arguments in part (a) suggests that biodiversity is essential for the perpetuation of communities?

   (c) State two examples in which the loss of one population from a community has had a severe effect on other populations of the community.

5. Define the following terms.

   habitat:

   biosphere:

6. Although there are several hundred species of eucalypt in Australia, the koala can only feed on the leaves of a few of these species. The koala's distribution is limited to regions where these species of eucalypt are found. Use this information to explain why the best way to preserve a species is to preserve its habitat.

7. State the size of the habitat that is now generally accepted to be the minimum to ensure the survival of an animal species.

8. (a) What is meant by the term resources?

   (b) List two resources from each of the following categories.

   soil:

   air:

   other organisms:

9. Why do biological communities need to recycle resources?

10. (a) What observation made during the Hubbard Brook experiment provides evidence that disturbed communities lose their chemical resources?

    (b) What conclusion was made about the fate of resources in undisturbed communities?

11. Explain why crops need to be provided with fertiliser, whereas natural communities can flourish without the addition of fertiliser.

12. (a) List two types of decomposer.

    (b) Explain why decomposers are essential to a natural community.

13. State three advantages that have resulted from the introduction of African dung beetles into Australia.

    (1)

    (2)

    (3)

Science as a Human Endeavour Questions

Subject Outline terms and phrases	**Communication and Collaboration, Development, Influence, Application and Limitation**

Answer these SHE questions on your own paper or device.

1. Although DNA was identified by around 1850 as the major chemical occupying a cell's nucleus, its role in storing and transmitting genetic information was not accepted by the scientific community until 1952. Up until then many scientists believed that proteins were the most likely storage form of genetic information in cells. The first people to recognise the importance of chromosomes in inheritance were Walter Sutton and Theodor Boveri who, in 1902, independently put forward the concept that chromosomes carry hereditary material. It was not until 1952 that two biologists, Alfred Hershey and Martha Chase, performed an experiment that supported the proposal that DNA and not protein contained the inheritable material of life.

   James Watson and Francis Crick are the names most often associated with the discovery of the structure of DNA, but two other people contributed significantly. Rosalind Franklin and Maurice Wilkins from Kings College, London, had generated information of the DNA structure from their research using X-ray crystallography that Watson and Crick then used.

   - Discuss how this information illustrates at least one of the science as a human endeavour key concepts.

2. Unlike DNA profiling, DNA phenotyping uses coding regions of a person's DNA. It can be used to deduce certain physical characteristics such eye colour, gender, and ethnic background. While DNA phenotyping is not currently in common usage, it has been used in some countries, when a DNA profile is not available. Some people are concerned about the way that humans might choose to use this new technology.

   - Discuss the **applications** and **limitations** of DNA profiling and DNA phenotyping.
   - Explain why the use of DNA profiling is more likely to be acceptable in society than the use of DNA phenotyping.

     (In your answer you could address social, economic, cultural, and ethical considerations and/or beneficial or unexpected consequences.)

3. Telomeres are repetitive sequences of DNA found at the end of most eukaryotic chromosomes. The telomeres in humans are single stranded DNA with several thousand repeats of the sequence TTAGGG.

   During each DNA replication, a few nucleotides are removed from the ends of the chromosomes, so if the telomere is present, it will be shortened rather than sacrificing essential DNA. When the telomere becomes too short, the cell dies. The enzyme telomerase reverse transcriptase (TeRT) can repair the damaged ends of telomeres and extend the life of the cell. This enzyme is found in high concentrations in both stem cells and cancer cells. (See textbook Fig. 1.11)

   In 2009, an Australian scientist, Elizabeth Blackburn, and her American colleagues, Carol Greider and Jack Szostak, were awarded the Nobel Prize for their research into telomeres. They showed that telomeres prevent the ends of chromosomes fusing with each other, thus preventing mutations, and that telomerase reverse transcriptase (TeRT) repairs telomeres, thus increasing the life expectancy of cells and the organism in which they reside. TeRT could be seen as the key to increasing life expectancy.

   - Discuss how the scientific knowledge resulting from Elizabeth Blackburn and her colleagues' work on telomeres may have **applications** that could have beneficial or unexpected consequences.
   - How might the acceptance and use of this scientific knowledge to increase human longevity be **influenced** by social, economic, cultural, and ethical considerations?

4. The protein cytochrome oxidase is found in the mitochondria of all **eukaryotes**. There are slight differences in the sequence of nucleotides that code for cytochrome oxidase in each species. Short DNA segments, about 700 nucleotides in length, can be quickly processed from thousands of specimens and unambiguously analyzed by computer programs. These unique sequences can be used to establish a database of different species and construct DNA 'barcodes' for each species. A region of the chloroplast gene rbcL is used for barcoding plants.

   Scientists from around two hundred countries are involved in the program *International Barcode of Life (iBol)* which is now used to detect food fraud, such as identifying various commercial fish species, and identifying products taken from conserved species such as timber from rain forests and ivory from elephants.

   Scientists at the University of Adelaide are also working on a DNA tracking system to identify even the specific region of origin of foods.

   - Explain how international **collaboration** is essential for the iBol project and why clear communication, international conventions, and review and verification of results is required for this project to be successful.
   - Describe how the **development** of new technologies contribute to the iBol project.

5. Human babies inherit their mitochondria from their mother. This means that a zygote contains DNA from three sources: nuclear DNA from each parent, and mitochondrial DNA from the mother only.

   Although mitochondrial DNA only comprises a small portion of a person's 'genome', faults in this DNA can have significant consequences. For example, Leber's Hereditary Optic Neuropathy is a form of mitochondrial disease that causes blindness,

   New technology, recently legalised in the United Kingdom, enables a zygote to be formed using the nuclear DNA of two parents and the mitochondrial DNA of a 'donor', in order to ensure that faulty mitochondrial DNA is not inherited. Thus, a baby produced in this way will have 'three biological parents', although 99.9 percent of their DNA comes from their 'natural' parents. There would still be only two legal parents.

   Some people have opposed the use of this technology, saying that it will lead to 'designer babies' and 'selective breeding'.

   - Discuss how social, ethical, economic, and cultural considerations can **influence** the use of this technology.

6. In 1951 a young woman named Henrietta Lacks was found to have cancer of the cervix. A sample of the tumour was taken and the cells were found to be most unusual as they grew vigorously and went through each cell cycle without restraint. Up until then human cells had been very difficult to grow and died after a few cycles. The cells from Henrietta, referred to as HeLa cells, were the first human cells to be successfully cultured and they were initially distributed, free of charge, to a large number of medical and scientific institutions.

   Late in the 1950s cultures of HeLa cells were used to develop a vaccine against polio, and since then, the cells have been used as the host cells in genetic engineering to produce a variety of proteins. The HeLa cell line is now found in biological laboratories throughout the world and continues to be the 'work-horse' for many human tissue experiments, including testing safety of pharmaceuticals, investigating the action of mutagens, and researching the control of the cell cycle. Interestingly, neither Henrietta nor her family gave permission for her cells to be used in this way.

   - Explain how **communication and collaboration** played an important role in the **development** of Hela cells for use in human tissue experiments.
   - Discuss how social, ethical, economic, and cultural considerations can **influence** the use of this technology.

7. Drugs in Sport (See textboxes *Drugs in Sport*, P146 and *Human Growth Hormone,* P119)

   The endocrine system is made up of endocrine glands which produce and secrete hormones. Disorders of the endocrine system include diabetes, goitre, dwarfism, gigantism, and Addison's disease, and these are due to the production of incorrect amounts of hormone or production of a faulty hormone.

   Genetic engineering processes use bacteria to produce human proteins such as insulin, growth hormone, adrenaline, erythropoietin (EPO), oestrogen, and testosterone, and these are used to treat endocrine disorders.

   Genetically engineered growth hormone, EPO, and testosterone have also been used by athletes to improve performance and their use has been the subject of intense scrutiny in the sporting world.

   - Discuss how the **development** of scientific understanding of the effect of hormones such as EPO and growth hormone can **influence** and be influenced by other areas of science such as sports science.
   - Use the production of EPO and growth hormone as examples of how the **application** of scientific knowledge may have beneficial or unexpected consequences and requires monitoring, assessment and evaluation of risk, and provides opportunities for innovation.

8. Initally, Darwin's and Wallace's views on evolution by natural selection were not universally accepted. Even today, some people are reluctant to accept the elegance of modern evolutionary theory, despite the huge body of scientific evidence in support of it.

   In June 2017 a decision was made in Turkey to remove the teaching of evolution from the school curriculum. The reason given was that the theory of evolution is 'too hard' for students to understand, although many people disagreed with this.

   The increased use of antibiotics in agriculture and medicine has caused populations of bacteria without genes that enable the host bacterial cell to resist antibiotics to decrease in number and those with the genes for resistance to increase. An unfortunate result of this is that more pathogenic bacteria are now resistant to antibiotics. Despite this knowledge, antibiotics are still overprescribed and used unnecessarily in many parts of the world, including Australia.

   - Use this information to describe how social and cultural considerations can **influence** the acceptance of scientific knowledge.
   - Explain how **communication** and **collaboration** will play an important role in addressing the **limitations** resulting from a lack of understanding of evolution in bacteria.

Science as a Human Endeavour Investigation

Subject Outline terms and phrases	**Communication and Collaboration, Development, Influence, Application and Limitation**

The Science as a Human Endeavour investigation involves researching and presenting evidence for the idea that science involves **Communication and Collaboration (CC), Development (D), Influence (I),** and **Application and Limitation (AL).** Details of these Key Concepts are in the subject outline, and are expressed as nine 'dot points'.

The table below has been developed to help students to choose an example of how science interacts with society. The Investigation should focus on a *recent* example linked to a biological topic, and focus on at least one of the key concepts. The table simply shows where Science as a Human Endeavour is highlighted in the textbook, and may provide some useful background information. As the range and scope of possible investigations is large (and growing), it is not possible nor desirable to provide more than this.

Example	Textbook page	Key concept	Scientists / Applications
History of DNA discovery	7	CC; D; I; AL	Sutton, Boveri, Avery, Hershey, Chase
Double-helix discovery	6, 11	CC; D; I; AL	Watson, Crick, Wilkins, Franklin
Telomeres	8	CC; D2; AL	Blackburn, Greider, Szostak (Fennic)
PCR	40	CC; D2; I; AL	Mullis (virus testing)
Sequencing DNA	42, 173, 174	D; I; AL	Sanger (synthetic proteins)
DNA profiling	43	D; I; AL	Jeffreys (ancestry investigation)
HUGO	46	CC; D; I; AL	Watson, Collins, Venter
DNA databases	44, 46, 47	CC; D; I; AL	**BOLD,** tracing sources of products
manipulation of DNA, gene therapy	49, 52-54, 114	CC; D; I; AL	vaccines
CRISPR	56	CC; D; I; AL	Doudna, Charpentier, Zhang, Church
design of specific proteins	56, 57	CC; D; I; AL	Nikolai Petrovsky
membrane structure	63	CC; D; I; AL	Davson, Danielli, Singer, Nicolson
effects of chemicals human use	98, 99, 119, 148	CC; I; AL	Carson, herbicides
cloning	104	CC; D; I; AL	Campbell, Wilmut
penicillin	121	CC; I; AL	Fleming, Florey, Chain
cell culturing	121, 122, 123	I; AL	vaccines, plant propagation
use of neurotoxins	139, 140	D; I; AL	botox, Bt gene
drugs in sport	146	D; I; AL	recent techniques
use of hormones	119, 148	CC; D; I; AL	HTR, insulin
diabetes mellitus	156, 157	I; AL	treatments
membranes and ribozymes	163; 164	CC; D; I; AL	Szostak, Cech, Altman
natural selection / evolution	179, 188	CC; I; AL	Darwin, Wallace
Mendelian genetics	181	D; I; AL	Mendel
superbugs	182	D; I; AL	
humans and succession	191	AL	
human impact	194 - 203	I; AL	

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By **completing answers to the questions throughout the year** students will **develop their knowledge and understanding** of biological principles and concepts that are relevant to the course.

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Twenty-five chapters covering all four subject outline topics
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ISBN: 978-1-7635294-0-3