



ACADEMIC
ASSOCIATES

STUDY GUIDE

HUMAN BIOLOGY

YEAR 12 ATAR COURSE – UNITS 3 & 4

REVISED EDITION



Glenda Leslie



WACE STUDY GUIDE

HUMAN BIOLOGY

YEAR 12 ATAR COURSE

Glenda Leslie



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About the Author

Glenda Leslie is a science educator having been Head of Science in a senior college and lecturer in Science Education at the tertiary level. She has worked in curriculum development for the national and state education authorities and has been a Science Curriculum Consultant at the system level of education in Western Australia.

Acknowledgements

- Grateful thanks to Jane Sanfelieu for the previous version of this workbook.

TO THE STUDENT

Welcome to Year 12 Human Biology!

This is a revision guide prepared for the Human Biology Year 12 ATAR Course. It consists of Revision Questions and Answers, Trial Tests and Answers, and a Glossary.

It is based on the syllabus as defined by the School Curriculum and Standards Authority (SCSA) that can be found at <https://senior-secondary.scsa.wa.edu.au/syllabus-and-support-materials/science/human-biology> for teaching and examination from 2020.

As a science, the subject matter of this course is founded on knowledge and understanding that has been gained through systematic inquiry and scientific research. However, this knowledge is far from complete and is being modified and expanded as new discoveries and advancements are made. During the course, you will develop your understanding of the cumulative and evolving nature of scientific knowledge and the ways in which such knowledge is obtained through scientific investigations. You will need to think critically, to evaluate evidence, to solve problems and to communicate understandings in scientific ways.

Use multiple sources of information to help you understand the content of the syllabus. The three sections of the syllabus are all important: the Science Inquiry Skills give an understanding of the development of knowledge in this area; the Science as a Human Endeavour provides specific contexts for the study of the content in the Science Understanding. Only these contexts are examinable. Each chapter begins with a Syllabus Checklist covering the Science Understanding and Science as a Human Endeavour content. Remember: the textbook is not the syllabus.

With each set of Review Questions there is a practice test. Answers are provided. The tests have multiple choice questions, short answer questions and extended answer questions. They are designed to reflect the structure of the external examination. You should attempt to complete each test in the recommended time. Check your answers carefully.

Read the test questions carefully. Understand what is being asked and the level to which you need to answer the question. A list of verbs is provided by the SCSA at the same site you will find the syllabus (given above). It is very useful to understand the complexity of answers expected for year 12 ATAR Human Biology. Don't try to memorise answers, as the questions in the ATAR paper are all original even if on the same topic or may use the same graphics. The questions in past papers and trial papers will not be in any future ATAR paper.

The key to success is regular revision and active engagement with the subject by understanding the concepts or big ideas covered by the content, the terminology appropriate to each topic and practicing answers to questions, including labelling diagrams.

An understanding of human biology is valuable for a variety of career paths. The course content deals directly and indirectly with many different occupations in fields such as science education, medical and paramedical fields, food and hospitality, childcare, sport and social work. The study of Human Biology is fascinating and highly relevant to our daily lives in understanding new innovations in health care, lifestyle choices and general wellbeing.

I hope you find this book helpful and supports you in your studies.

Work smart and seek clarification when needed, and your scores will reflect your efforts.

Glenda Leslie

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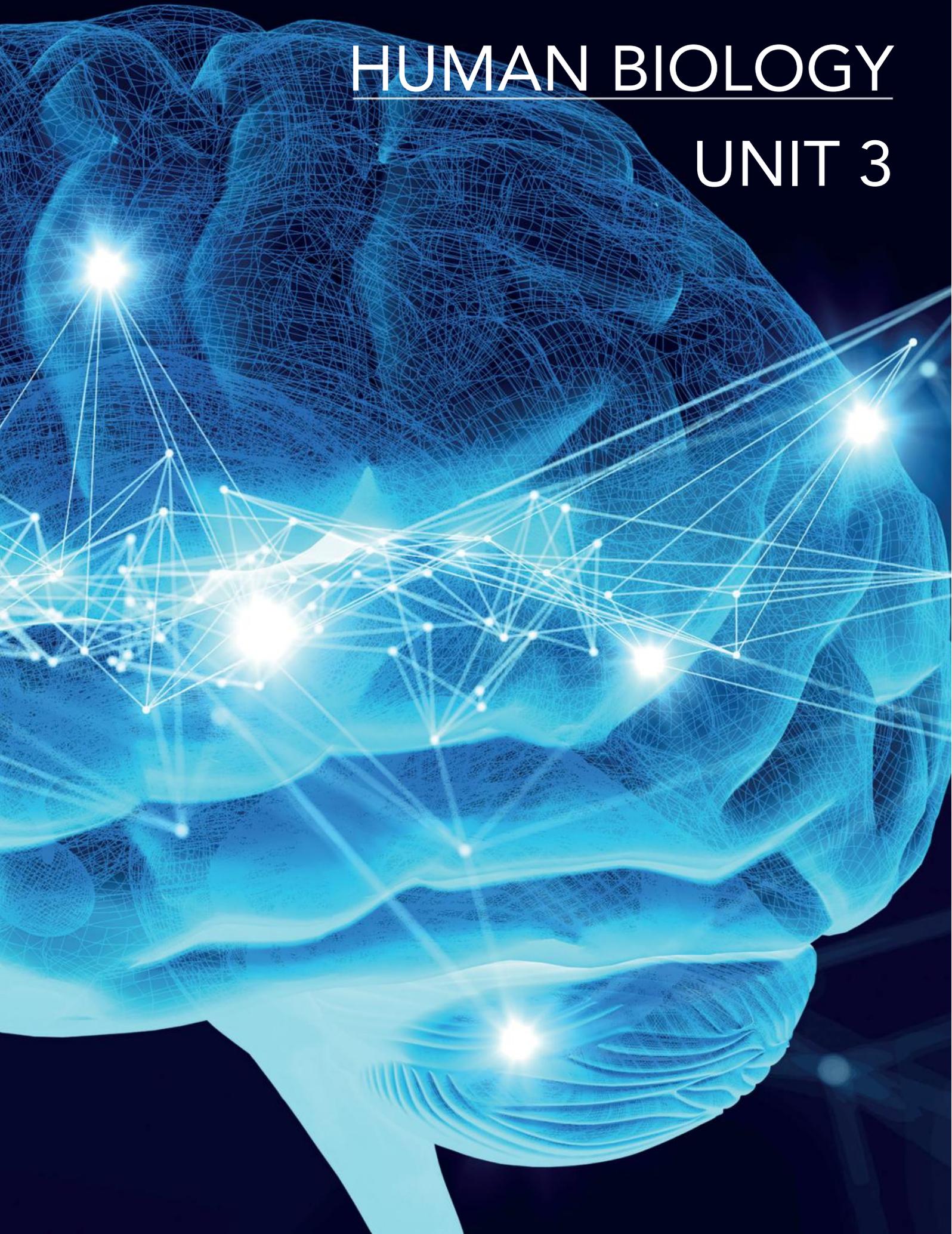
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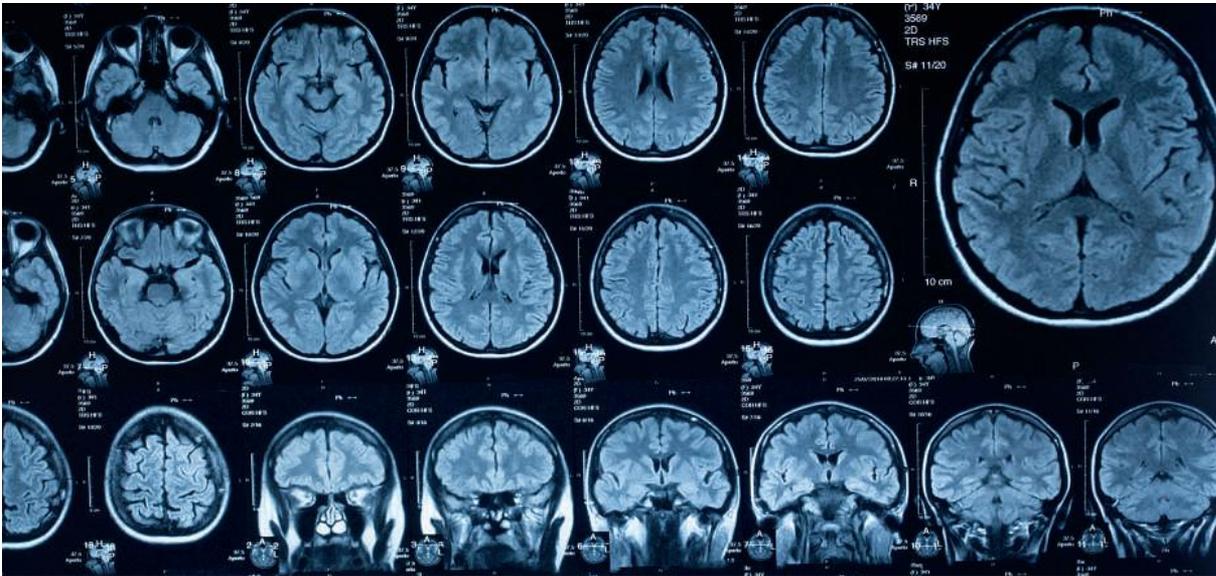
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HUMAN BIOLOGY

UNIT 3





SYLLABUS CHECKLIST

On completion of this course you should be able to:

- Identify, research and construct questions for investigation; propose hypotheses and predict possible outcomes.
- Design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics.
- Conduct investigations, safely, competently and methodically for the collection of valid and reliable data.
- Represent data in meaningful and useful ways including: the use of mean, median, range and probability; organise and analyse data to identify trends, patterns and relationships; discuss the ways in which measurement error, instrument accuracy, the nature of the procedure and the sample size may influence limitations in data; select, synthesise, and use evidence to make and justify conclusions.
- Interpret a range of scientific and media texts and evaluate models, processes, claims and conclusions by considering the quality of available evidence, and use reasoning to construct scientific arguments.
- Select, use and/or construct appropriate representations, including: diagrams, models and flow charts, to communicate conceptual understanding, solve problems and make predictions.
- Communicate to specific audiences, and for specific purposes, using appropriate language, nomenclature, genres and modes, including scientific reports.

Review Questions

1. (a) Human Biology is a science-based subject. What fields of science are used in the study of human biology?

- (b) What future studies and careers would benefit from undertaking Human Biology at ATAR level?

- (c) How has technology influenced the understanding of the human body?

2. Read and answer the following:

A student surfing the Internet for information on diabetes noticed that there were a number of articles on late-onset diabetes or diabetes Type II. Many of these articles suggested that this form of diabetes is more common in people who originate from the Pacific Islands than in people who are of European ancestry. The same trend was obvious in Aboriginal populations compared to non-indigenous Australians.

- (a) Suggest a hypothesis that could explain this observation.

- (b) What are some ways that researchers could have collected their data?

- (c) What limitations or sources of error could there be?

(d) What are the ethics to be considered in this investigation?

3. (a) List some aspects of an investigation that could affect how accurate the data is and consequently affect the accurate interpretation of the results.

(b) What factors would influence the reliability of the data and the conclusions?

(c) How could the validity of the investigation be maximised?

4. The data collected from dentists in country regions indicate that one town, Goodteef, has a very low rate of dental decay (cavities). A researcher considered this information.

(a) What observation has been made?

(b) What would be the source of this data?

(c) The town with the low rate of dental decay sources its water directly from a spring. All the other towns use collected rainwater or river water. Suggest a possible hypothesis to explain the observation.



(d) What data would have to be collected to support your hypothesis?

(e) What data would refute your hypothesis?

(f) How would you ensure that the data collected was reliable and valid?

5. (a) What are the parts of a scientific report? Outline the headings you would use.

(b) What has to be done for a scientific report to be accepted as valid by the wider scientific community?

6. Can a scientific theory be accepted as a hundred percent correct? Why or why not?

7. (a) What is a 'double blind' test?

(b) Why are they used?

(c) Suggest when they could be used.

(d) What are the ethics involved in double blind treatment investigations?

(e) Placebos are used in some investigations. What is the purpose of this?

(f) Placebos often give positive results in some investigations. Suggest why this is so.

(g) When treatments are compared, the efficacy is often quoted as a percentage. What does this mean?

8. (a) Data can be qualitative or quantitative. What is the difference?

- (b) Quantitative data can be discrete or continuous. Outline the difference and give an example of each type of data using human biology information.

9. Tables have a very specific structure related to the hypothesis and the independent (IV) and dependent variables (DV).

- a. Title: includes both the IV and DV
- b. IV is the left-hand column
- c. DV in the right-hand column(s)
- d. Column headings – name of the variable and the units of measurement
- e. Columns and rows in a logical order
- f. Entering data into tables – numerical data only is recorded in the table space as units have already been stated in the column heading.

- (a) Draw a table that collects data on heart rates before and after exercise of 4 different people

- (b) Draw a table that organises the following information:

Three students were timing their cars on a track that could be lifted to three different heights. The students were Billy Brown had the orange car which was fastest on the highest track. It took only 5.3 s. Joey Black had the red car, which he thought was going to be the fastest, but it did the medium track in 8.3 s. Ebony Green's brown car took the longest at the lowest level: 12.2 s. Her car beat Joey's at the medium level, taking 8.1 s, but it didn't win against Billy's orange car which did the same distance in 7.8 s. The red car was 0.2 s faster than the brown car's time of 6.1 s on the highest track. Ebony's car was 0.6 s slower than Joey's red car at the lowest level. Joey's car did the lowest track 0.5 s faster than Billy's car.

(c) How does the structure of tables help with the construction of graphs?

10. There are some common features to all graphs:

- a. Title – includes the IV and DV
- b. X-Axis runs horizontally. The X-axis contains the IV data and is labelled with the IV and the units of measurement.
- c. Y-Axis runs vertically. The Y-axis is for recording the DV data and is labelled with the DV and the units of measurement
- d. Data is plotted by using the scale on the X-axis to locate the required time or category, and then by using the Y-axis, you can locate the point for the line graph or the height of the column in the histogram/column graph.
- e. Legend is used when there is more than one set of data graphed.

(a) The type of graph chosen to present data from an investigation depends on the type of data collected.

(i) What type of graph is used for discrete data?

(ii) What type of graph can be used for continuous data?

(iii) What type of data can be presented as a pie chart?

(b) Draw a graph of the racing car data given in the paragraph above.



SYLLABUS CHECKLIST

This is the knowledge that you should understand after completing this section:

- The hypothalamus, pituitary, thyroid, parathyroid, pancreas, thymus, gonads, pineal and adrenal glands, are endocrine glands found in the human body.
- Hormones secreted from the hypothalamus, pituitary, thyroid, parathyroid, pancreas and adrenal glands are involved in homeostasis by affecting specific target organs.
- The secretions of the pituitary gland are controlled by the hypothalamus through the transport of hormones, either via nerve cells or the vascular link between them.
- Hormones can be lipid-soluble and able to cross cell membranes to bind with and activate intracellular receptors or, water-soluble and able to bind with and activate receptors on cell membranes, and require secondary messengers to affect cell functioning.
- Synthetic hormones may be developed to control or treat endocrine dysfunction, including diabetes mellitus, hypothyroidism and hyperthyroidism, to improve the quality of life for individuals.
- Gene therapy can be used to treat a range of diseases, including diabetes mellitus.
- Hormones and vaccines can be developed using recombinant DNA technology.

Review Questions

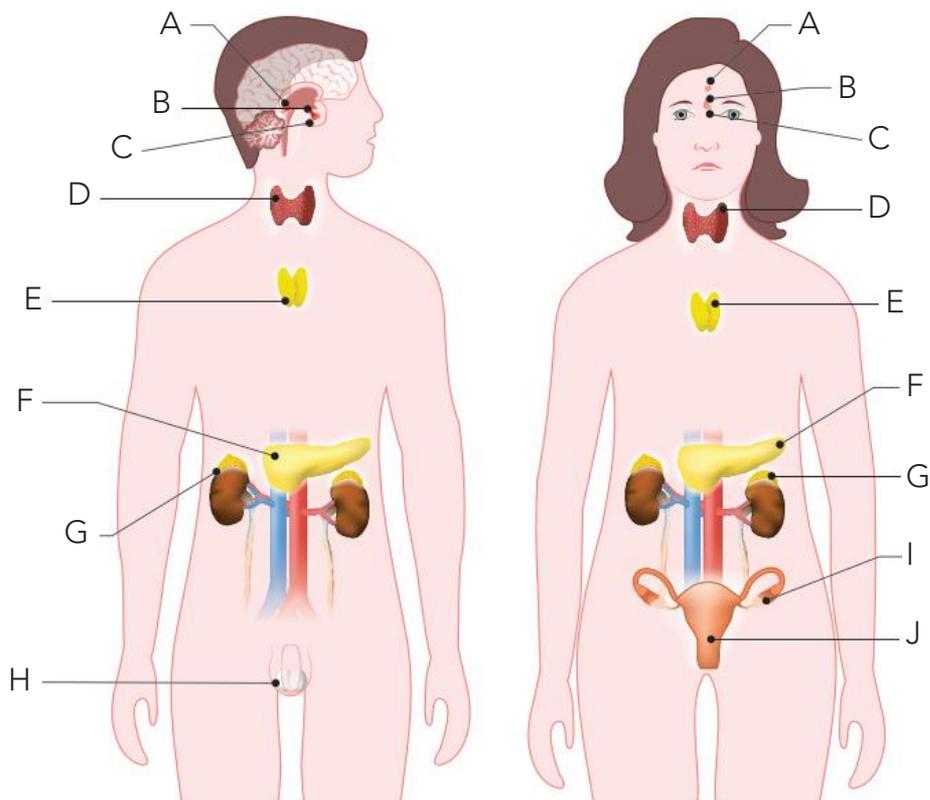
1. Differentiate between endocrine and exocrine glands.

2. What system is significantly dependent on endocrine glands to function efficiently?

3. What system is significantly dependent on exocrine glands to function efficiently?

4. The location of the endocrine glands in the body is independent of the location of the target cells. Explain why.

5. (a) Name the endocrine glands labelled in the diagrams below.



A. _____

B. _____

C. _____

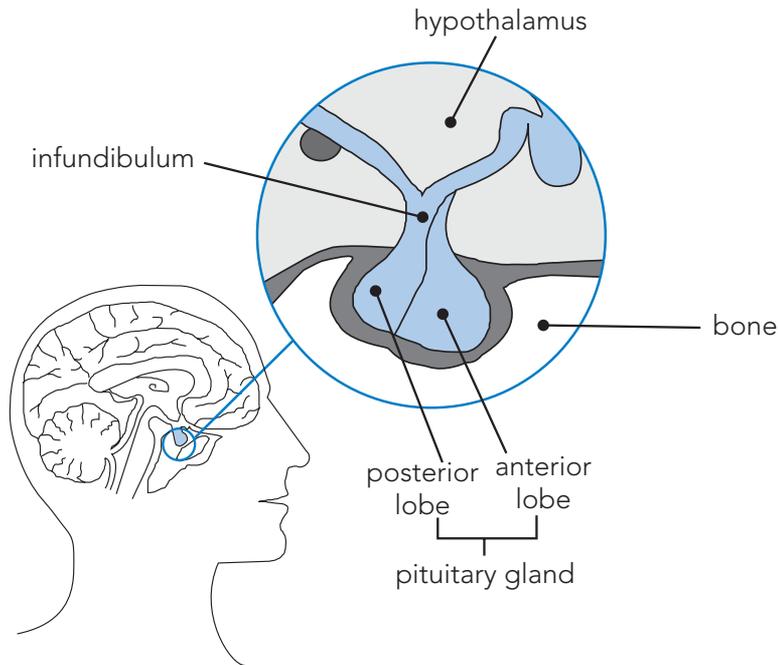
- D. _____
- E. _____
- F. _____
- G. _____
- H. _____
- I. _____
- J. _____

(b) Females may also have another endocrine gland in operation at particular times in life. What is it and what hormone does it secrete?

6. Hormones produced by endocrine glands may be water soluble or lipid soluble. How does this change the way in which they effect cells?

7. Draw up a table to show examples of lipid-soluble and water-soluble hormones.

8. Draw in the connections between the hypothalamus and the pituitary.



9. What are releasing factors? Where are they produced? How are they transported and what is their target organ?

10. The hypothalamus and pituitary are also connected by a set of neurosecretory cell fibres, originating in the hypothalamus and terminating in the posterior pituitary. What are they for? What do they carry?

11. Hormones do not persist in the body fluids. What happens to them? Why do they need to be cleared from body fluids?

12. How do cells know what hormones to react to?

13. Complete the following table by filling in the appropriate information in each space.

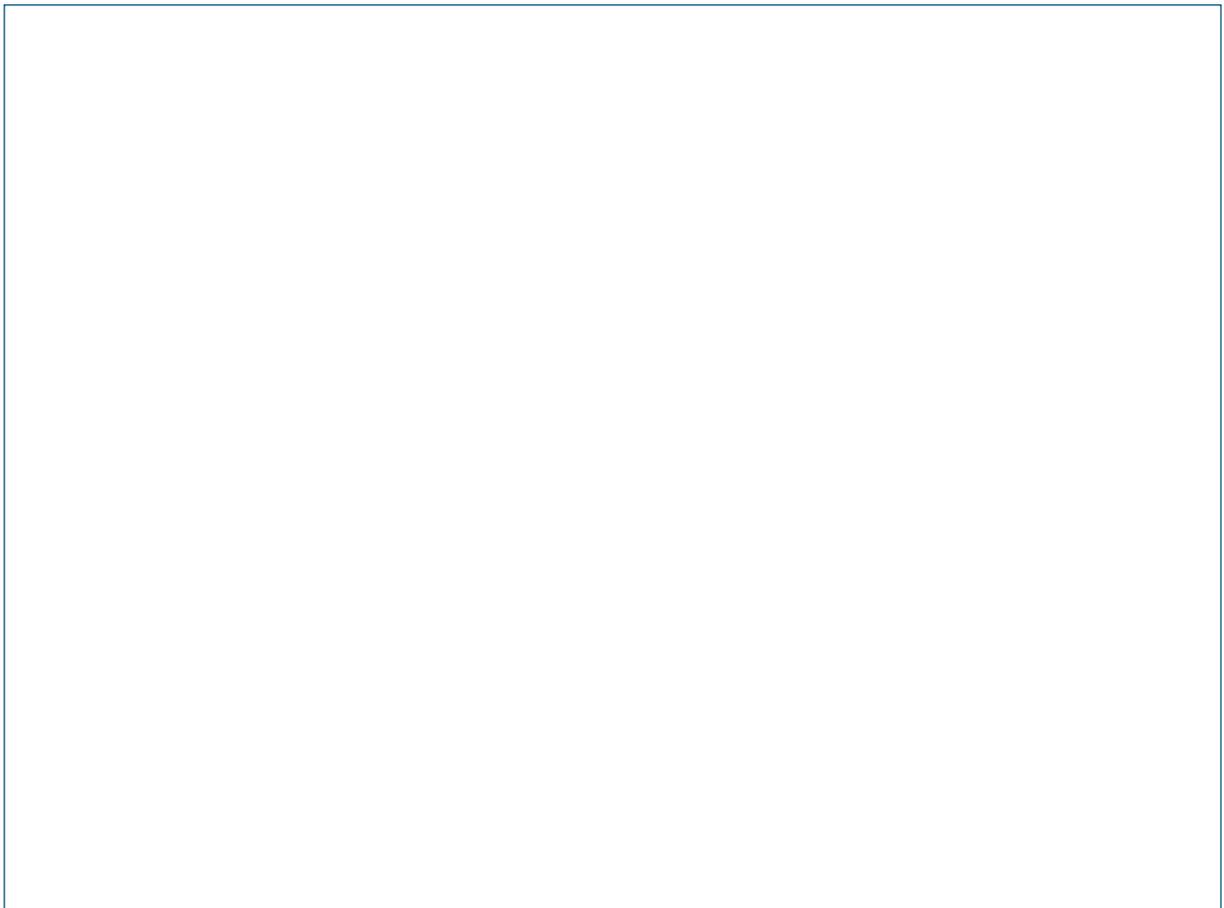
Endocrine Gland	Hormone	Target Organ	Function
Pituitary - anterior lobe	Growth hormone		
	Follicle stimulating hormone		
			Ovulation and formation of corpus luteum in females and secretion of testosterone in males.
		Thyroid gland	Stimulates the thyroid to produce and release thyroxine.
	Adrenocorticotropic hormone		Stimulates the adrenal cortex to secrete hormones, mainly cortisol.
			Breast development and milk production in females.
- posterior lobe			Increases the permeability of the distal convoluted tubule and the collecting duct so that water is reabsorbed back into the blood and urine production decreases.
	Oxytocin		
Hypothalamus	Releasing and inhibiting factors	Anterior pituitary	Controls the release of various hormones from the anterior pituitary.

Pineal gland		The part of the brain that operates as a biological clock (the suprachiasmatic nucleus, SCN).	Biological rhythms related to reproduction, or skin pigmentation. Light/dark cycles.
Thyroid gland		Most cells	
	Calcitonin		Lowers the levels of calcium and phosphates in the blood by increasing uptake by the bones (inhibits the activity of the osteoclasts).
	Parathormone (parathyroid hormone)	Bone, kidney and small intestine.	
Thymus	Thymosin	Stimulates T-cells	Development of the immune system.
Pancreas – (Beta cells in the Islets of Langerhans)		Most cells	Decreases blood sugar level by increasing sugar (glucose) uptake by cells, changes sugar (glucose) into glycogen (glycogenesis), increases protein synthesis, and lipogenesis, decreases glycogenolysis and gluconeogenesis.
Pancreas – (alpha cells in the islets of Langerhans)			Increases blood sugar (glucose) level, decreases sugar uptake by cells changes glycogen into glucose (glycogenolysis), forms glucose from amino acids and lipids (gluconeogenesis) and increases the release of sugar into the blood.
Adrenal cortex		Kidney tubules	
	Cortisol	Mainly muscle cells, blood vessels and cells involved in the inflammatory response.	
Adrenal medulla			Fight or flight response, i.e. increases heart rate, blood pressure and respiration rate etc.
Ovaries	Oestrogen		
	Progesterone		
Testes	Testosterone		

14. (a) What is a negative feedback system? Why are they important in the control of body system function?

- (b) What are tolerance limits? Explain why some factors have very narrow tolerance limits and others may be much wider.

15. Use a flow diagram to show the main components of a generalised negative feedback system.



16. Sometimes, one organ has two roles in a feedback system in control of human hormones. Give an example of this.

17. The functioning of different endocrine glands can be diagnosed by the symptoms of hypo- and hyper- secretion of hormones. What are the symptoms of thyroid malfunction?

18. How is the thyroid linked to temperature control of the body?

19. What dietary deficiency can lead to hypothyroidism?

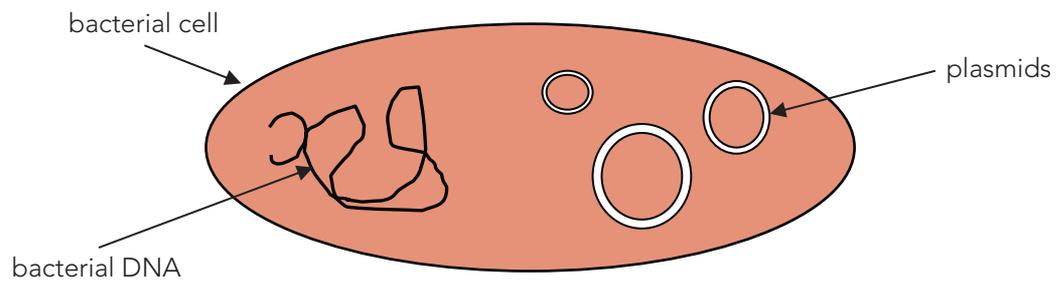
20. Some people with thyroid problems have hormone replacement therapy. What is involved in this therapy and how could it work?

21. Some endocrine diseases can be treated using gene therapy. What does this involve?

22. DNA recombinant techniques can be used to produce a variety of proteins, hormones and vaccines for the treatment of disorders of the body or to fight infection.

(a) Why is it possible to produce recombinant DNA?

(b) Transferring particular sequences of DNA from one cell to another requires a vector. What is a vector?



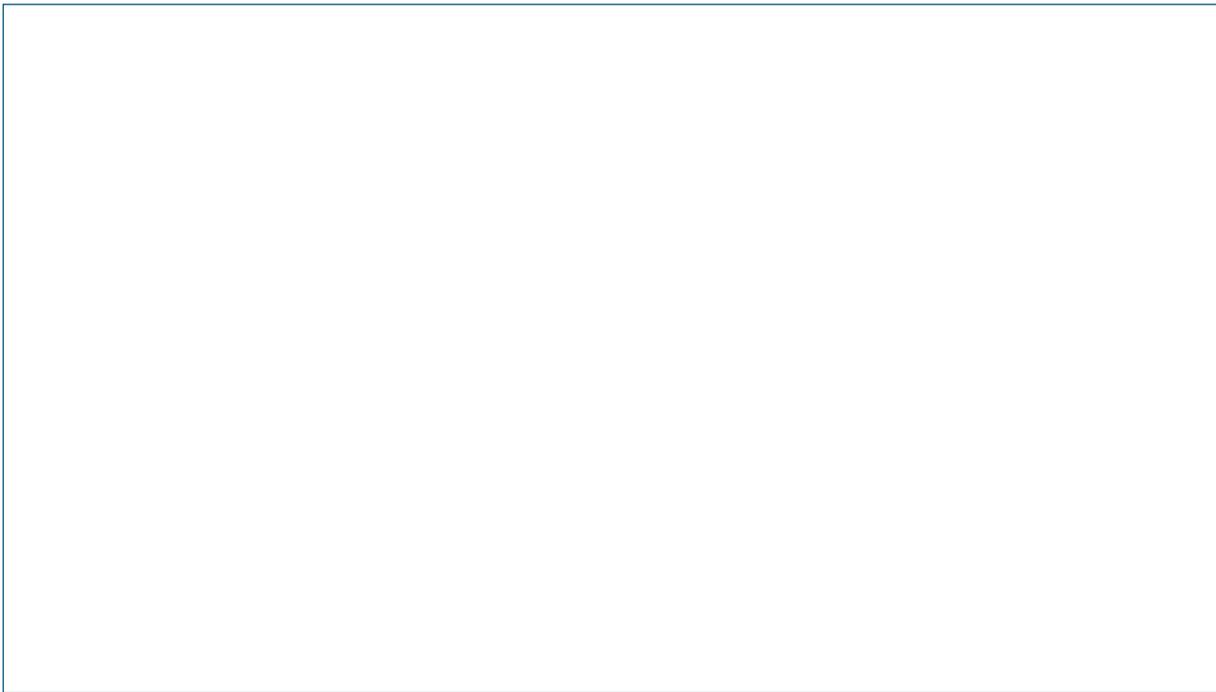
(c) What is the role of plasmids in recombinant DNA technologies?

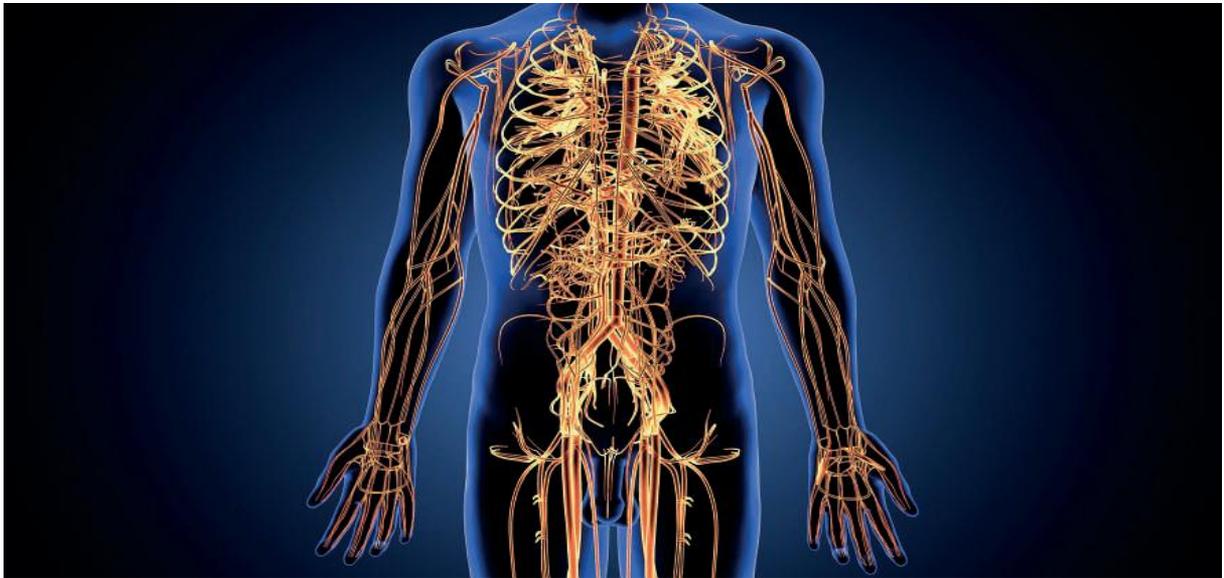
(d) What enzyme are used to cut the plasmid? Why is the same enzyme used to cut the donor DNA?

(e) What are 'sticky ends'? Why are they better than 'blunt ends' when transferring sections of DNA?

(f) Insulin is produced by recombinant DNA. Why is this better for the patient than others sources of insulin such as from cows or horses?

(g) Draw a flow chart to show the steps in producing recombinant DNA.





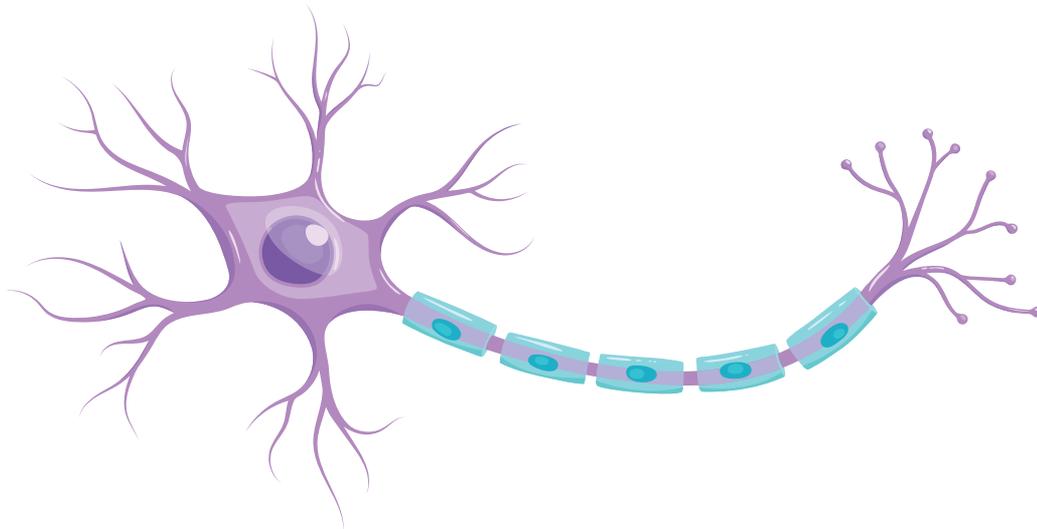
SYLLABUS CHECKLIST

This is the knowledge that you should understand after completing this section:

- Structure and function of the divisions of the nervous system can be observed and compared at different levels in detecting and responding to the changes in the internal and external environments including:
 - central-peripheral
 - afferent-efferent
 - autonomic-somatic
 - sympathetic-parasympathetic.
- The parts of the central nervous system, including the brain (cerebrum, cerebellum, medulla oblongata, hypothalamus, corpus callosum) and spinal cord, have specific roles in the co-ordination of body functions and are protected by the bones of the skull, the meninges and cerebro-spinal fluid.
- Different receptors detect changes in the internal and external environments, including thermoreceptors, osmoreceptors, chemoreceptors and receptors for touch and pain.
- The reflex arc comprises of specially structured neurons, including sensory, interneuron and motor neurons, to transmit information from the receptor to the effector to respond rapidly to stimuli.
- Transmission of nerve impulses is via electro-chemical changes that occur at the generation of the impulse, the propagation of the impulse along the nerve fibre, and the transfer of the impulse across the synapse.
- The nervous and endocrine systems work together to co-ordinate functions of all body systems, but differ in terms of:
 - speed of action
 - duration of action
 - nature and transmission of the message
 - specificity of message.
- Cell replacement therapy has the potential to treat nervous system disorders including Alzheimer's and Parkinson's disease.

Review Questions

1. The basic cell type found in the nervous system is called a _____
2. All neurons have three basic parts. These are:
_____, _____,
and _____.
3. State the four types of structural neurons and where each is found:
 - (a) _____
 - (b) _____
 - (c) _____
 - (d) _____
4. Label the parts of a motor neuron using the parts listed below.



5. What are the functions of:
nerve cell body? _____
axon? _____
dendrites? _____
myelin sheath? _____
Schwann cells? _____
nodes of Ranvier? _____
axon terminal? _____

6. (a) Neurons can also be classified in two other ways:

By function

(i) _____

(ii) _____

(iii) _____

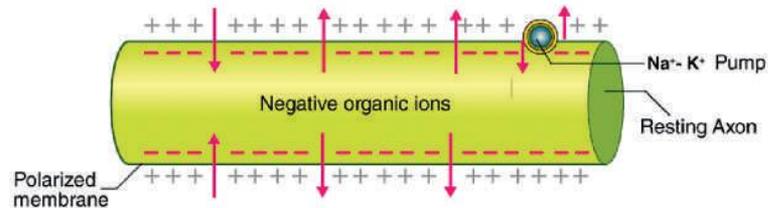
By direction of nerve impulse transmission:

(iv) _____

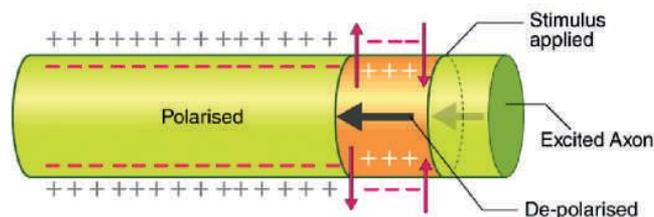
(v) _____

(b) Where do interneurons or connector neurons occur and what is their function? What would be the consequences if this area was damaged?

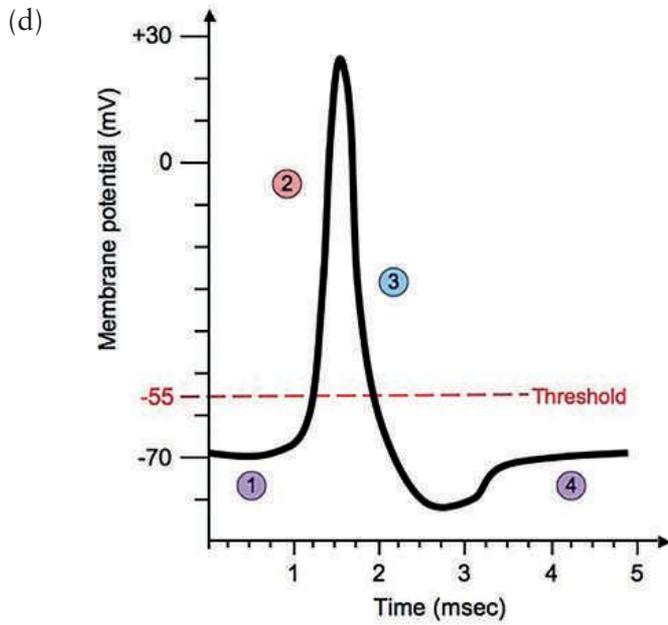
7. (a) What are the two main ions involved in the generation of a nerve impulse? Where are each of these in higher concentration before depolarisation of the membrane? How is the membrane potential maintained before depolarisation? In which direction do the Na and K ions tend to move while the neuron is at rest? Why?



(b) Show the ion movement that occurs when the nerve cell membrane is depolarised.



(c) What is the role of active transport (Na/K pump) across the nerve cell membrane after the depolarisation occurs?



State the movement of ions across the neuron cell membrane at each of the four stages indicated on the action potential graph above.

1.

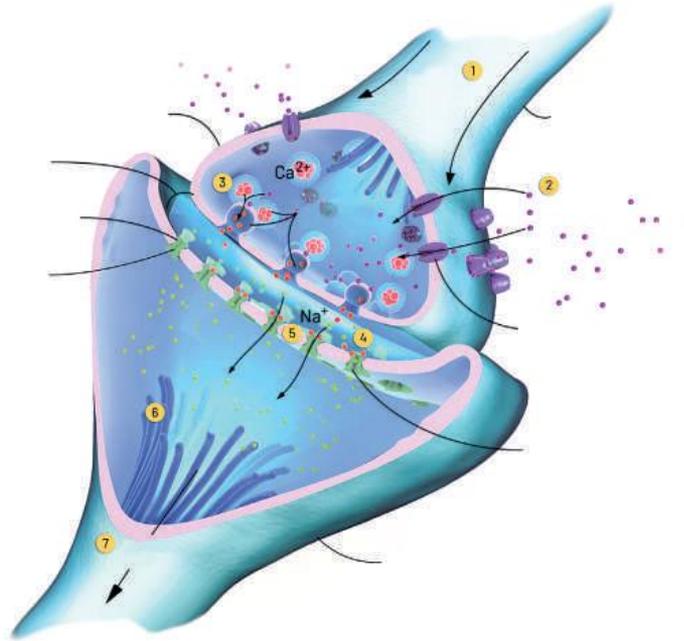
2.

3.

4.

(e) What happens if the stimulus does not reach the threshold level?

8. (a) What is a synapse? How does it differ from a neuromuscular junction?

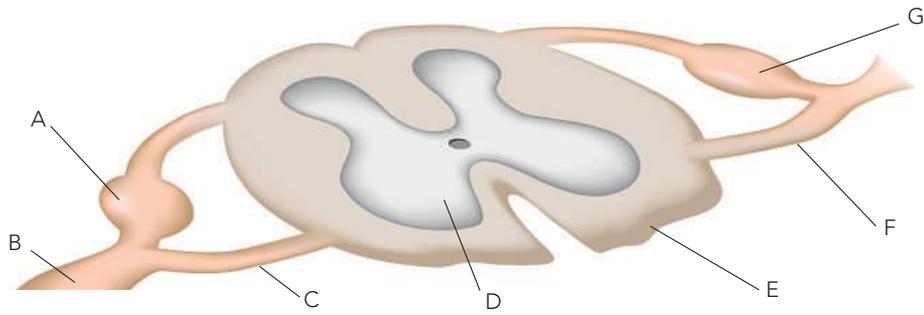


(b) Annotate the picture to outline what happens at a synapse.

(c) Give two examples of neuro-transmitters.

(d) Outline the action of different drugs that act at synapses.

9.



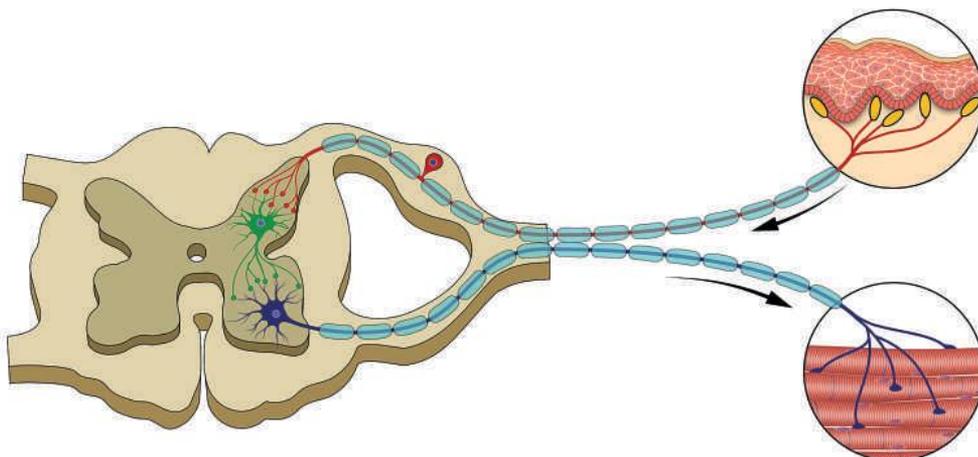
(a) Draw up a table to outline the labelled structures and their functions.

(b) What is found in structures A and G?

(c) What type of neuron can be found in D?

10. Neurons link together to transfer information from one part of the body to another. The responses to stimuli can be as a reflex action or a voluntary action. What are the differences?

11. Annotate this diagram to show the names of the structures involved in this reflex arc.



12. Describe how this pathway changes if the action is made voluntarily.

13. Newborns are tested for seven different reflexes. What does this involve and why are they tested?

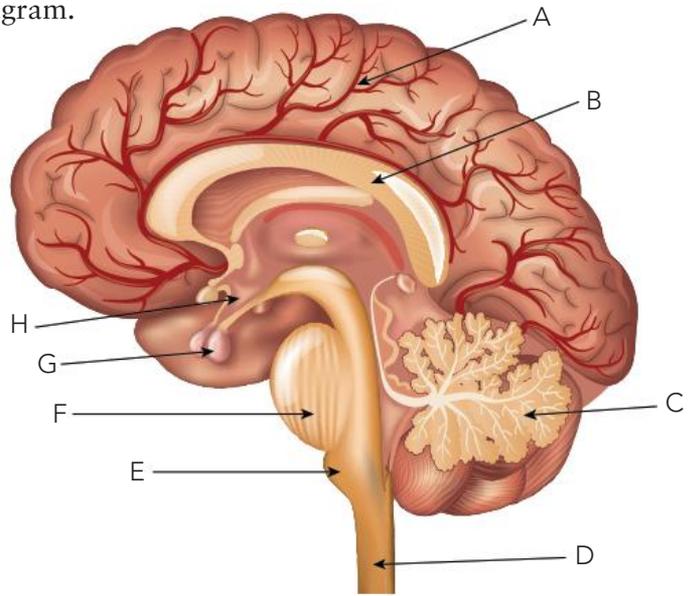
14. Names some reflexes found in adult humans and suggest why they are useful.

15. How does a conditioned reflex differ from an innate reflex action? Give an example of a conditioned reflex action.

16. In general terms, why do we need a nervous system? What does it do for us?

17. Identify the structures shown in the diagram.

- A _____
- B _____
- C _____
- D _____
- E _____
- F _____
- G _____
- H _____



18. State the functions of these structures.

Structure	Function
cerebral cortex (cerebrum)	
cerebellum	
medulla oblongata	
hypothalamus	
corpus callosum	
spinal cord	

19. List the meninges in order from the skull to the surface of the brain, and complete the table.

Meninges layer	Structure	Function

20. Two other structures protect the brain. What are they and explain how they work.

21. (a) Distinguish between grey and white matter.

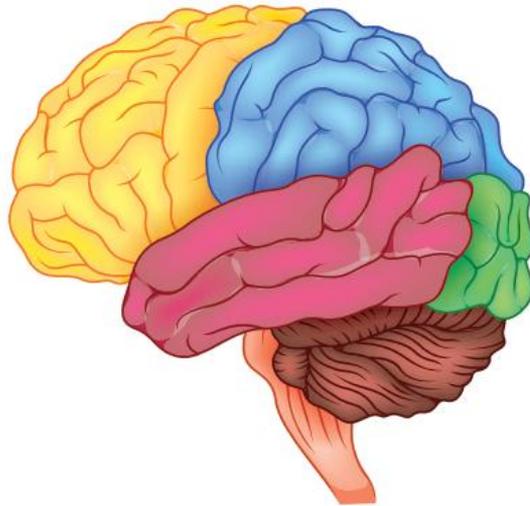
- (b) Compare the locations of grey and white matter in the spinal cord and the brain.

22. What major parts of the brain are involved with:

- (a) voluntary control of movement and handling objects?

- (b) involuntary control of posture and balance?

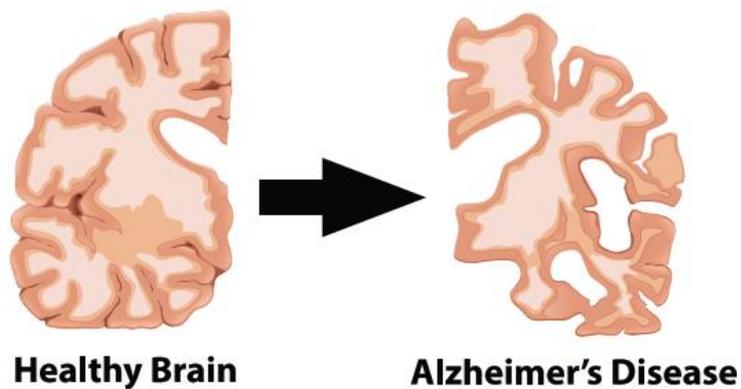
23. (a) Annotate the diagram of the brain below to indicate the areas of the brain and the functions each controls.



- (b) Name the junction between the yellow and blue areas.

- (c) What are the main functions of the areas immediate adjacent to this structure?

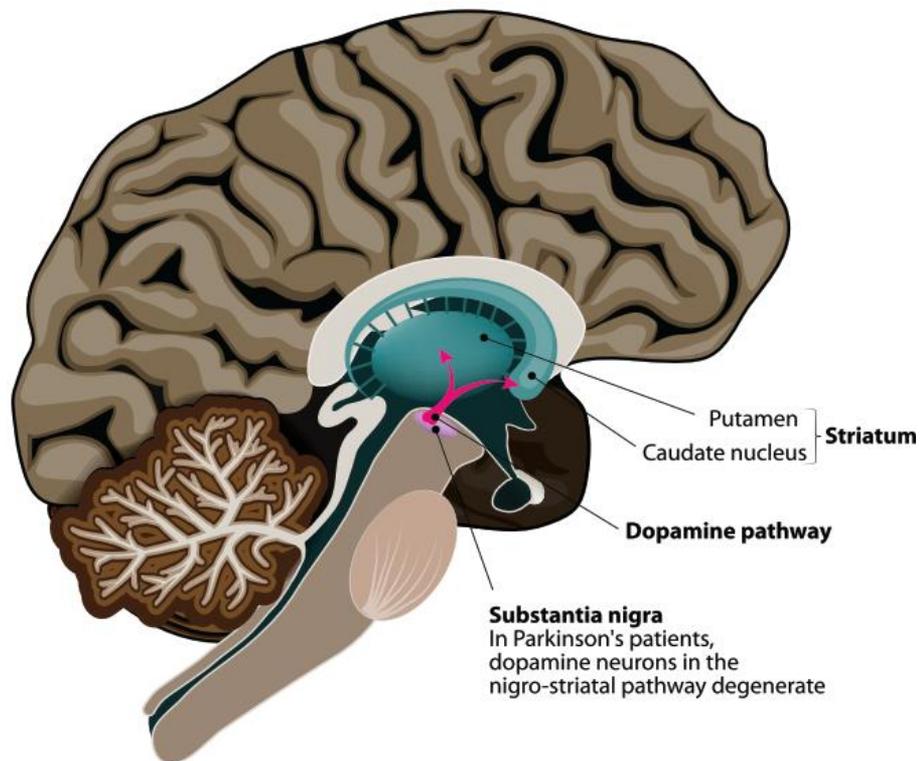
24. The diagram below shows the changes in the cerebrum due to Alzheimer's disease.



- (a) What functions are compromised due to this condition?

(b) Cell replacement therapy has potential to treat Alzheimer's disease. What type of cells could be used? What would they do?

25. This graphic shows the location of degeneration that causes Parkinson's disease.



(a) What does dopamine do?

(b) How is gene therapy being used to treat this condition?

(c) What are the problems involved in using this therapy?

26. What are stem cells?

27. Two major sources of stem cells are:

(a) _____

(b) _____

28. Two characteristics of stem cells are:

(a) _____

(b) _____

29. Uses of stem cells in the future could include stem cell-based therapies.

(a) What is a stem cell-based therapy?

(b) Give two examples where it could be used.

30. (a) What are some of the advantages of using stem cells?

(b) What are some of the concerns regarding the use of stem cells?

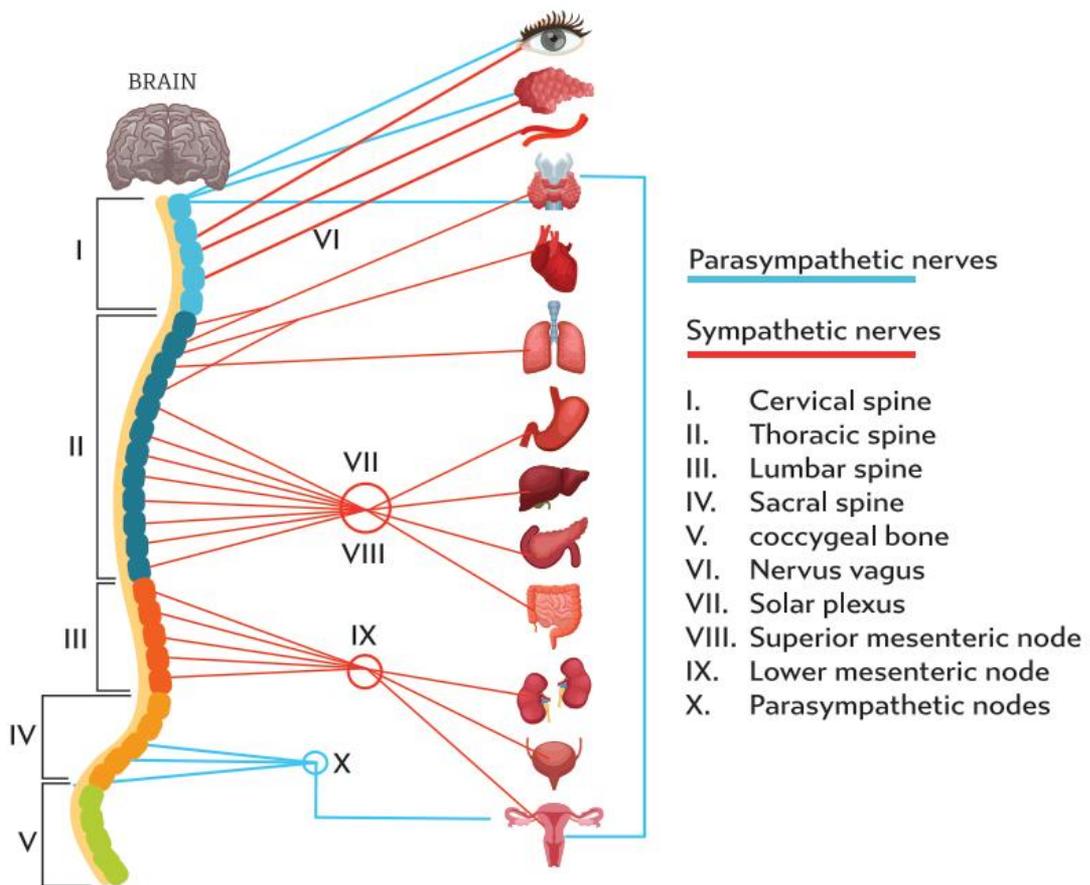
31. What does the peripheral nervous system (PNS) consist of?

32. What is the difference between the cranial and spinal nerves?

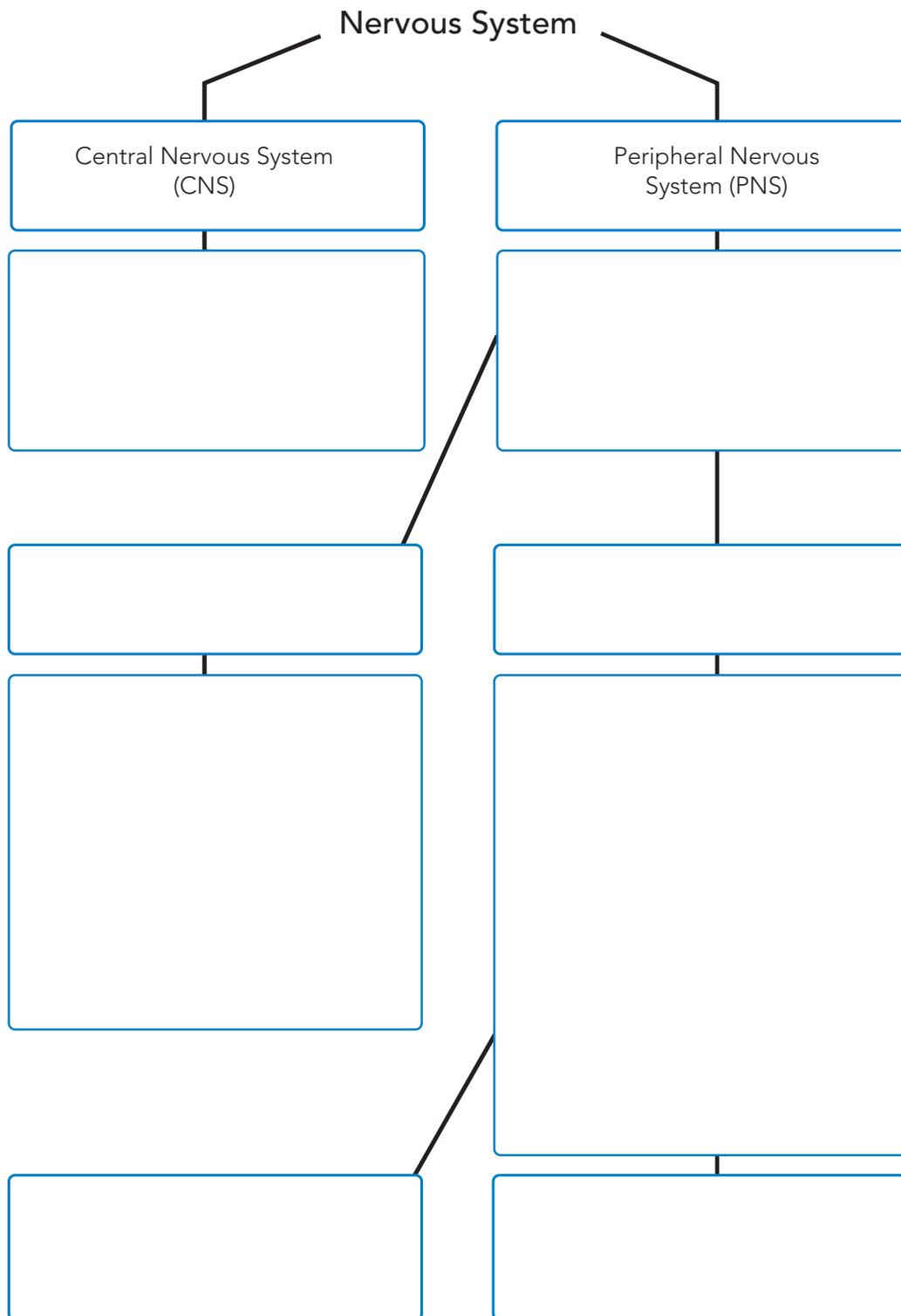
33. The divisions of the PNS are the _____ and _____

34. The efferent system can be further divided into the _____ and _____

35. The autonomic division can be further divided into the _____ and _____

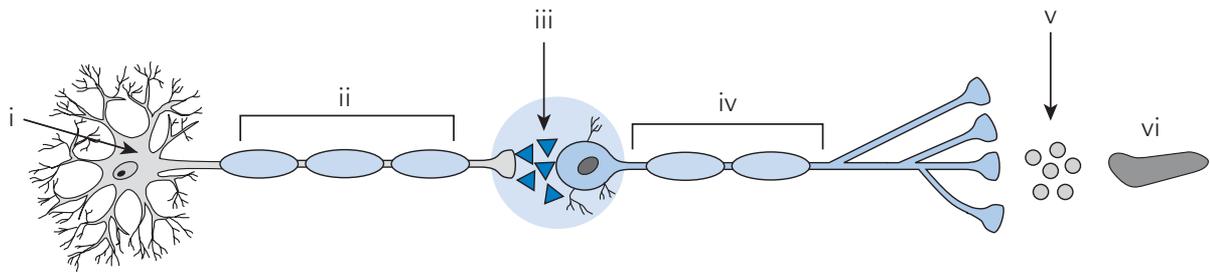


36. Fill in the flow chart below showing the divisions of the nervous system. Beneath each division fill in what it does and what it consists of.



37. Why is the autonomic nervous system considered to be 'automatic'?

38. Label the following diagram summarising the general structure of the autonomic nervous system.



(i) _____ (ii) _____ (iii) _____

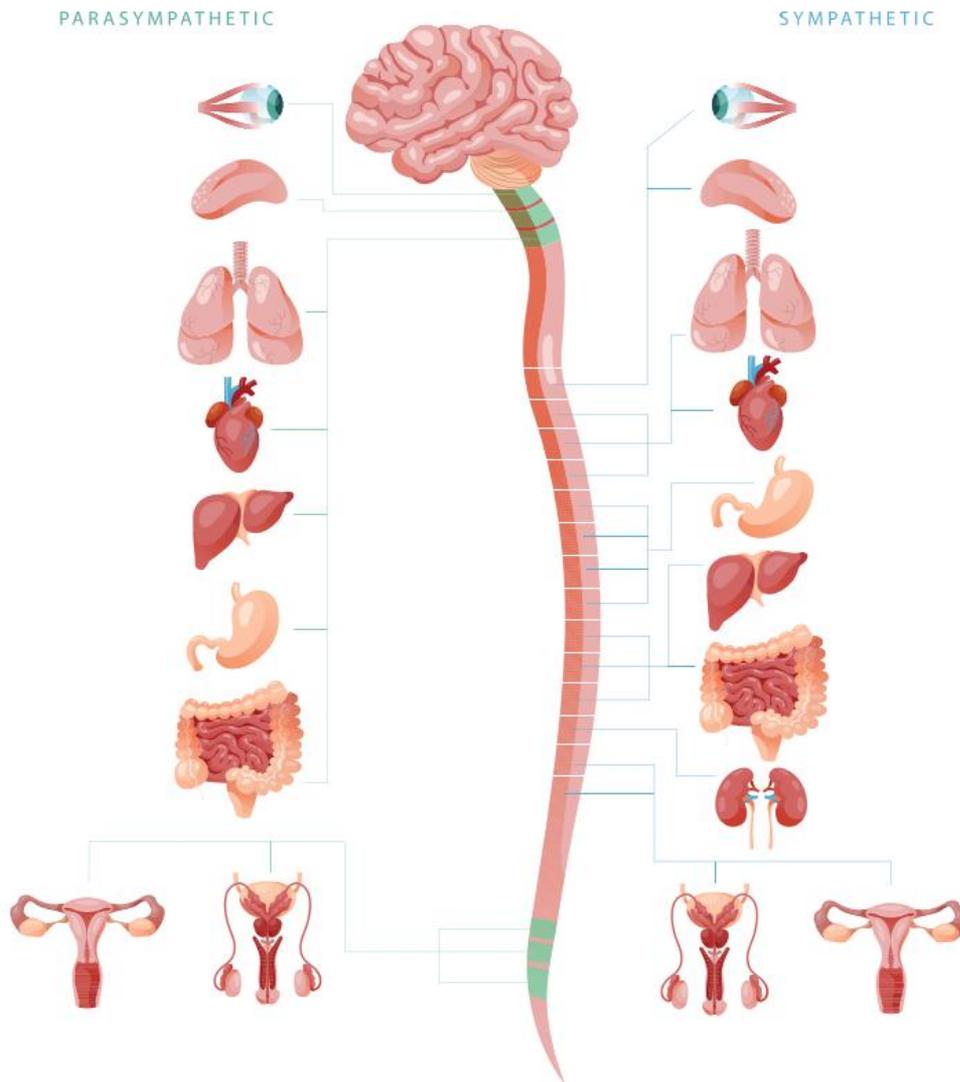
(iv) _____ (v) _____ (vi) _____

39. What is a ganglion (plural, ganglia)? What is its purpose? Where are they found?

40. The autonomic nervous system can be divided into two parts: the sympathetic and parasympathetic nervous systems. Compare and contrast the parasympathetic and sympathetic nervous systems in the table below.

Sympathetic	Parasympathetic

41. State the effects the sympathetic and parasympathetic nervous systems have on some body organs by annotating the diagram below.



42. Complete the following table.

	Somatic Nervous System	Autonomic Nervous System
Control		
Innervates		
Type of neurons		
Number of neurons per path		
Effect		
Neurotransmitters		

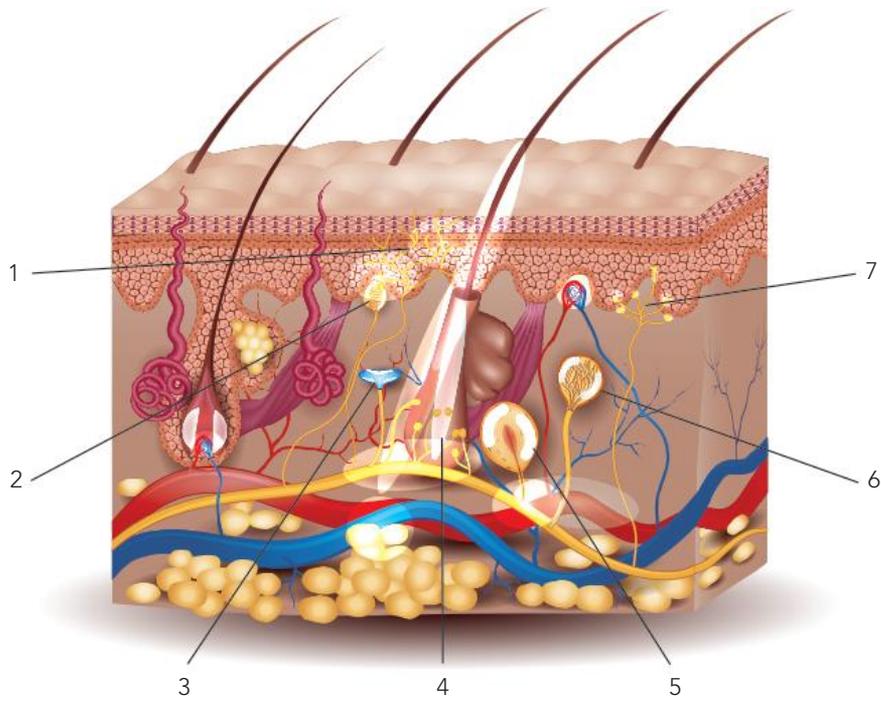
43. Draw a table below to contrast the actions and effects of nerves and hormones. Consider the speed, duration (how long the effect is for), transmission and specificity.

44. Why does the body have receptors?

45. List some stimuli and the body's receptors for these.

46. Match the following stimuli and receptors.

Stimulus	Receptor
touch	chemoreceptor
taste	thermoreceptor
stretch in a limb	free nerve endings
heat	proprioceptor
pH of the blood	mechanoreceptor
sound	osmoreceptor
blood salt concentration	chemoreceptor



47. Label the receptors shown in this section of skin, and state what each one responds to.

	Receptor	Function
1		
2		
3		
4		
5		
6		
7		

48. Complete the following table indicating the location of receptors for different factors in the body:

Feature	Location of receptor
1. Body temperature	
2. Carbon dioxide level in the blood	
3. Glucose levels in the blood	
4. Salt concentration in the blood	



SYLLABUS CHECKLIST

This is the knowledge that you should understand after completing this section:

- Homeostatic processes involve nerves and hormones in maintaining the body's internal environment within tolerance limits through the control of metabolism and physiological and behavioural activities.
- Thermoregulation occurs by the control of heat exchange and metabolic activity through physiological and behavioural mechanisms.
- Blood sugar levels are maintained by controlling sugar uptake, its storage and release by cells and use in metabolism; these processes involve the hormones of the pancreas and adrenal glands.
- Body fluid concentrations are maintained by balancing water and salts via the skin, digestive system and the kidneys, which involve the actions of antidiuretic hormone (ADH) and aldosterone on the nephron and the thirst reflex.
- Gas concentrations are controlled by balancing the intake of oxygen and the removal of carbon dioxide via the lungs, through the actions of the medulla oblongata and the autonomic nervous system.
- Synthetic hormones may be developed to control or treat endocrine dysfunction, including diabetes mellitus, hypothyroidism and hyperthyroidism, to improve the quality of life for individuals.
- Gene therapy can be used to treat a range of diseases including diabetes mellitus.

Review Questions

1. (a) The two body systems that regulate homeostasis are _____
and _____ .

(b) What is the main difference between the two systems?

2. Why is homeostasis important?

3. Why do the internal conditions of the body need to be kept relatively constant?

4. List some aspects of the body's internal environment that are kept at relatively constant levels.

5. What are tolerance limits? What happens if the levels exceed the tolerance limits?

THERMOREGULATION

9. What is meant by **core body temperature**?

10. What is the optimum human body temperature?

11. What are the tolerance limits for human core body temperature?

12. How does the temperature of the body's extremities differ from that of the core body temperature?

13. Why do the core body temperature tolerance limits differ from the extremities limits?

14. (a) Fill in the table below listing ways in which our bodies gain and lose heat.

Mechanisms to Produce or Retain Heat	Mechanisms to Lose Heat

(b) How can behaviour change heat gain or loss?

15. (a) During exercise we often sweat profusely. How does sweating aid in cooling the body?



- (b) Why is sweating ineffective on humid days but quite effective on dry days?



16. Consider the image above. How has heat exchange between the body and the environment been altered?

17. Distinguish between **vasodilation** and **vasoconstriction**. Under what conditions do these occur in humans?

18. What is shivering? How does shivering raise the body temperature?

19. Explain why piloerection is not useful for controlling body temperature in humans.

CONTROL OF BLOOD SUGAR LEVELS

20. List three factors that impact blood sugar levels in humans.

21. Two hormones control the level of sugar in the blood. Name them and state the effect of each.

(a) _____

(b) _____

22. How do the following organs contribute to the maintenance of blood sugar levels?

Liver

Pancreas

Muscles

23. Distinguish between:

(a) glycogenesis _____

(b) glycogenolysis _____

(c) gluconeogenesis _____

24. What are the sources of glucose in the diet?

25. Is the level of sugar (glucose) in the blood high or low:

(a) just before a meal? _____

(b) very early in the morning before breakfast? _____

26. Draw two feedback loops to show how the level of glucose in the blood is maintained in the body by insulin and glucagon:

(a) when the glucose level is high.

(b) when the glucose level is low.

27. Diabetes mellitus can be Type 1 or Type 2. Explain the difference.

28. What are the symptoms of diabetes mellitus? Explain why they occur.

29. There are two groups of diseases that are commonly called diabetes – diabetes mellitus and diabetes insipidus – and different hormones are associated with each. Name the hormones associated with each form of diabetes.

30. Hypoglycaemia refers to a low level of sugar in the blood.

(a) What causes hypoglycaemia?

(b) How could you tell if one of your friends was hypoglycaemic?

(c) If one of your friends fell into a hypoglycaemic condition, what could you do to help them?

OSMOREGULATION

31. Distinguish between:

(a) plasma and lymph

(b) intracellular fluid and extracellular fluid

32. What are three kinds of extracellular fluid?

33. What is urine? What substances does it normally contain?

34. How does plasma compare to urine?

35. (a) Define osmotic pressure.

(b) What could cause the concentration of water to increase in the blood?
(i.e. osmotic pressure decreases)

(c) What could cause the concentration of water to decrease in the blood?
(i.e. osmotic pressure increases)

36. What are diuretics? Name two common examples.

37. (a) How much filtrate is produced each day by an average person?

(b) How much urine is produced each day by an average person?

(c) So what happens to all that filtrate?

38. Even if we do not drink very much, we still produce some urine.

(a) Where does the water come from?

(b) Why do we have to produce urine even under the most dehydrated conditions?

39. What is urea? Where is it produced? Why do we have to excrete it?

40. A person loses a lot of water through sweating on a hot day.

(a) How does this effect the osmotic pressure of the tissue fluids?

(b) What part of the brain is sensitive to water concentration (osmotic pressure) in the blood?

(c) If the water levels have dropped in the blood, what sensation do you feel?
(i.e. osmotic pressure is higher than normal)

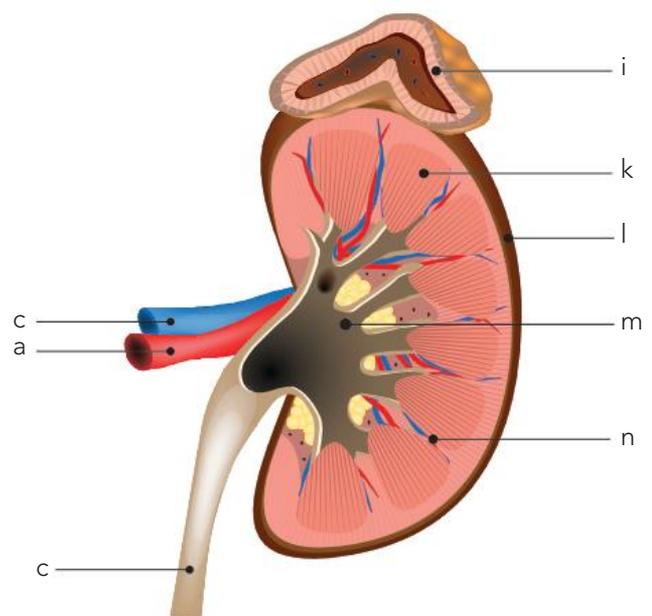
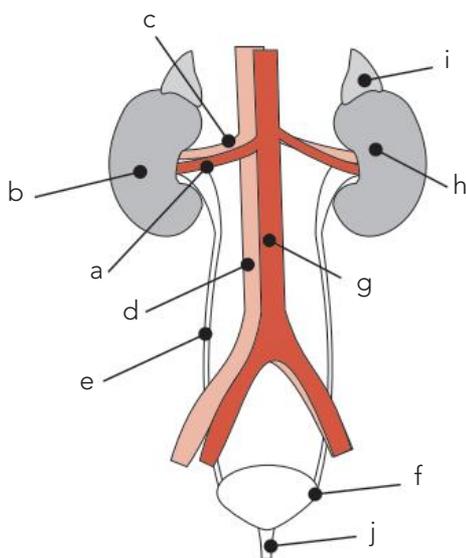
(d) What homeostatic mechanisms are used in an effort to restore the correct amount of water in the blood?

41. List the metabolic wastes that the body produces and next to each write down the name of the organ(s) that excretes it.

Metabolic Wastes	Excretory Organ

42. Describe the functions of the kidneys.

43. (a) Label these diagrams.



- a) _____
- b) _____
- c) _____
- d) _____
- e) _____
- f) _____
- g) _____

- h) _____
- i) _____
- j) _____
- k) _____
- l) _____
- m) _____
- n) _____

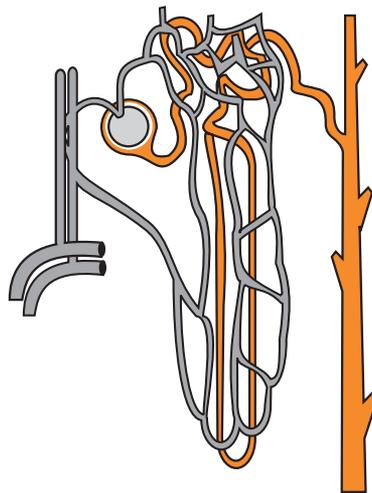
(b) What substance is not normally found in e) but can be found in both a) and c)?

(c) What substance would you find in a) and e) but in much lesser quantities in c)?

(d) What substance is stored in f)?

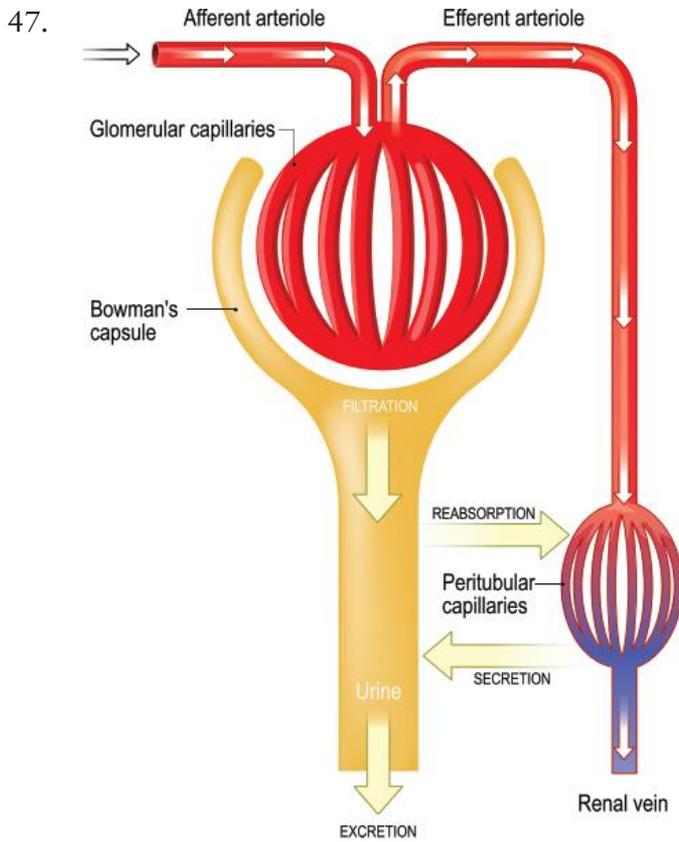
(e) What changes would there be to the contents of structure f if you drank lots of tea on a cold day?

44. Label a diagram of a nephron.



45. Colour the blood vessels to indicate the location of the arterioles (red) and venules (blue).

46. List in order the structures that materials filtered from the blood will flow through in the nephron.



Explain how the structure of the glomerulus and the Bowman's capsule help achieve the high rates of filtration observed in a person.

48. (a) What materials are filtered from the glomerulus into the Bowman's capsule?

(b) What substances are not filtered into the Bowman's capsule?

(c) Explain three factors that influence the rate of filtration from the glomerulus to the Bowman's capsule.

(i) _____

(ii) _____

(iii) _____

49. (a) What is **selective reabsorption**?

(b) What materials are reabsorbed back into the blood?

(c) Where does this reabsorption take place?

50. (a) What is **tubular secretion**?

(b) What substances are secreted into the nephron?

(c) In what part of the nephron are most substances secreted?

(d) What are two effects of tubular secretion?

51. The amount and concentration of the urine produced by the kidneys are controlled by two hormones. What are they and from where are they secreted?

Hormone	Secreted from

52. Draw two flow diagrams in the space provided: one to show the effect of antidiuretic hormone (ADH) on increased water levels in the blood and one to show the effect of antidiuretic hormone (ADH) on reduced water levels in the blood.



53. Kidney failure which can result from damage due to infection, kidney stones, drug abuse (analgesics, etc.) or genetic disorders, means that the body is unable to remove toxic materials or metabolic by-products (e.g. urea) from the blood. This can be remedied by dialysis and/or kidney transplants.

(a) What is meant by **dialysis**?

(b) How does a kidney machine work?

(c) What problems are involved with kidney transplants?

54. Explain how diabetes can disrupt kidney function.

CONTROLLING GAS CONCENTRATIONS

55. Cellular respiration requires a constant supply of oxygen and continuous removal of carbon dioxide. State the respiration reaction.

word equation _____

chemical equation _____

56. Where does the exchanges of gases between the body and the environment occur?

57. What controls the rates of gas exchange at the cell membrane?

58. Besides oxygen and carbon dioxide, what other factor is detected in order to control gas concentrations in the blood?

59. Complete the table below, by adding the information for each of the receptors for maintaining gas concentrations.

Receptor site	Where found	Function
Aortic body		
Carotid body		
Medulla oblongata		

60. Draw a feedback loop to show what happens when there is a change in carbon dioxide concentration in the blood.



61. How does hyperventilation effect breathing rates? Why?

62. Emphysema is a lung disease in which the alveoli are affected. Its main symptom is shortness of breath or breathlessness and this gets progressively worse. Another symptom is hardening of the lung tissue (known as fibrosis or scar tissue). The destruction of the lung tissue also causes blood to flow slower through the lungs.

- (a) What happens to the alveoli?

- (b) Explain how the symptoms could be related to what has happened to the alveoli.

- (c) What is one way you could prevent this disease from developing?

RESPONSE TO INFECTION



SYLLABUS CHECKLIST

This is the knowledge that you should understand after completing this section:

- Infectious diseases are caused by invasion of pathogens in the form of bacteria and viruses and can be transmitted from one host to another.
- Transmission of pathogens occurs by various mechanisms including direct and indirect contact, transfer of body fluids, disease specific vectors and contaminated food and water.
- The body's external defence mechanisms against pathogens include features of the skin, digestive tract, urogenital tract, respiratory system, the ear and the eye.
- Pathogens that enter the body are targeted by non-specific immune responses of inflammation and fever.
- Antiviral and antibiotic drugs are used for treating infections and differ in their specificity to pathogens.
- Passive immunity can be acquired as antibodies gained through the placenta or antibody serum injections; active immunity can be acquired through natural exposure to the pathogen, or the use of vaccines.
- Immunity is gained through the exposure to specific antigens by the production of antibodies by B lymphocytes and the provision of cell-mediated immunity by T lymphocytes; in both cases memory cells are produced.
- Hormones and vaccines are developed using recombinant DNA and associated biotechnological techniques.
- The decision to participate in immunisation programs can be influenced by the social, economic and cultural context in which it is considered.

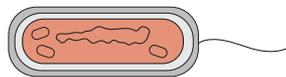
Review Questions

1. Distinguish between infectious and non-infectious diseases. Provide examples of each.

2. Are all microorganisms pathogens? Explain your answer.

3. List types of pathogens other than bacteria and viruses and give an example of a disease caused by each.

4. Name the three main shapes of bacteria shown below.



5. Different types of bacteria can be identified by:

(a) _____

(b) _____

(c) _____

6. What conditions do bacteria need to grow and reproduce?

7. (a) What process do bacteria use to reproduce? _____

(b) Sketch it in the box provided.

(c) If one cell divided every 30 minutes, how long would it take to reach

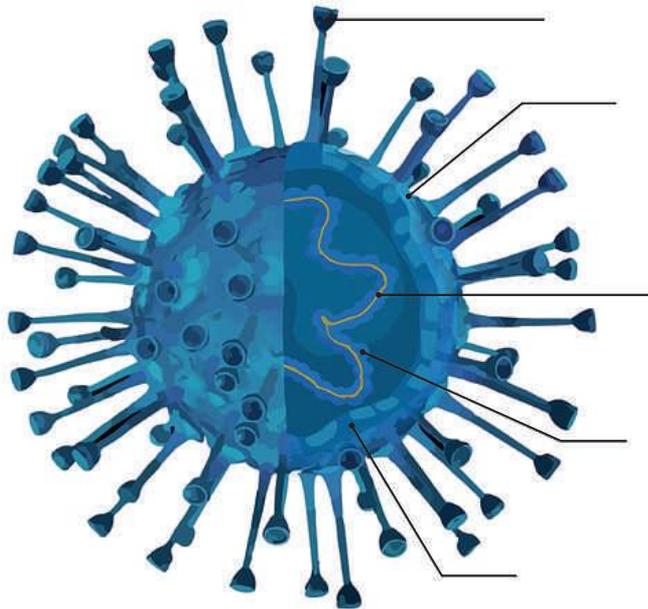
1000 cells? _____

100,000 cells? _____

1,000,000 cells? _____

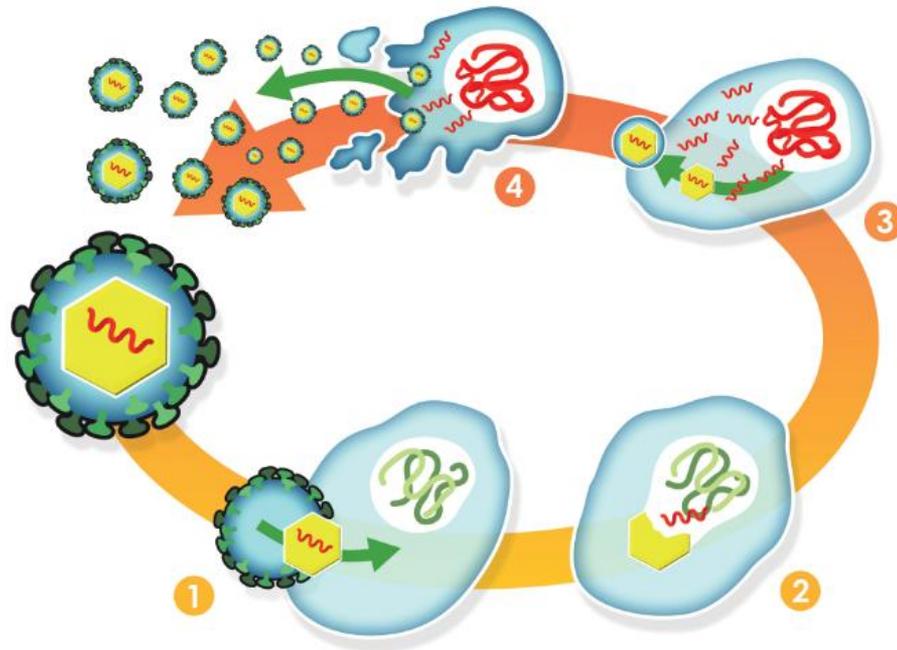
8. Some diseases caused by bacteria include:

9. Label the diagram of a virus particle.



10. Are viruses living cells? Why or why not?

11. The diagram below shows how a virus particle can invade a cell and replicate in it. Annotate the diagram using steps 1–4 and label the coloured structures.

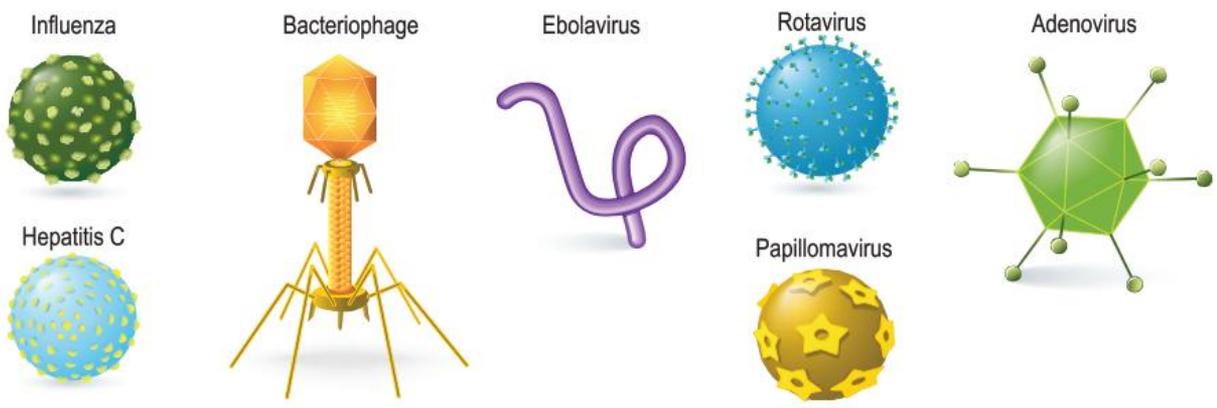


12. What does 'host specific' mean?

13. What are bacteriophages?

14. List some diseases caused by viruses.

Viruses are found in a large variety of shapes specific to the diseases they cause.



15. In the table below, summarise some main points about each pathogen.

Bacteria	Viruses

16. How can pathogens enter the body?

17. List five ways in which transmissible diseases can be caught by people.

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

18. Pathogens are all around us. How do the following external barriers protect us from infection?

- Skin

- Ear wax

- Mouth

- Nasal hairs

- Vaginal fluid

- Stomach acid

- Tears

- Urine

- Respiratory cilia

- Mucous membranes

19. Describe three ways in which a person can assist the body in providing external protection.

(a) _____

(b) _____

(c) _____

20. (a) What is personal hygiene?

(b) What are some things we can do to prevent ourselves from catching a disease caused by bacteria or viruses?

(c) What special personal hygiene is recommended for women?

(d) What special personal hygiene is recommended for men?

21. (a) Distinguish between what is meant by the body's 'natural' protection and 'assisted' protection.

(b) Distinguish between what is meant by 'external' and 'internal' assisted protection.

22. List some of the chemical barriers that can inhibit the growth of, or kill, pathogens.

23. (a) Name three parts of the body that produce fluids with a low pH.

(b) How does this low pH affect microorganisms that may enter these areas?

24. (a) Name two body systems that produce mucus that protects the body from pathogenic invasion.

(b) Describe how the mucus protects the body from pathogenic invasion in each system.

25. Why is the digestive mucosa considered to be an external barrier to pathogens?

26. List ways in which the spread of influenza in a population can be reduced by an individual's behaviour.

27. Distinguish between communicable disease, contagious disease and non-communicable disease.

28. Distinguish between endemic, epidemic and pandemic.

29. Some pathogens need aid to transfer from an infected person to a non-infected person. What are these animal carriers called?

30. List some specific disease-carrying organisms and the diseases they carry.

31. How can this indirect transmission of pathogens be controlled to help prevent the spread of these specific diseases?

32. How can pathogens get into the internal environment of the body?

33. What cells recognise the pathogens as 'no-self' cells? What is their reaction to the detection of these invaders?

34. Describe phagocytosis. Which type of white blood cell is actively engaged in it?

35. (a) What is the lymphatic system?

(b) What is its role in defending the body against disease?

36. How is lymph moved through lymph vessels?

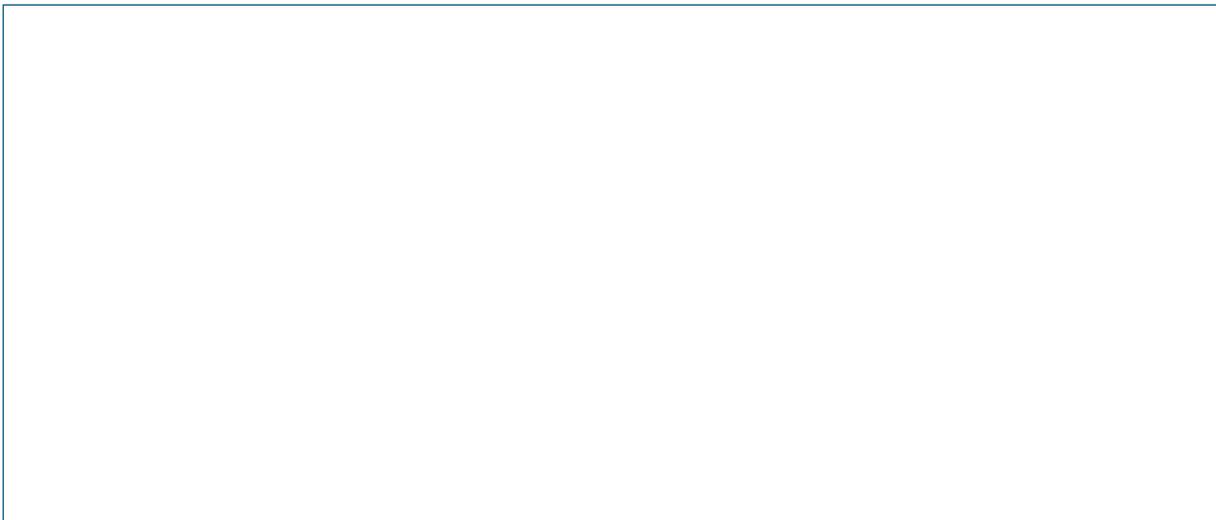
37. List some organs that contain lymphatic tissue.

38. Describe what happens inside lymph nodes.

39. (a) What causes inflammation?

(b) How can inflammation be recognised?

(c) Draw a flow diagram to show the body's response to pathogens entering via a wound.



40. What is 'pus'?

41. The presence of some pathogens is only recognised when a person's temperature increases beyond the normal range. This is called a 'fever'. What causes a fever?

42. When a fever starts, the person feels very cold and often shivers. When the fever 'breaks' the person feels very hot. Explain what is happening in terms of homeostasis of body temperature.

43. Why is a high temperature fever dangerous to cellular functioning?

44. (a) What are antibiotics?

(b) What determines when a particular antibiotic is used?

(c) How do antibiotics work?

(d) Explain why it is important to complete a course of antibiotics.

(e) Why are antibiotics NOT given to 'flu sufferers?

(f) Why are some antibiotics no longer effective against some infections?

45. (a) What are antiviral drugs?

(b) What are two differences between an antibiotic and an antiviral drug?

(c) How do viral drugs work?

(d) Why are both antibiotic and antiviral drugs usually considered an 'internal protection'?

46. The basis for an immune response is for the body to distinguish 'self' from 'non-self'. How does it do this?

47. What is the immune response?

48. Two types of lymphocytes found in lymphoid tissue that are involved in the immune response are T-lymphocytes and B-lymphocytes. Summarise information about each into the table below.

T Lymphocytes	B Lymphocytes

49. Distinguish between the two types of immune response below.

(a) Cell-mediated immune response.

(b) Antibody-mediated (humoral) immune response.

50. Distinguish between plasma cells and memory cells.

51. (a) Describe the primary immune response.

(b) What happens if a person is exposed to a pathogen to which they have been exposed to before?

52. Describe the link between the receptors on the surface of lymphocytes and the specific antigen they recognise.

53. Describe the range of T-cells in the immune system. Why are there so many different T-cells?

54. Complete the table below to show how each situation occurs.

	Natural Immunity	Artificial Immunity
Passive Immunity		
Active Immunity		

55. What is a vaccine?

56. What does a vaccine consist of?

57. How can vaccines be delivered?

58. (a) Australians are required by law to have their children immunised against some diseases. What diseases and what are the consequences if they don't have the vaccinations?

(b) What are some diseases for which you can receive vaccinations

- as an adolescent?

- as an adult?

(c) What are some diseases for which there are no vaccinations available?

(d) What diseases do pneumococcal, Hib and meningococcal C vaccinations prevent?

59. What is herd immunity? How does it impact the spread of a disease?

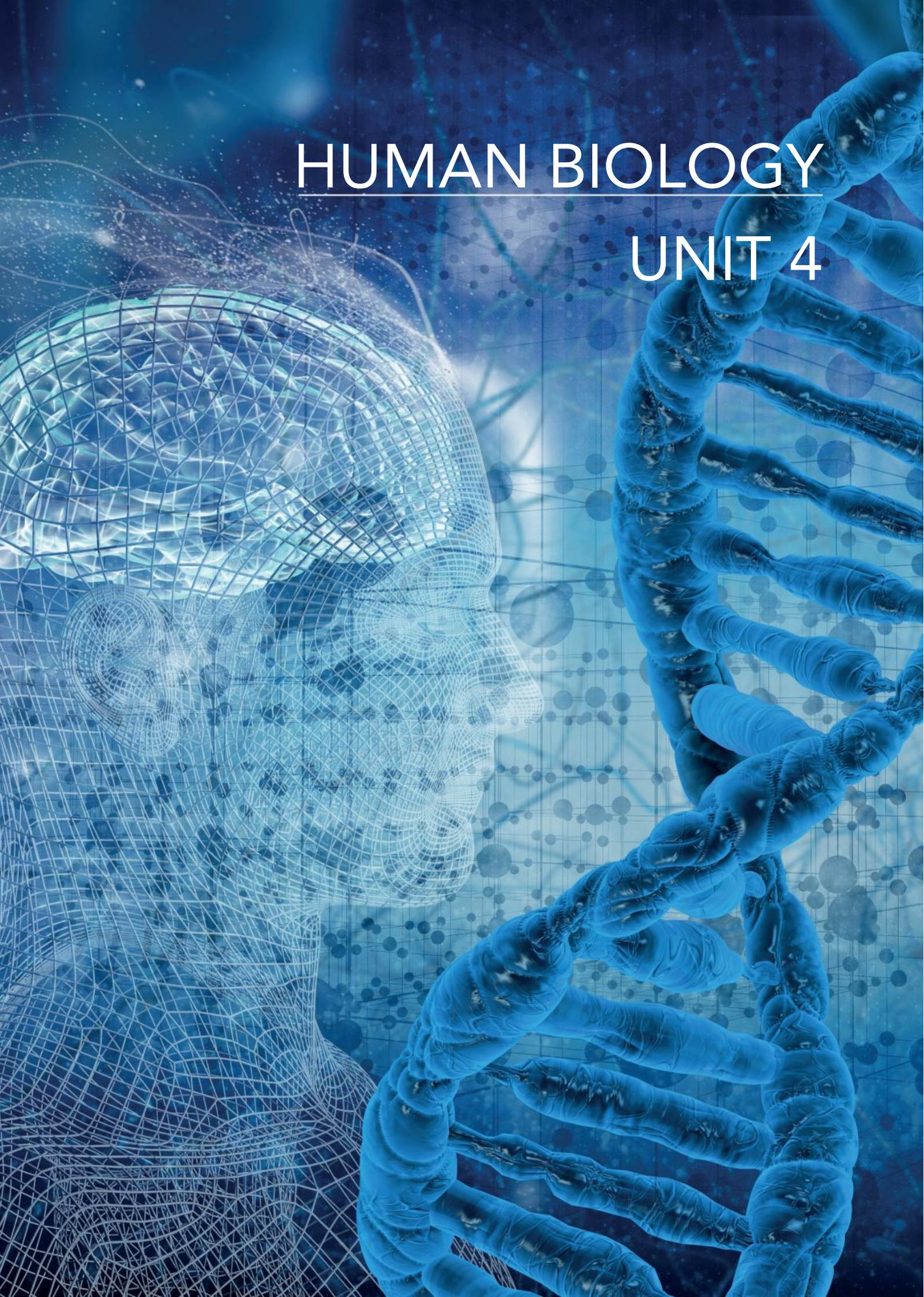
60. Why do some people object to having a vaccination?

61. Vaccines can be made using recombinant DNA technology. Outline the steps involved in this.

62. Some people with allergies can not be immunised with manufactured vaccines used to protect against viruses. Find out why.

HUMAN BIOLOGY

UNIT 4





SYLLABUS CHECKLIST

This is the knowledge that you should understand after completing this section:

- Mutations in genes and chromosomes can result from errors in DNA replication, cell division or from damage from mutagens.
- Different genotypes produce a variety of phenotypes, which are acted on differently by factors in the environment, producing different rates of survival.
- Mutations are the ultimate source of variation introducing new alleles into a population: the new alleles may be favourable or unfavourable to survival.

* Tay-Sachs disease and Thalassemia ($\alpha + \beta$) have been removed from the syllabus, but they have been used here as examples of mutations and their effects on genotypes, phenotypes and survival rates.

There is no requirement to know the etiology of the diseases other than the information given in the questions.

Review Questions

1. The focus of modern biotechnology is based on what molecule?

2. Where in the cell is this molecule found?

3. What is the shape of the chromosomes in

(a) humans during meiosis?

(b) in bacteria?

4. Bacterial chromosomes are called

5. (a) What are the basic units of DNA?

(b) How many different types of these units are found in DNA?

(c) What are the names of the different units?

(d) What are the side rails of the DNA molecule made of?

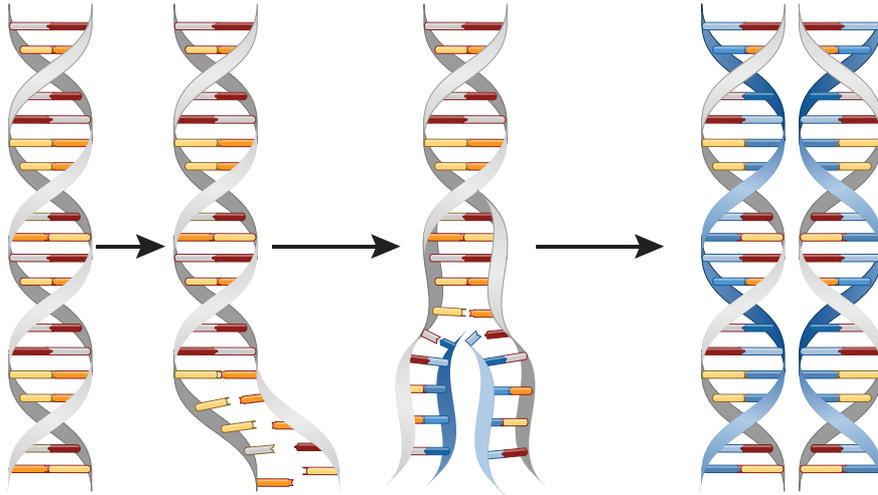
(e) What type of chemical bond joins the bases together across the helix?

(f) What type of chemical bond joins the bases along a strand?

(g) State the pairings of the bases.

(h) Why do the bases only make these pairs?

- (i) Annotate the diagram labelling the parts of the DNA molecule and the processes that are occurring.



6. (a) What is a mutation?

- (b) When do most mutations occur?

- (c) Differentiate between point mutations and chromosomal mutations and give an example of each.

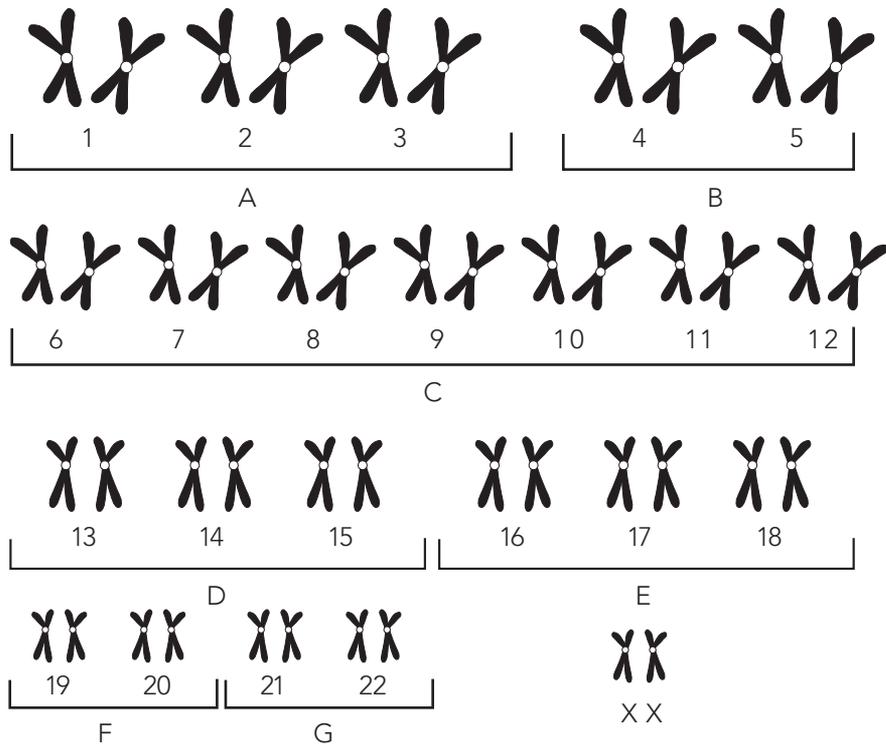
7. (a) What is the difference between a germ line mutation and a somatic mutation?

(b) Discuss the most significant difference in the possible outcome of each of these mutation types.

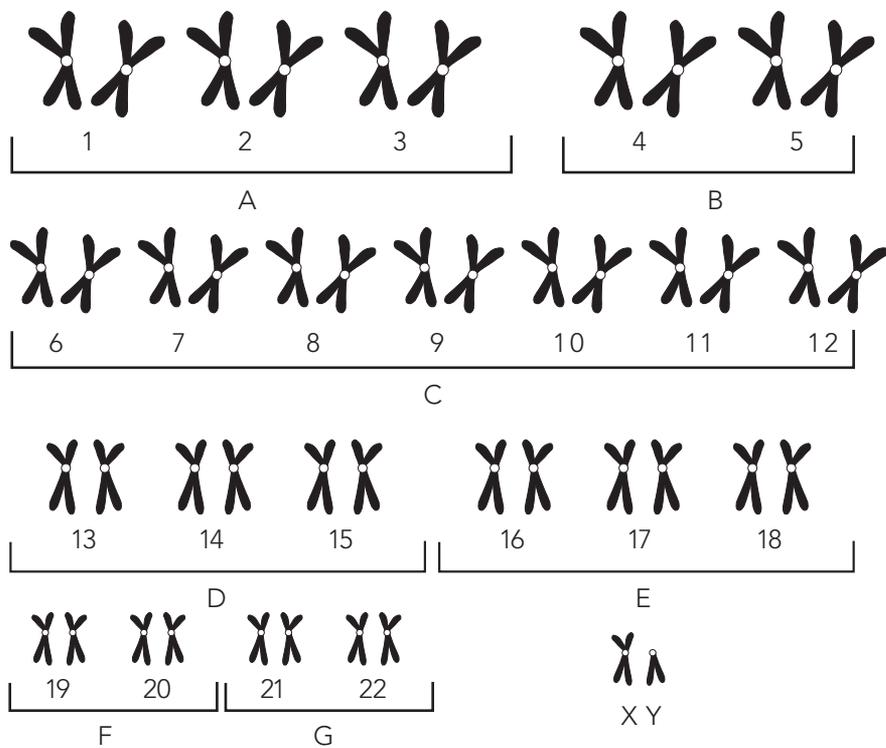
8. What factors may cause mutations to occur?

9. The following diagrams are karyotypes from two different individuals.

Individual 1



Individual 2



(a) What type of mutations are detected using karyotypes?

(b) In what ways are the karyotypes shown similar to each other?

(c) In what ways are these karyotypes different to each other?

(d) To which sex does each karyotype belong? What evidence from the karyotype supports your suggestion?

(e) How would these karyotypes differ if it was from a child with Down's Syndrome?

(f) How could a gamete acquire an extra chromosome?

10. Sometimes the extra chromosomes gained (or lost) in zygotes are sex chromosomes rather than autosomes. Two human conditions caused by gaining or losing sex chromosomes are Turner and Klinefelter's Syndromes.

A person with Turner Syndrome has only one X chromosome. Instead of XX they can be represented as XO.

(a) What gender would such a person be? _____

(b) How many chromosomes would they have in one somatic cell?

A person with Klinefelter's Syndrome has two X's and one Y chromosome, shown as XXY.

(c) What gender would such a person be?

(d) How many chromosomes would they have in one somatic cell?

11. Explain, using diagrams, how the genetic code is used to produce proteins.

12. Do all point mutations result in a change in the sequence of amino acids in a protein? Explain your answer.

This chart indicates the triplet codes for different amino acid selection in protein synthesis.

		Second nucleotide				
		U	C	A	G	
First nucleotide	U	UUU Phe UUC UUA Leu UUG	UCU UCC Ser UCA UCG	UAU Tyr UAC UAA STOP UAG STOP	UGU Cys UGC UGA STOP UGG Trp	U C A G
	C	CUU CUC Leu CUA CUG	CCU CCC Pro CCA CCG	CAU His CAC CAA Gln CAG	CGU CGC Arg CGA CGG	U C A G
	A	AUU Ile AUC AUA AUG Met	ACU ACC Thr ACA ACG	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA AGG Arg	U C A G
	G	GUU GUC Val GUA GUG	GCU GCC Ala GCA GCG	GAU Asp GAC GAA Glu GAG	GGU GGC Gly GGA GGG	U C A G

(b) If a mutation results in an improved phenotype, what is this improvement called?

(c) Give an example of such changes which may have occurred in human evolution.

15. (a) There are many deleterious alleles in the human genome. However, most of these are recessive and since humans have two alleles for each trait, the deleterious alleles are not expressed. When would such deleterious alleles be expressed in an offspring?

(b) When is this combination of deleterious alleles most likely to occur?

16. Tay-Sachs disease is a rare, neurodegenerative disorder. The most common form is usually fatal during early childhood. There are also juvenile and adult forms of Tay-Sachs disease, but these are even rarer than the infantile form. Children with the juvenile form usually live until later in childhood or adolescence. The adult form may develop anytime from adolescence to the mid-30s. The mutations in the HEX-A gene that cause Tay-Sachs disease are inherited in an autosomal recessive manner. Tay-Sachs disease occurs with greater frequency among Jewish people of Ashkenazi descent, i.e. those of Eastern or Central European descent.

(a) State the possible genotypes of

(i) A person not of this heritage who does not exhibit any signs of Tay Sachs disease

(ii) A person who has members of their family with Tach Sachs but they themselves don't have the disease

(iii) A person with Tay Sachs disease

(b) Why was this disease more common in this population than in surrounding populations?

(c) A woman with Ashkenazi heritage whose brother died of Tay Sachs in infancy is pregnant to a man not of this heritage. What is the probability of having an affect child? Use a Punnet Square to show your reasoning.

(d) A person with late onset Tay Sachs has had children with a partner of Ashkenazi heritage. What are the possible genotypes of their children?

(e) What tests can be done to determine if individuals carry the Tay Sachs allele?



SYLLABUS CHECKLIST

This is the knowledge that you should understand after completing this section:

- Populations can be represented as gene pools that reflect the frequency of alleles of a particular gene; gene pools can be used to compare populations at different times or locations.
- Gene pools are dynamic, with changes in allele frequency caused by: mutations, differing selection pressures, random genetic drift, including the Founder effect and changes in gene flow between adjoining groups.
- The incidence of genetic diseases in particular populations illustrates the effects of different factors on the dynamics of gene pools, for example sickle-cell anaemia.
- Natural selection occurs when factors in the environment confer a selective advantage on specific phenotypes to enhance survival and reproduction.
- The mechanisms underpinning the theory of evolution by natural selection include inherited variation, struggle for existence, isolation and differential selection producing changes to gene pools to such an extent that speciation occurs.
- Developments in biotechnology, for example polymerase chain reaction (PCR), gel electrophoresis and DNA sequencing, have increased access to genetic information of species, and provide evidence for evolution (the process of obtaining a DNA sequence is not required).

Review Questions

1. What does a gene pool represent?

2. Why is it useful to consider gene pools rather than populations?

3. List four ways in which changes in allele frequencies can occur.

4. (a) What is meant by variation within a population?

(b) Describe an example of variation caused by environmental factors.

(c) List four ways in which variation occurs independently of environmental factors.

(i) _____

(ii) _____

(iii) _____

(iv) _____

5. (a) Explain how gene flow affects variation in a population.

9. What is the Founder effect? Describe an example of it.

10. (a) What is meant by reproductive isolation?

(b) What effect does this have on gene flow?

(c) List four possible causes of reproductive isolation in human populations.

11. In some isolated populations there is a greater incidence of some genetic diseases than in the rest of the general population, e.g. Thalassaemia 15% of the Greek and Turkish Cypriots are carriers of beta-thalassaemia alleles, while 10% of the population carry alpha-thalassaemia alleles.

(a) Why might the frequency of this allele be higher amongst these people than in the general population?

*Thalassaemia is no longer a required example in the syllabus, but it is used here as an example of dynamics of small populations.

- (b) There is no cure for a child born with thalassemia which is caused by a recessive autosomal allele. If you were a genetic counsellor with this community, what could you tell a couple who were planning to have children?

12. Charles Darwin used the term 'survival of the fittest' when explaining how gene pools change over time. Explain what this term means by giving an example.

13. How does natural selection differ from artificial selection? Give an example of each.

14. What factors in the environment act as selection pressures?

15. Describe how gene flow between adjoining groups in a population could be compromised.

16. Explain the difference between the terms 'genotype' and 'phenotype' using a human example.

17. Selection pressures work on phenotypes not genotypes. Explain why.

18. What is meant by 'differential survival rates of phenotypes'? Compare this phrase with 'selective advantage of phenotypes'.

19. Why do some very deleterious alleles still exist in populations?

20. Explain the importance of the four mechanisms for natural selection:

(a) Inherited variation

(b) Struggle for existence

(c) Isolation

(d) Differential selection

21. What happens to gene pools as a result of natural selection?

22. Explain, in terms of gene pools, the concept of speciation. What evidence would indicate that speciation has occurred?

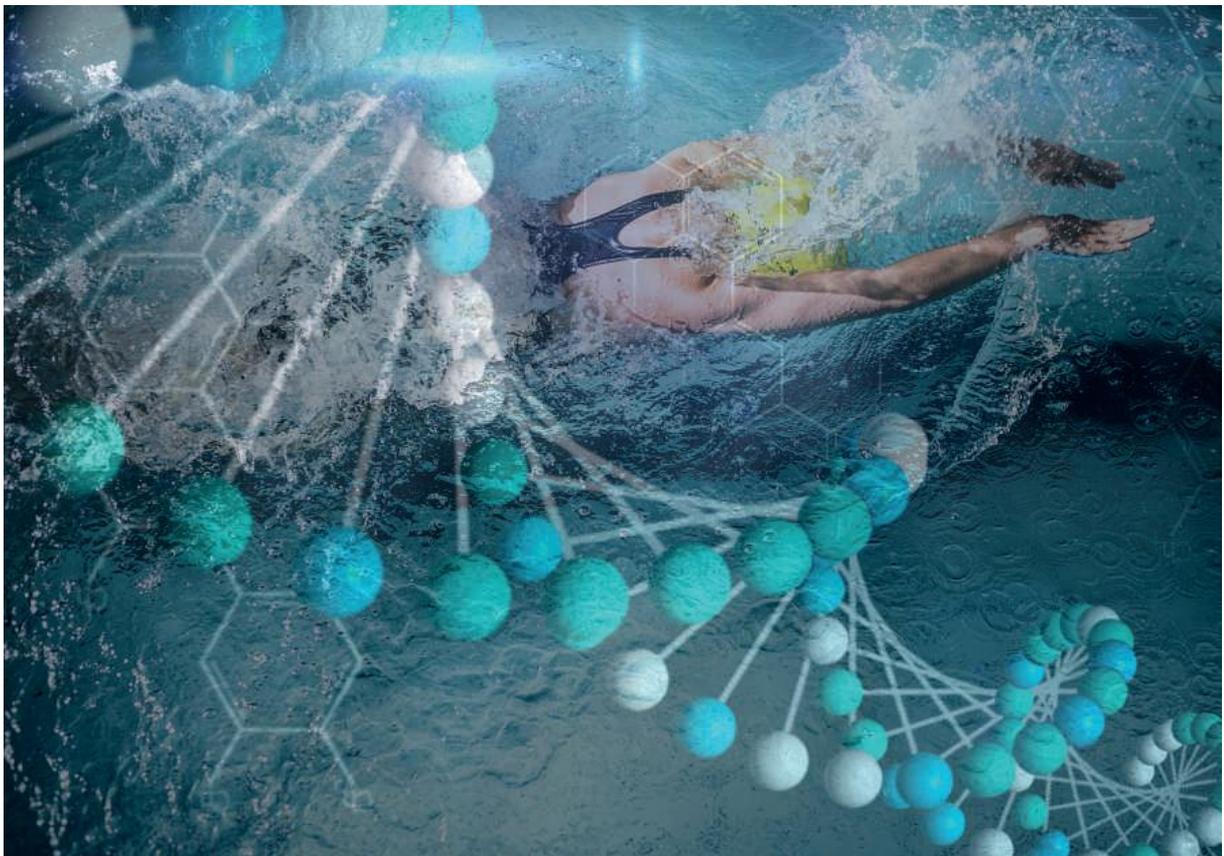
23. How does natural selection lead to evolution?

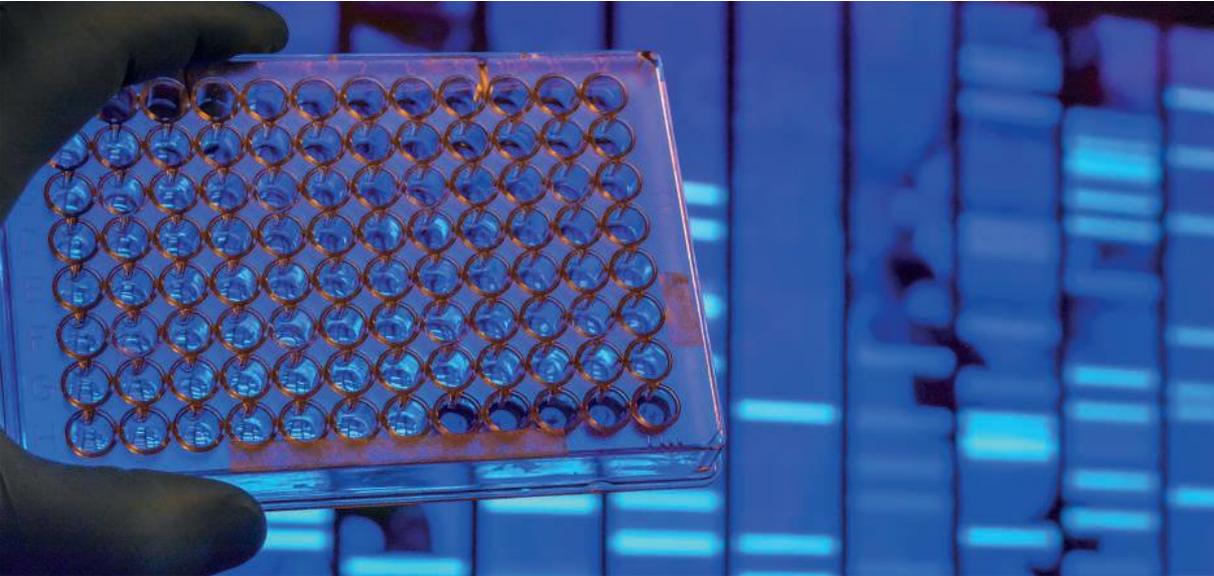
24. Over the last 100,000 years, humans have modified both their internal and external environments.

(a) List ways that we have done this.

(b) How could it affect our gene pool?

(c) What could be some of the implications for humans in the future?





SYLLABUS CHECKLIST

This is the knowledge that you should understand after completing this section:

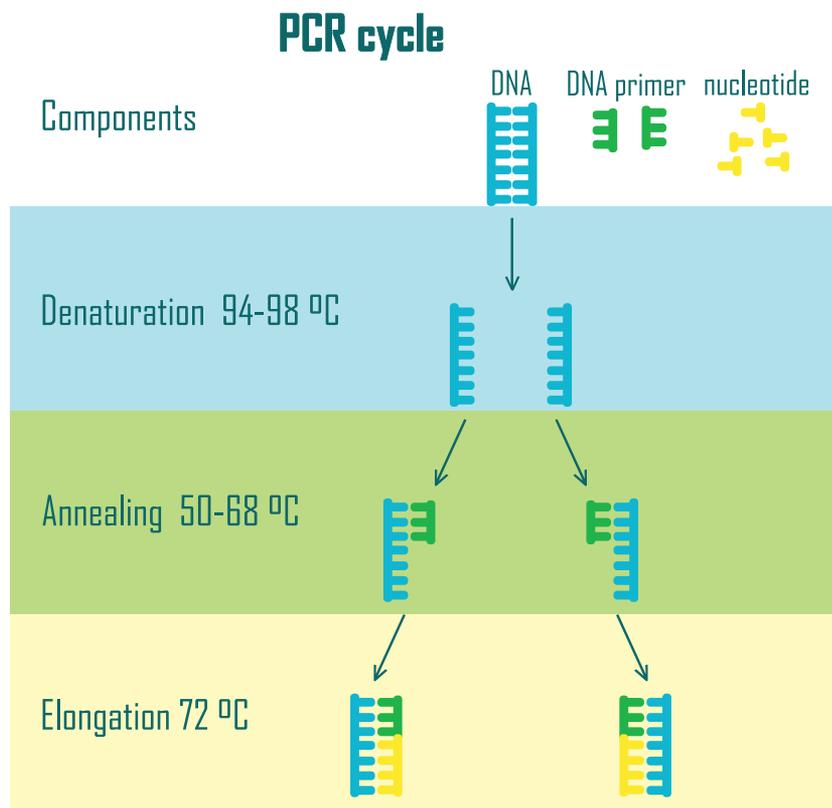
- Evolutionary relationships between groups can be represented using phylogenetic trees (construction phylogenetic trees is not required).
- The fossil record is incomplete and cannot represent the entire biodiversity of a time or a location due to many factors that affect fossil formation, the persistence of fossils and accessibility to fossilised remains.
- Sequencing a fossil record requires a combination of relative and absolute dating techniques to locate fossils onto the geological time line.
- Both relative dating techniques, including stratigraphy and index fossils and absolute dating techniques, including radiocarbon dating and potassium-argon dating, have limitations of application.
- Developments in the fields of comparative biochemistry (including DNA and protein sequences) and bioinformatics have enabled identification of further evidence for evolutionary relationships, which help refine existing models and theories.

Review Questions

1. Biotechnological techniques revolve around what chemicals? Why are these chemicals important for evidence of evolution?

2. What does PCR stand for? Why is it used?

3. This graphic shows a simplified version of PCR.



- (a) Restriction enzymes are used in the analysis of DNA. What do restriction enzymes do? Where would they appear in this graphic?

(b) The source of most restriction enzymes is from bacteria that live in hot springs. Why are these more effective than using human restriction enzymes?

(c) What is the overall result of the PCR process?

(d) The primers can be changed according to the location of the section of DNA to be copied. This primer is 3 bases long. Explain how changing the length of the primer can change the specific site of the section of DNA to be copied.

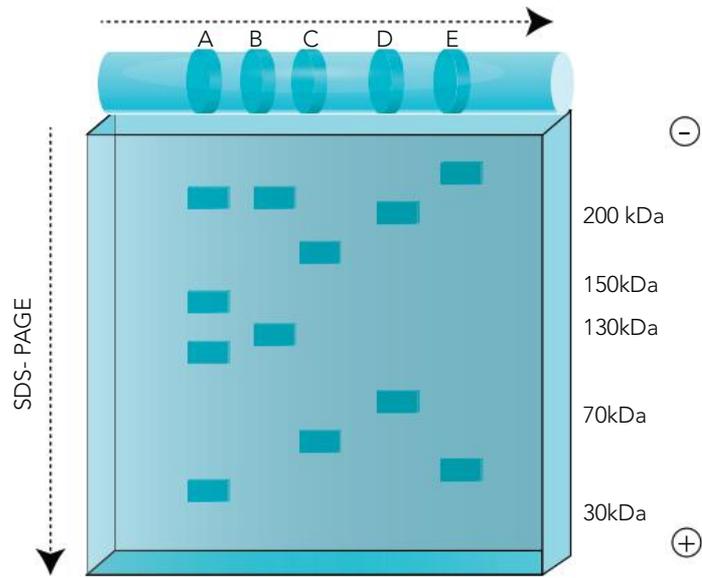
4. Gel electrophoresis is used to separate DNA fragments produced from the PCR process.

(a) What force is used to move the fragments through the gel?

(b) Explain the direction of movement of the fragments in the gel.

(c) Explain why DNA fragments of different sizes are separated during electrophoresis.

(d) What factors influence the movement of the fragments through the gel?

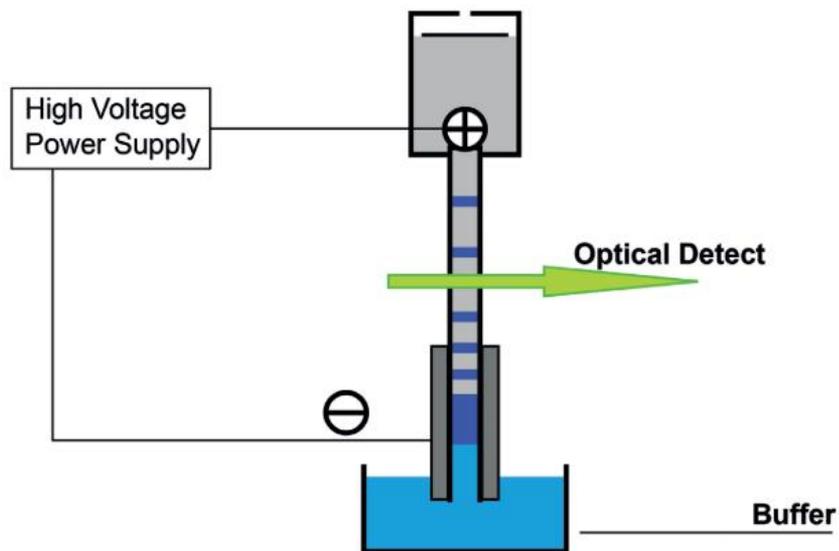


(e) The results from a gel electrophoresis are shown in the image above. What is in the locations marked A – E?

(f) What do the blue rectangles represent?

(g) What happens to the blue rectangles once the electrical current is switched off?

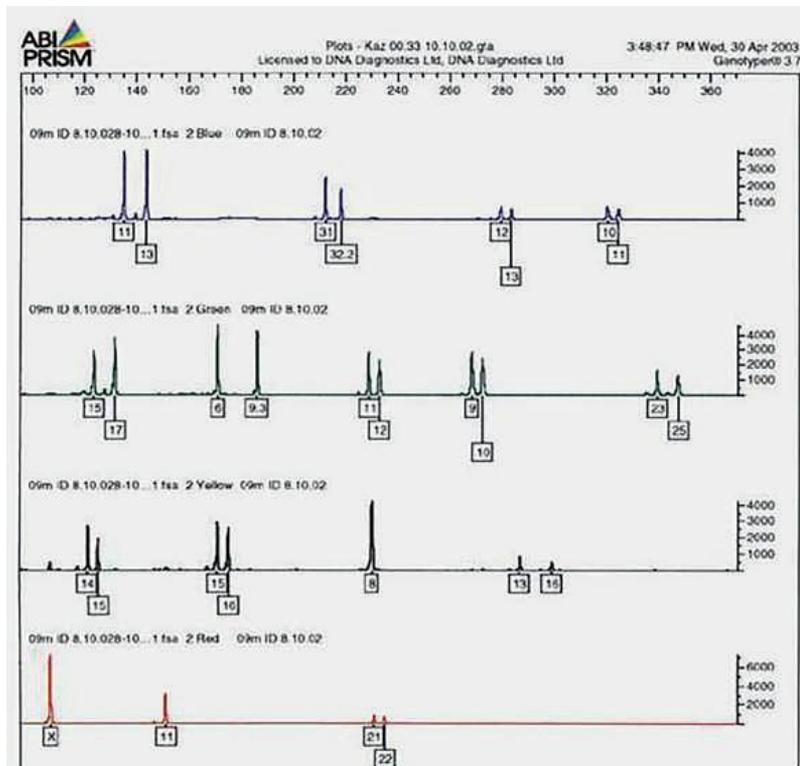
5. Modern PCR does not use flat bed gel electrophoresis as shown in the image above. Capillary electrophoresis is used.



(a) Where would the initial sample be placed?

(b) In which direction would the fragment move?

- (c) A computer detects the optical differences and records them as shown below:
What do the peaks represent?



The result of the capillary electrophoresis can also be presented as numbers.

Sample	Amelogenin	D3S1358	vWA	FGA	D8S1179	D21S11	D18S51
Victim	XY	14, 15	18, 20	24	13, 16	28, 30.2	14, 15
Suspect	XY	14, 15	15, 18	21, 22	13, 14	30	14, 15
Blood Stain from Crime Scene	XY	14, 15	15, 18	21, 22	13, 14	30	14, 15

The sample has been treated with several different restriction enzymes.

- (d) Compare the precision of this method with the flat bed gel method.

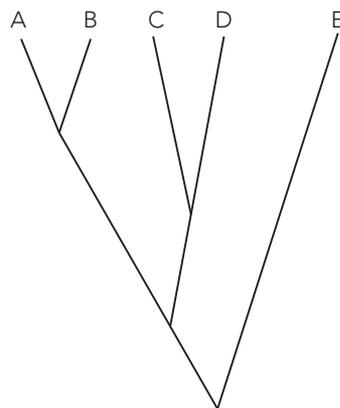
6. What is DNA sequencing?

9. (a) Why are DNA sequences compared?

(b) What do the differences mean?

(c) Compare mitochondrial DNA with genomic DNA. Explain why the mitochondrial DNA only gives information about the maternal inheritance line.

10. Look at the diagram below.



(a) What is a diagram like this called?

(b) What information is used to draw this diagram?

14. (a) Define fossil.

(b) List some examples of things which may be preserved as fossils.

15. List three conditions that are necessary for bones to form fossils.

(i) _____

(ii) _____

(iii) _____

16. (a) What is meant by relative dating?

(b) Two examples of relative dating methods are:

(i) _____

(ii) _____

(c) Explain the limitations of each.

(i) _____

(ii) _____

17. What are radioisotopes? Give some examples used in absolute dating techniques.

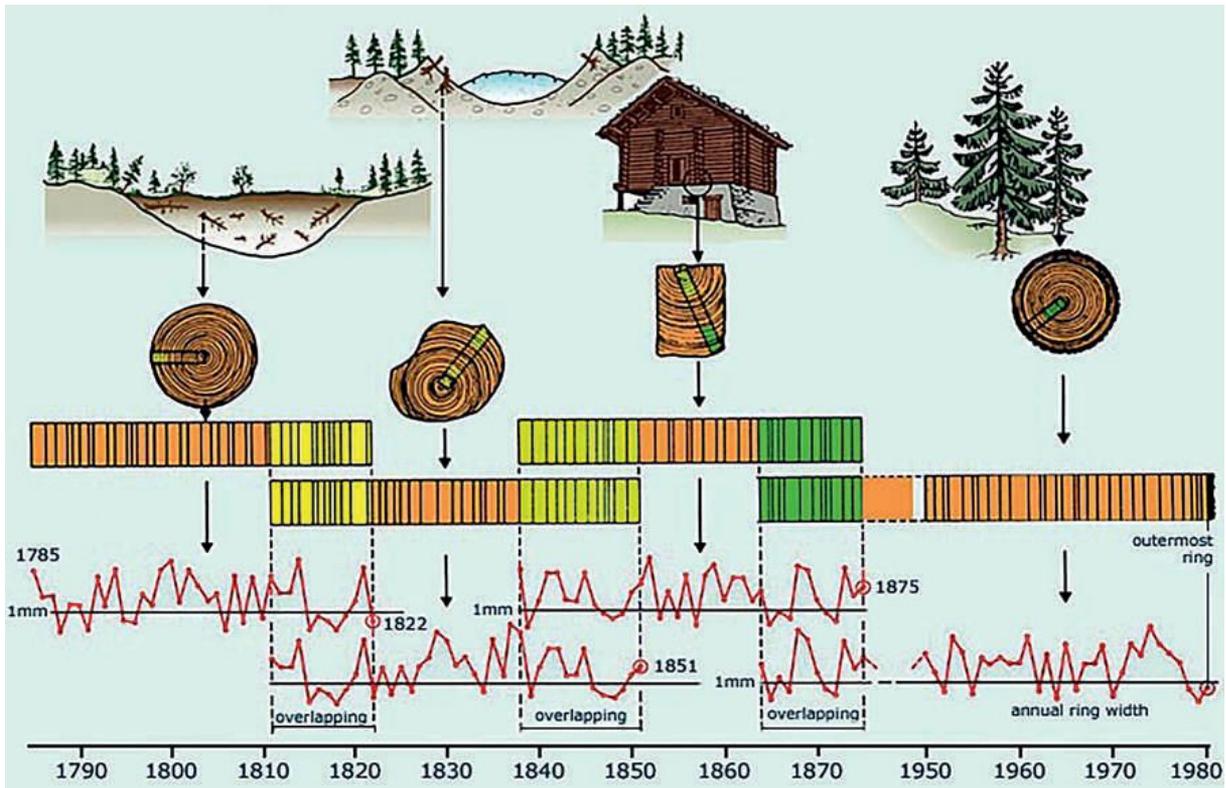
18. Define half-life. Give some examples for radioisotopes used in absolute dating techniques.

19. How does absolute dating differ from relative dating? Why is it essential to know the half life of the radioisotopes involved?

20. Explain how carbon-14 dating works.

21. Explain how potassium-argon dating works.

22. Explain tree-ring dating.



23. What information would you **not** get from fossils?

24. What problems are there with the fossil record?



SYLLABUS CHECKLIST

This is the knowledge that you should understand after completing this section:

- Humans as primates are classified as the great apes. The species within the great ape family are differentiated by DNA-nucleotide sequences, which brings about differences in:
 - Relative size of cerebral cortex.
 - Mobility of the digits.
 - Stance and locomotion adaptations to bipedalism, brachiation and quadrupedalism.
 - Prognathism and dentition.
- Determining relatedness and possible evolutionary pathways for hominids uses evidence from comparisons of modern humans and the other great apes with fossils of:
 - *Australopithecus afarensis*.
 - *Australopithecus africanus*.
 - *Paranthropus robustus*.
 - *Homo habilis*.
 - *Homo erectus*.
 - *Homo neanderthalensis*.
 - *Homo sapiens*.
- Tool use is seen in a number of hominid species and the study of these tools provides important insight into the evolution of human cognitive abilities and lifestyles. Trends are seen in the changes in manufacturing techniques and the materials used in the tool cultures of:
 - *Homo habilis*.
 - *Homo erectus*.
 - *Homo neanderthalensis*.
 - *Homo sapiens*.

Review Questions

1. What does 'the species within the family are differentiated by DNA nucleotide sequences' mean?

2. Describe the features of primates.

3. (a) Complete the following table showing the classification of humans and apes.

Kingdom	Animalia
Phylum	
Class	
Order	
Family	

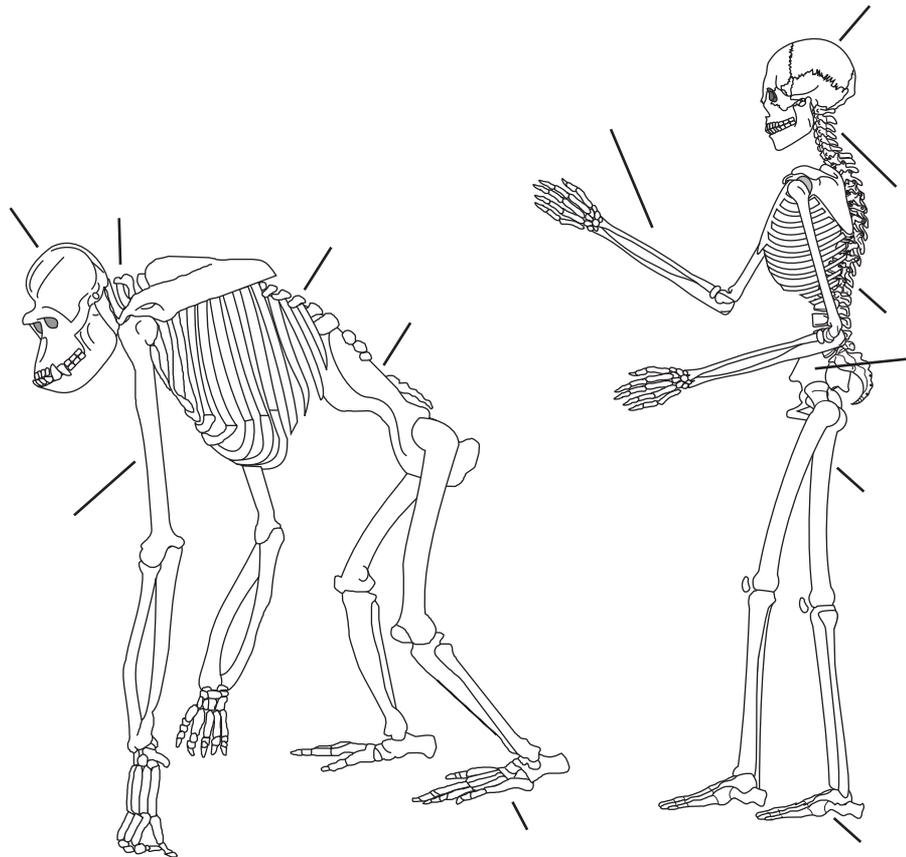
- (b) Distinguish between 'hominid' and 'hominin'.

4. Name some examples of the great apes.

5. (a) Distinguish between a 'power' grip and 'precision' grip.

(b) Which primate group has a precision grip?

6. (a) Label these diagrams of ape and human skeletons.



(b) Compare the differences between apes and modern human using the table below.

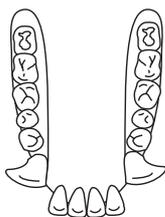
Feature	Modern Humans	Apes
Skull		
Spinal column		

Pelvis		
Legs		
Feet		
Hands		

7. List some advantages of being bipedal and explain why each is an advantage.

- i) _____
- ii) _____
- iii) _____
- iv) _____

8. Name the primates who have the following dentition.

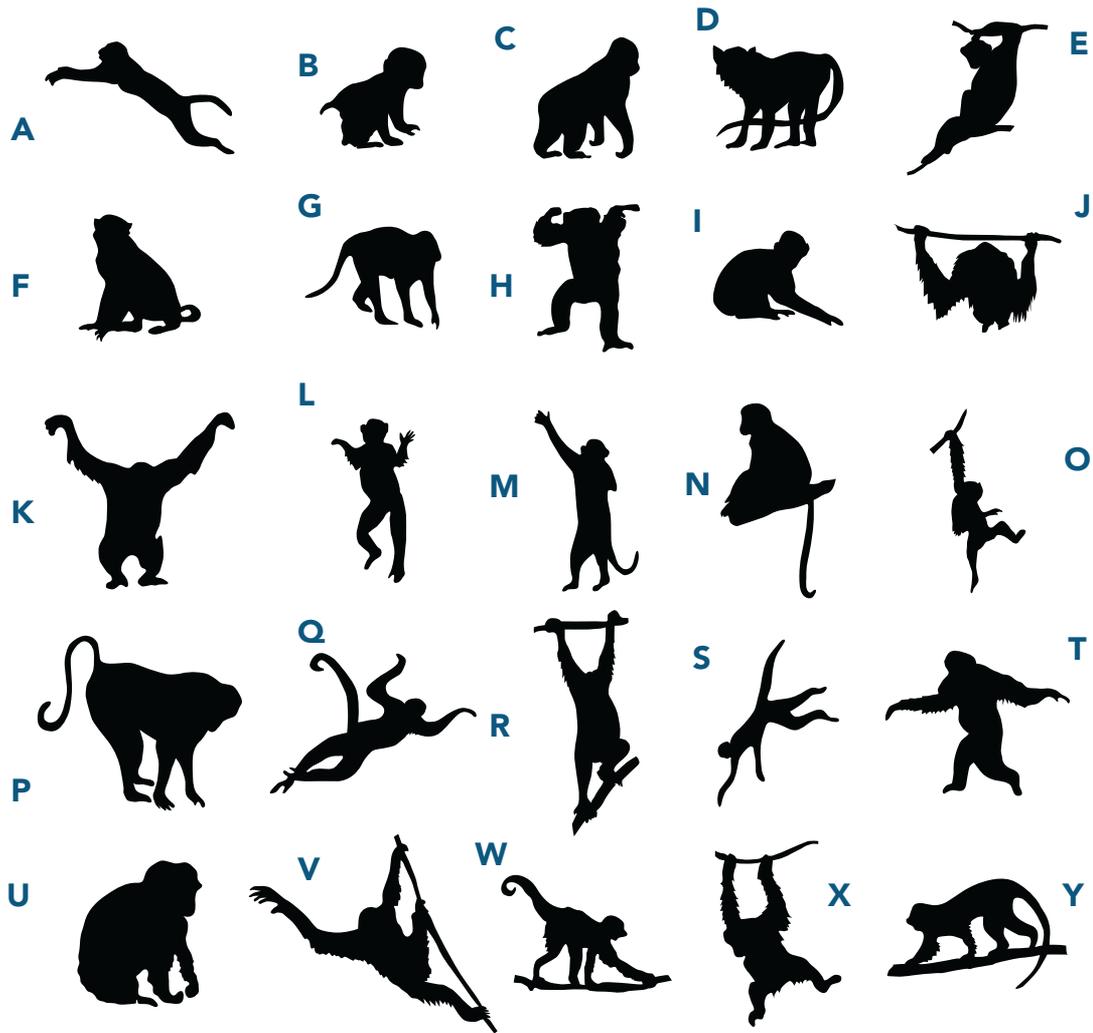


- (a) _____ (b) _____ (c) _____

9. How does dentition influence the structure of the skull?

10. Use a variety of resources to find information to complete the chart below.

11. Circle the outlines that demonstrate brachiation.



12. The environment inhabited by our primate ancestors changed from woodland forest to savannah in our early evolution. How did this influence the method of locomotion used?

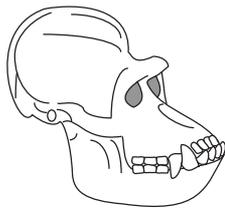
13. Which fossil hominid group first showed convincing evidence of bipedalism?

14. The information in question 10 indicates an increase in cranial capacity.

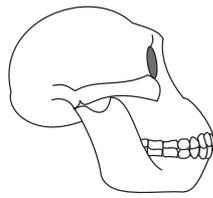
(a) Which part of the brain has increased in size?

(b) What does this indicate about the cognitive abilities of these groups?

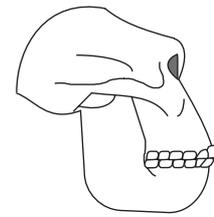
15. Identify these skulls.



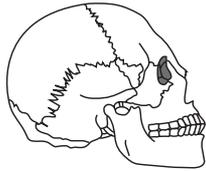
(a) _____



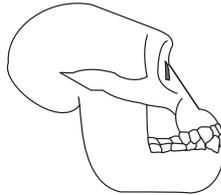
(b) _____



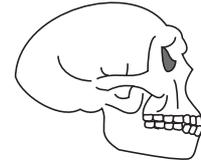
(c) _____



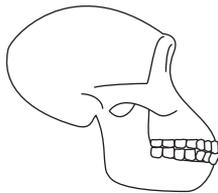
(d) _____



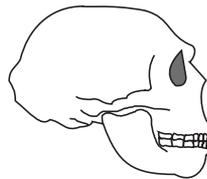
(e) _____



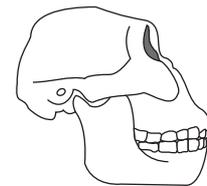
(f) _____



(g) _____



(h) _____



(i) _____

16. What are the most distinguishing features used to classify these skulls?

17. What other information would be helpful in classifying these skulls?

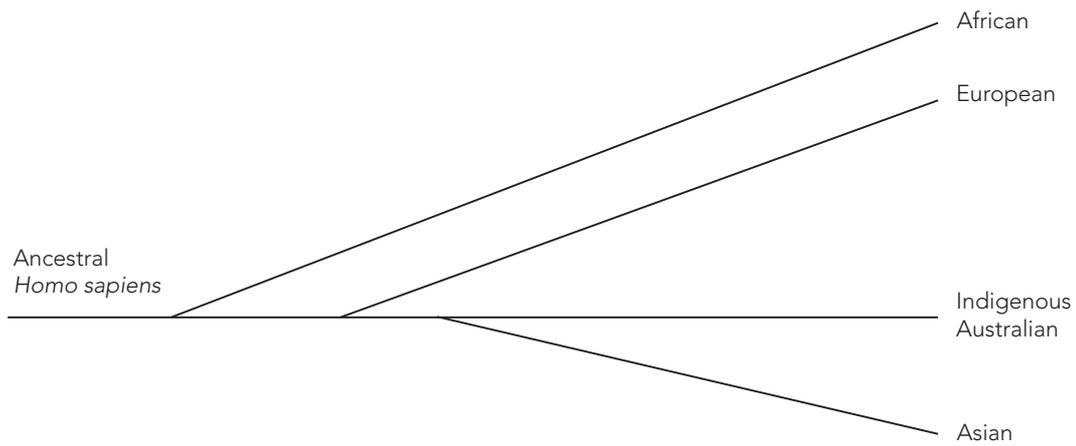
18. (a) Which hominin most probably first communicated by speech?

(b) What evidence is there to support this idea?

19. About 98 per cent of chimpanzee and human genes appear to be the same. What does this suggest about the two species?

20. The use of biotechnological techniques has enabled the sequencing of some fossil and modern human genomes. This information can then be used to show the relationships between them.

A possible relationship is shown below.



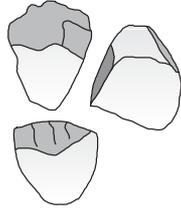
(a) Which groups are the most closely related? Why?

(b) What is the limitation of sequencing fossil genomes?

21. (a) What are **artefacts**? List some examples.

(b) How can these be interpreted?

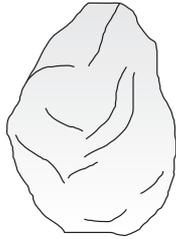
22. Identify each of the hominin groups that made these tools and name their culture.



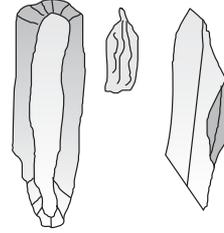
(a) Hominin: _____
Culture: _____



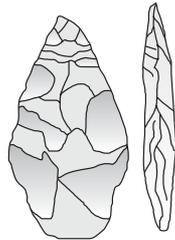
(b) Hominin: _____
Culture: _____



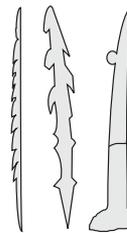
(c) Hominin: _____
Culture: _____



(d) Hominin: _____
Culture: _____

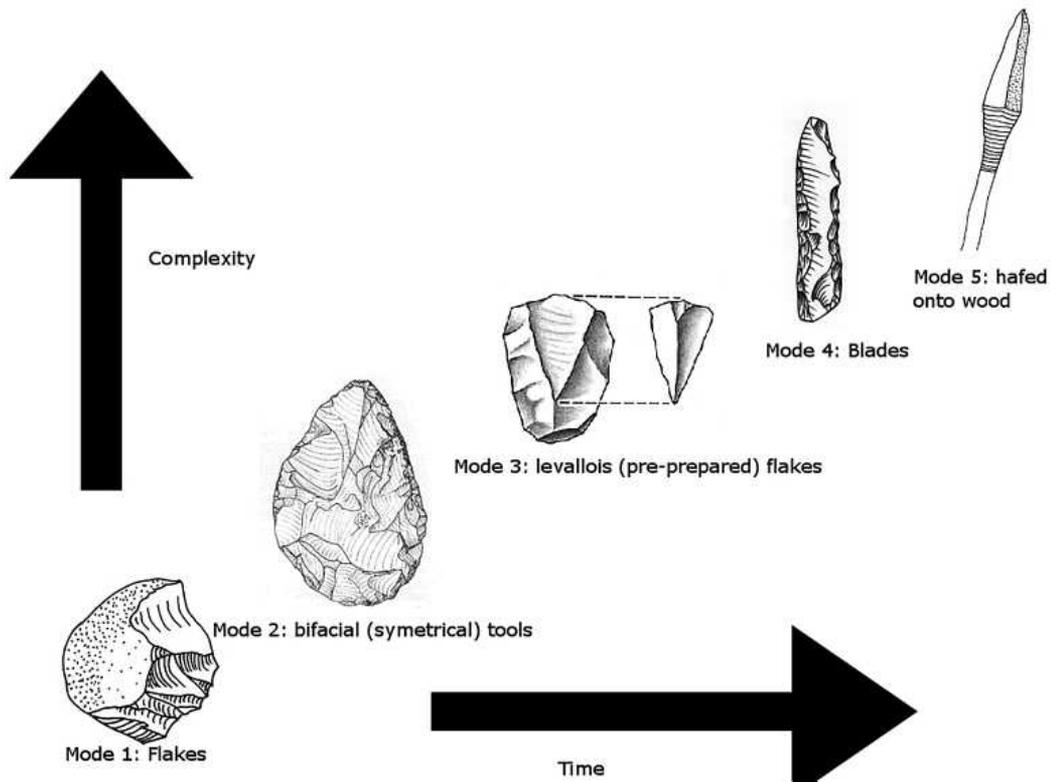


(e) Hominin: _____
Culture: _____



(f) Hominin: _____
Culture: _____

23. This image shows the development of tools across the years.



(a) How did the tools change in terms of complexity?

(b) What does the complexity of the tools indicate about the cognitive abilities of the people making them?

(c) Which groups of hominins can be associated with each tool type?

1. _____
2. _____
3. _____
4. _____
5. _____

(d) How does the specialisation of tools change over time?

- (e) How does the number of different types of tools in use by any one group change over time? Why?

24. (a) The dietary choices of early hominins may have been enhanced by the use of tools. Explain.

- (b) What advantages might the addition of meat in the diet have had for early hominins?

25. (a) What is **culture**?

- (b) Give some examples of cultural evolution.

- (c) How does biological evolution differ from cultural evolution?

26. (a) What is a **kitchen midden**? What can you find in one?

(b) What is the significance of kitchen middens in understanding the social and cultural aspects of the life of the people associated with them?

27. (a) Which hominin most probably first used fire?

(b) What evidence is there to support this idea?

(c) What advantages would there be in using fire?

28. (a) Which hominin most probably started to consider an afterlife or spirit world?

(b) What evidence is there to support this idea?



TRIAL TEST 1: SCIENCE ENQUIRY SKILLS

Time allowed: 60 minutes	Section One – Multiple Choice	10 marks
Total marks: 80	Section Two – Short Answer	50 marks
	Section Three – Extended Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

- A research team wants to learn more about the effects of a new treatment on patients with diabetes. The steps the team take to best study this treatment are:
 - form a hypothesis, conduct an experiment, record data, make a conclusion
 - conduct an experiment, form a hypothesis, make a conclusion, record data
 - form a hypothesis, record data, conduct an experiment, make a conclusion
 - record data, form a hypothesis, make a conclusion, conduct an experiment
- Quantitative data refers to which of the following statements?
 - The volume of urine collected from a patient.
 - The quality of responses given in an interview.
 - The length of time taken for the blink reflex to occur.
 - The mass of food intake by an athlete before a race.
 - (i) only
 - (ii) only
 - (i) and (iii)
 - (i), (iii) and (iv)
- What part of the scientific method uses data to help explain the results of the investigation?
 - purpose
 - conclusion
 - observation
 - hypothesis
- The hypothesis is supported by:
 - analysis of the collected data using known mathematical methods producing positive results
 - modification of the data collection method to produce data that aligns with hypothesis
 - the accuracy of the predictions and using selected data from the investigation
 - the design of subsequent experiments that produce more detailed data
- Which is not a unit of measurement used in the International System of Units?
 - grams
 - metres
 - litres
 - inches
- To obtain valid data in an experiment, you should:
 - repeat your experiment many times.
 - do a different experiment.
 - use a control.
 - use a variety of people in an experiment.

7. If a theory is challenged by new evidence, which of the following would happen?
 - (a) the theory would be altered to incorporate the new evidence.
 - (b) the theory is accepted but the evidence is rejected.
 - (c) the evidence is accepted as it comes from world renowned scientists.
 - (d) a vote is taken at an international conference on whether to accept the new evidence.

8. Researchers normally publish reports on their research so that:
 - (a) other scientists can verify their results in different circumstances
 - (b) others can build on the new findings to extend the field of knowledge
 - (c) there is a record of the methods used and data collected can be reviewed
 - (d) all of the above in the critical analysis of the research by peers

9. A student used an instrument called an anthropometer to measure the length of a person's foot from the heel to the end of the longest toe. Data was collected from 20 students from five different year groups in primary school. The mean of the foot lengths was calculated for each group. In graphing the results of this study, the student should use:
 - (a) a line graph and plot the mean lengths on the X-axis and year groups on the Y-axis.
 - (b) a column graph with groups on the X-axis and Mean lengths on the Y-axis.
 - (c) a histogram with groups on the Y-axis and mean lengths on the X-axis.
 - (d) a pie chart showing percentages of students with different foot lengths.

10. The statement that "Homo erectus formed family groups for tool-making" is:
 - (a) a hypothesis
 - (b) an observation
 - (c) an inference
 - (d) a theory

SECTION 2 – SHORT ANSWER (50 MARKS)

1. In a chemistry investigation, a student decided to measure the effect of heat on the vitamin C concentration in a variety of vegetables. She heated samples of broccoli, potatoes, green beans and spinach after her research suggested that these contained good quantities of vitamin C. She then performed some chemical tests to measure the vitamin C content in the water the vegetables were boiled in. As vitamin C is water-soluble, she thought that the amount in the water would give her an indication as to how much had been leached out of each vegetable.

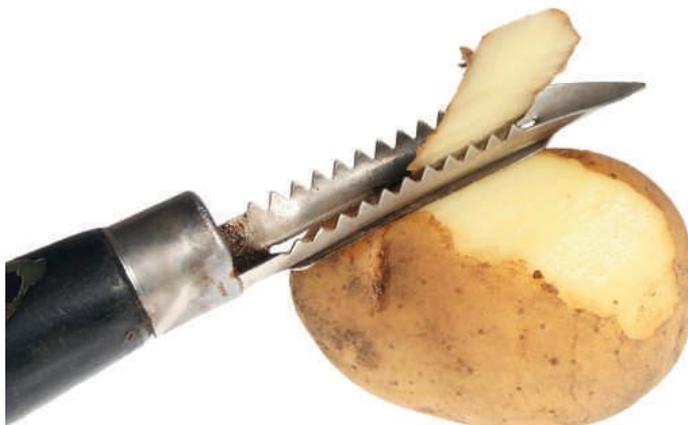
Her results are shown below:

Vegetable	Test 1	Test 2	Test 2	Average
Broccoli	14.7 mg	14.5 mg	15.3 mg	14.8 mg
Spinach	2.0 mg	2.5 mg	2.3 mg	2.27 mg
Peeled potato	5.0 mg	5.2 mg	4.8 mg	5.0 mg
Sliced green beans	9.0 mg	9.1 mg	8.9 mg	9.0 mg

- (a) Write a hypothesis for this experiment. [2 marks]

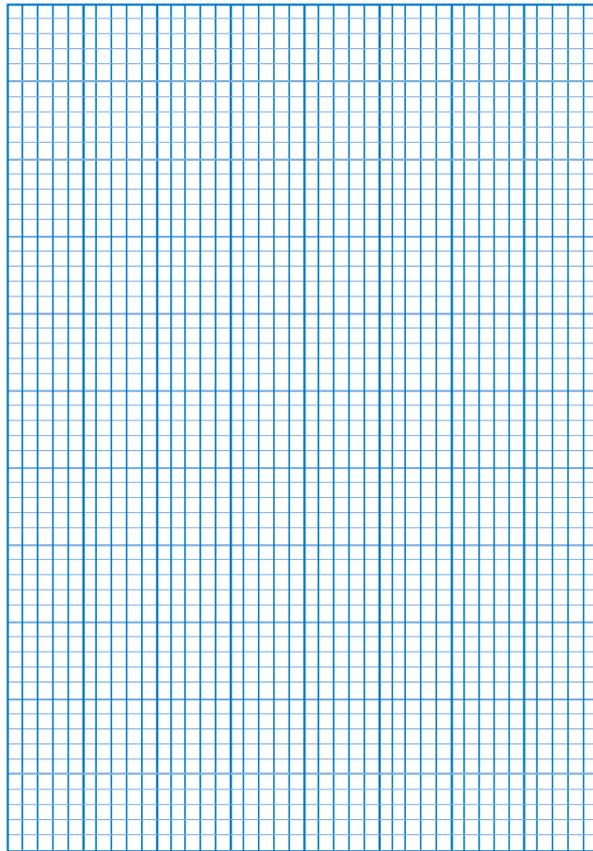
- (b) What are three variables that should have been kept the same? [3 marks]

- (c) How could this experiment be controlled? [2 marks]



(d) Graph the results on the graph paper below.

[6 marks]



(e) What conclusion could this student make based on the data?

[2 marks]

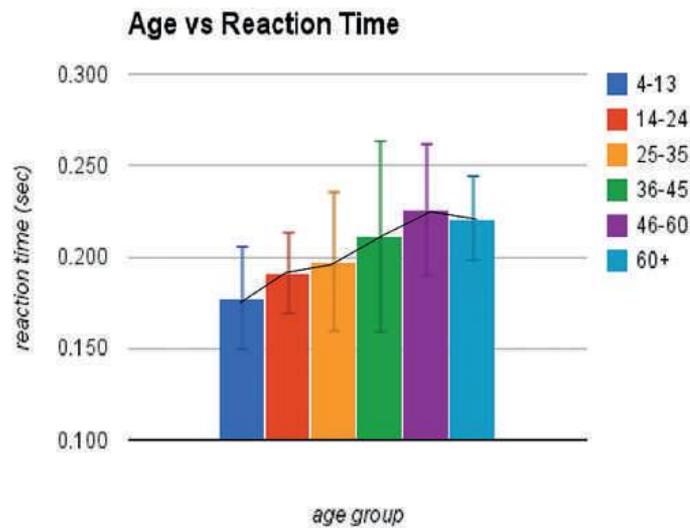
2. (a) What is a double-blind test?

[4 marks]

(b) Why are they used?

[2 marks]

3. The graph below shows the mean reaction times of people at different ages.



This graph was presented with no indication of the specifics of how the data was collected.

- (a) What factors should have been the same across all testing of reaction times? [3 marks]

- (b) Suggest the selection of the sample to be tested in each age group and give a reason for your suggestion. [3 marks]

- (c) Each age group graphed has error bars. What do they represent? [2 marks]

- (d) Consider the 4-13 years age group. Discuss the abilities of this group to comment on the appropriateness of the grouping of these ages. [3 marks]

- (e) In the conclusion it was stated: “During a few of our experiments, subjects often asked for “retries” or insisted that we should vary the method of measurement to produce a better result. Not wanting to upset our experimental subjects, we often complied with their requests.” Comment on the impact of this on the results. [2 marks]

4. *Salmonella* is a food-borne pathogen that causes diarrhoea, stomach cramps, fever, nausea, vomiting and loss of appetite. It can be obtained from eating contaminated or undercooked food, especially chicken. It can even be passed on from utensils used to process contaminated food.

A group of students on a school camp came down with some of the symptoms above and were diagnosed with *Salmonella* poisoning. They had eaten at the camp, in a restaurant and from a take-away outlet.

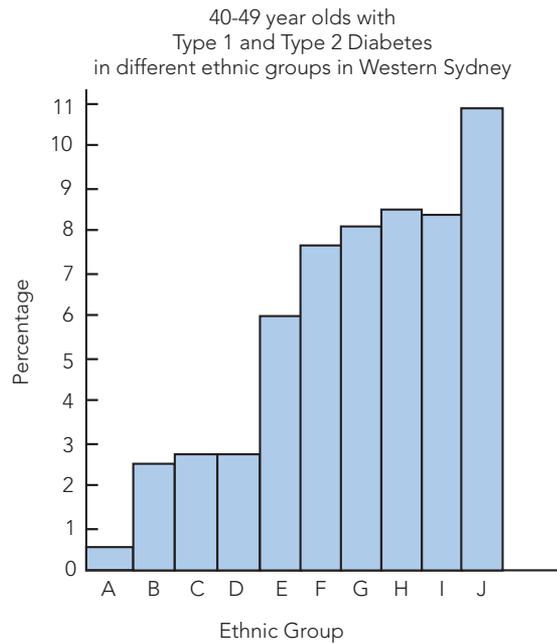
- (a) Formulate a hypothesis that suggests where the source of the *Salmonella* could be. [1 mark]

- (b) Suggest a method to investigate the outbreak to isolate the source of the *Salmonella*? [2 marks]

- (c) What information would help decide on the source of the *Salmonella*? [2 marks]

(d) How could *Salmonella* be prevented from being passed on to other students? [2 marks]

5. The information below has been taken from a survey of patients visiting some medical practices in Western Sydney.



(a) Summarise the incidence of the observed level of diabetes in these patients. [1 mark]

(b) What could be possible contributing factors to the variation between the different groups? [1 mark]

(c) Would this data reflect the rates in the general public? Explain. [2 marks]

(d) What changes to the presentation of data could be implemented to give a clearer picture of the diabetes problem in Western Sydney? [1 mark]

(e) Suggest why the survey concentrated on the age bracket 40–49 years of age. [1 mark]

(f) Suggest two initiatives that could be implemented to reduce the incidence of Type 2 Diabetes. [2 marks]

TRIAL TEST 2: THE ENDOCRINE SYSTEM

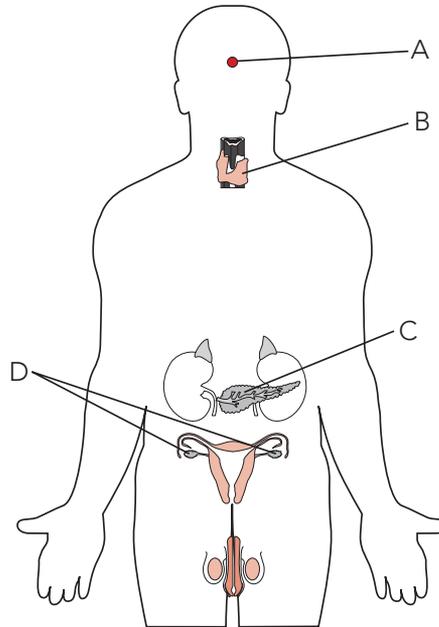


Time allowed: 60 minutes	Section One – Multiple Choice	10 marks
Total marks: 80	Section Two – Short Answer	50 marks
	Section Three – Extended Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

- The release of hormones from the anterior pituitary is regulated by the:
 - Thyroid
 - Posterior pituitary
 - Pancreas
 - Hypothalamus
- Which of these glands has endocrine and exocrine functions?
 - pancreas
 - thyroid
 - adrenal medulla
 - anterior pituitary
- Anaesthetics inhibit the secretion of ADH. The effect of anaesthetics on urine production will:
 - Increase production of urine
 - Increase concentration of urine
 - Decrease volume and increase concentration of urine produced
 - Decrease concentration and increase volume of urine produced.
- A single endocrine hormone produces a wider response in more of the body than one nerve cell. This is because:
 - A single hormone can target many different cells, whereas a nerve only targets a single cell.
 - Blood can carry hormones throughout the body, producing responses from different cells; nerve cells can only target a small number of cells.
 - Nerve cells and blood work together. The endocrine has nothing to do with the nervous system.
 - Endocrine hormones only target a very small number of precise cells.
- Which of the following produce opposite responses?
 - calcitonin and parathyroid hormone
 - thyroxine and TSH
 - glucagon and insulin
 - ADH and aldosterone

6. Endocrine glands produce substances which:
- (i) affect every cell in the body.
 - (ii) affect only some cells and tissues.
 - (iii) are carried by the blood.
 - (iv) travel down ducts.
 - (v) are only released on stimulation by the hypothalamus.
- (a) (i) and (iii)
 (b) (i), (iii) and (v)
 (c) (ii) and (iii)
 (d) (ii) and (v)



7. On the diagram above:
- (a) A is the pituitary gland, B is the thyroid gland, C is the pancreas and D is the testes.
 - (b) A is the hypothalamus gland, B is the parathyroid gland, C is the pancreas and D is the adrenal gland.
 - (c) A is the pituitary gland, B is the thyroid gland, C is the pancreas gland and D is the ovary.
 - (d) A is the hypothalamus gland, B is the parathyroid gland, C is the ovary and D is the testes.

8. Nervous stimulation causes hormones to be released from the hypothalamus. These stimulate the anterior pituitary to produce and release adrenocorticotrophic hormone (ACTH). This in turn stimulates the adrenal cortex to produce cortisol which promotes metabolism. The level of cortisol is detected in the blood and suppresses the release of ACTH.

Which of the flow diagrams below shows this information?

- (a) Hypothalamus → pituitary → adrenal cortex → cortisol
- (b) Hypothalamus → pituitary → adrenal cortex → cortisol
 ↑ feedback
- (c) Hypothalamus → pituitary → adrenal cortex → cortisol
 ↑ feedback
- (d) Hypothalamus → pituitary → adrenal cortex → cortisol
 ↑ feedback

9. Protein based, water soluble hormones:
 - (a) Diffuse through the cell membrane
 - (b) Bind with receptors on the cell membrane
 - (c) Act directly on intracellular functioning
 - (d) Require energy to cross the cell membrane.

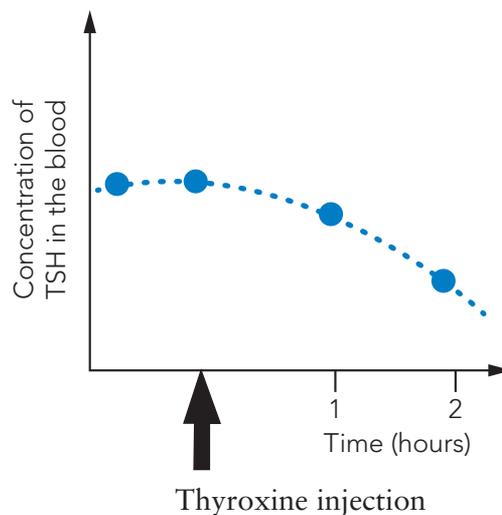
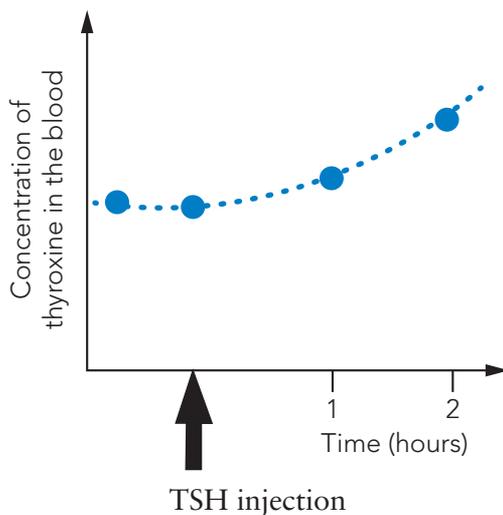
10. The concentrations of calcium and phosphate in the blood are regulated by hormones from which gland?
 - (a) Pancreas
 - (b) Parathyroid gland
 - (c) Adrenal glands
 - (d) Thyroid gland

SECTION 2 – SHORT ANSWER (50 MARKS)

1. Complete the following table by stating the glands which produce each hormone. [4 marks]

Hormone	Secreted by
Glucagon	
Aldosterone	
Adrenalin	
Calcitonin	

2. The concentrations of thyroxine and thyroid stimulating hormone (TSH) in the blood were measured as part of an investigation exploring the relationship between them. The graphs below show the blood concentrations of each hormone over the time of the experiment. At time 0 hours indicated by the arrows, an intravenous injection of the hormones was given.



(a) Why were the concentrations measured before the injection? [1 mark]

(b) State the relationship between the concentrations of thyroxine and TSH. [2 marks]

(c) State the endocrine glands that are involved in this investigation. [3 marks]

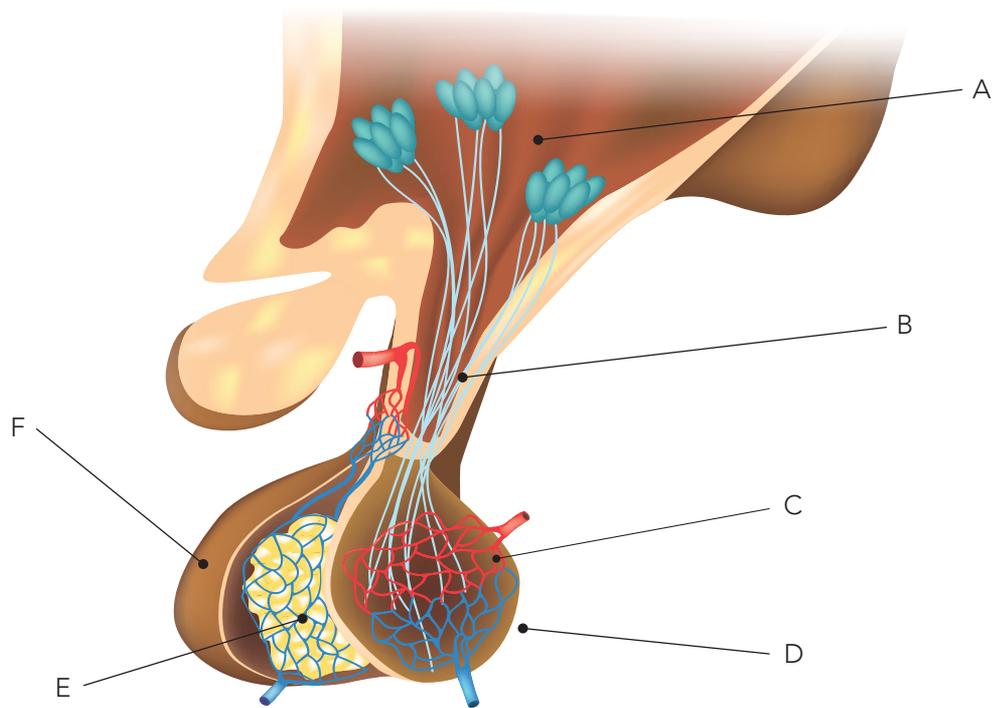
(d) Describe the body's responses to the release of thyroxine. [3 marks]

(e) Explain why people with hypothyroidism don't like winter conditions. [3 marks]

(f) Suggest 2 causes of hypothyroidism. [2 marks]

(g) A 'dietary supplement' was being advertised on social media claiming to be an easy way to lose weight. When the material was analysed, it was found to contain an artificial form of thyroxine. Critique the claim and suggest 2 ethical problems associated with it. [4 marks]

3. The diagram shows the 'master gland' and its direct neural and vascular connections.



(a) Name the locations [3 marks]

a. A: _____

b. D: _____

c. F: _____

(b) Describe the connections between A and D indicated at B. [2 marks]

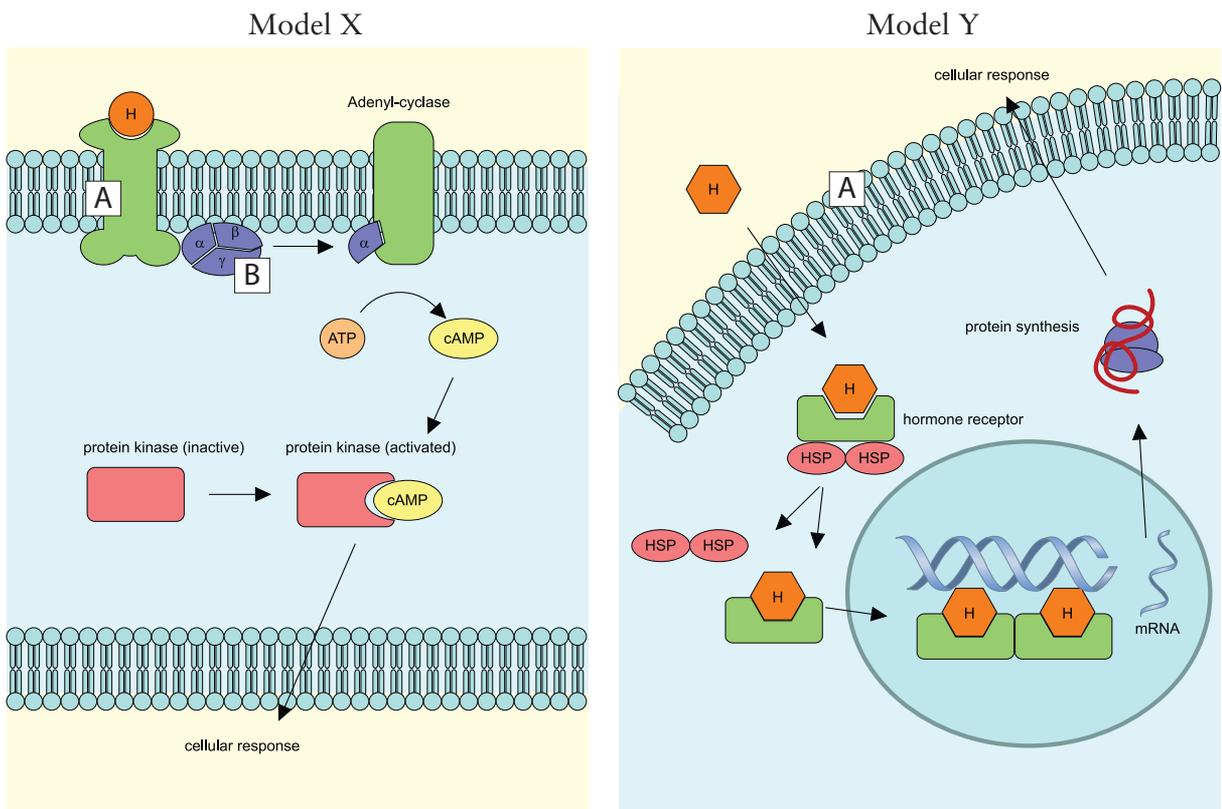
(c) Name two hormones that move down the connections at B. [2 marks]

(d) Areas D and F are supplied with very dense capillary networks (as indicated by C and E). Explain why this is necessary for the proper functioning of these two glands. [2 marks]

- (e) Area F cells have large numbers of ribosomes, endoplasmic reticulum and Golgi bodies. Explain why in terms of the function of this area. [3 marks]

- (f) A young woman was diagnosed with a tumour on the anterior pituitary. Explain the impact this would have on her reproductive capacity. [3 marks]

4. Model X and Model Y (below) show the way that the two major chemical types of hormones are thought to act on cells.



H – hormone

- (a) Hormones can be steroid or protein in structure. What type of hormone action is represented by Model X? [1 mark]

(b) Compare the actions of the hormones crossing the plasma membranes as indicated at positions labelled A. [3 marks]

(c) Name the chemical at B. What is its function? [2 marks]

(d) Describe how the hormone in Model Y acts to promote the cellular response. [3 marks]

(e) Calcitonin is a hormone made from amino acids. Explain how it stimulates its target cell. Refer to the models in your answer. [4 marks]

TRIAL TEST 3: THE NERVOUS SYSTEM



Time allowed: 60 minutes	Section One – Multiple Choice	10 marks
Total marks: 80	Section Two – Short Answer	50 marks
	Section Three – Extended Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

- A frog that had its brain destroyed, but still had its spinal cord undamaged, had its leg pricked with a pin. The leg flinched. It did this whenever the leg was pricked. This indicates that the action was:
 - under conscious control
 - under autonomic control
 - was a reflex action
 - was a conditioned response
- Dopamine is an important neurotransmitter. Which disease or disorder results when the neurons in the brain that produce dopamine die?
 - Multiple sclerosis
 - Parkinson disease
 - Seizure disorder
 - Alzheimer's disease
- Acetylcholinesterase prevents the:
 - neurotransmitter from crossing the synaptic cleft
 - binding of acetylcholine to receptors
 - loss of acetylcholine and allows continued stimulation
 - repeated stimulation of the target cell.
- Interneurons transmit impulses:
 - between receptors
 - toward receptors
 - in the brain and spinal cord
 - between neurons.
- Impulse conduction is fastest in neurons that are:
 - myelinated
 - unmyelinated
 - sensory
 - motor
- Preparing the body for “fight-or-flight” response during threatening situations is the role of the:
 - sympathetic nervous system
 - cerebrum
 - parasympathetic nervous system
 - somatic nervous system

7. A reflex action is a pathway that typically involves several neurons and mediates:
 - (a) an action that has to be learned
 - (b) an action that involves conscious thought
 - (c) an action that is repeated
 - (d) an involuntary response to a stimulus

8. Most sensory receptors:
 - (a) are stimulated by a range of stimuli
 - (b) are stimulated only by specific stimuli
 - (c) possess a high threshold for their specific stimuli
 - (d) are functional at certain times and locations

9. The blood-brain barrier is effective against the passage of:
 - (a) nutrients such as glucose
 - (b) metabolic waste such as urea
 - (c) toxins and pathogens
 - (d) anaesthetics

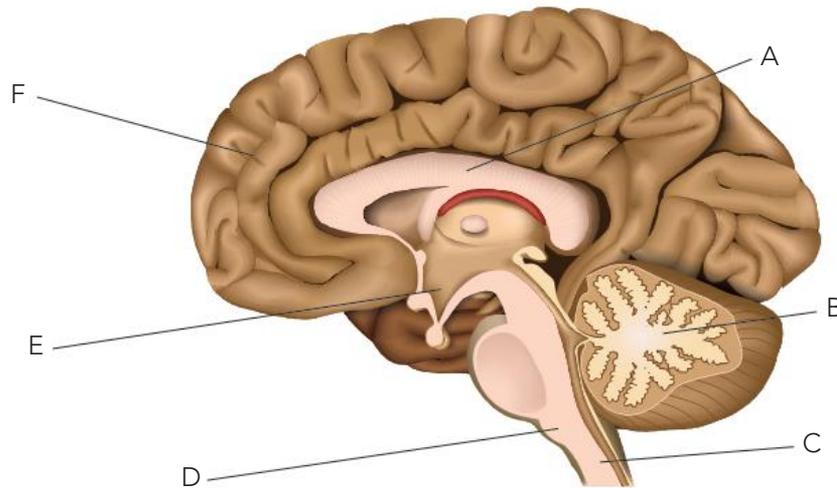
10. Sympathetic innervation of the liver regulates which function?
 - (a) Formation of glucose from glycogen
 - (b) Bile synthesis and production
 - (c) Iron storage
 - (d) Endocrine function

SECTION 2 – SHORT ANSWER (50 MARKS)

1. The nervous system has several different divisions which all have specific functions. Using the table below, state one difference between the following sections of the nervous system: [2 marks]

Two systems to compare	Main functional difference
Central nervous system compared to the peripheral nervous system	
Afferent division vs Efferent division of the peripheral nervous system	

2. (a) Identify the parts of the brain on the following diagram and state their function: [6 marks]

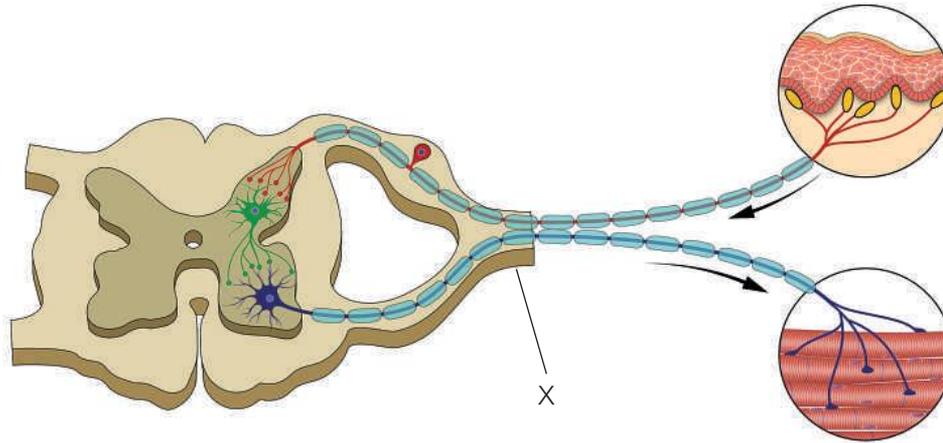


Part	Name	Function
A		
B		
D		

- (b) (i) Label the central sulcus on the diagram. [1 mark]
- (ii) Where are the motor and sensory areas located with respect to the central sulcus? [2 marks]

- (c) A person was hit heavily on the back of the head and reported seeing 'stars'. What area of the cerebrum would have been impacted? Why did the person 'see stars'? [2 marks]

3.

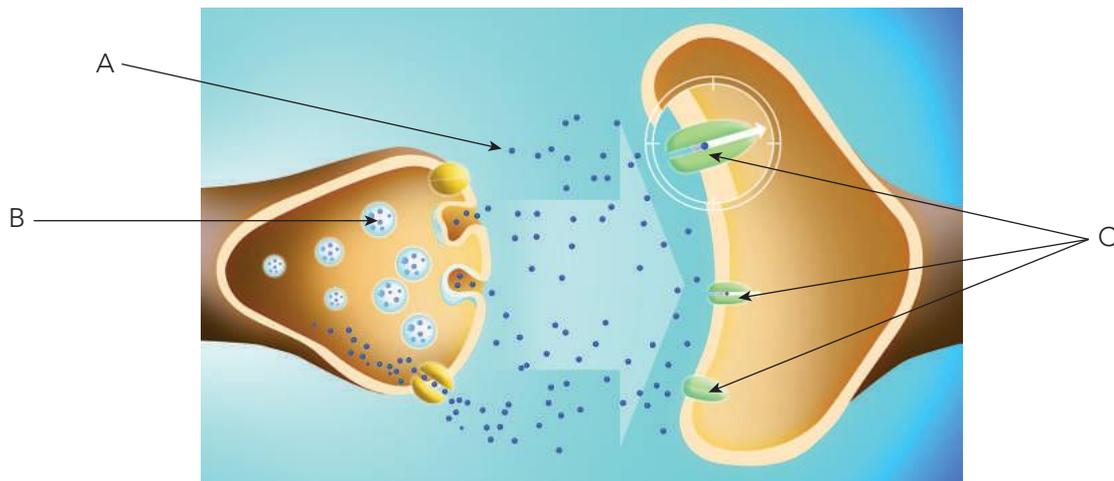


- (a) On the diagram of the neuro-pathway seen above, label the following parts.
- (i) sensory neuron
 - (ii) sensory receptors
 - (iii) neuromuscular junction
- [3 marks]
- (b) Dan was playing sport when he damaged his spine. Tests diagnosed damage at point X as shown on the diagram. Describe the consequences of this damage.
- [2 marks]

- (c) Sam was playing on a shallow reef when he was bitten by a blue-ringed octopus. The first signs were that he was having trouble breathing and couldn't move his limbs. People around started resuscitation. He could hear and feel all that was happening but he could not physically respond. At what point in the neural pathway would the poison from the octopus act? Explain your answer.
- [3 marks]

- (d) Sara accidentally touched a hot baking dish. Before she knew she had done this, she had moved her hand away from the dish. Explain why this happens, using the diagram in your explanation.
- [3 marks]

4. The following diagram shows the junction between two neurons.



(a) Name the structures labelled [3 marks]

A: _____

B: _____

C: _____

(b) What causes the release of A into the space between the neurons? [1 mark]

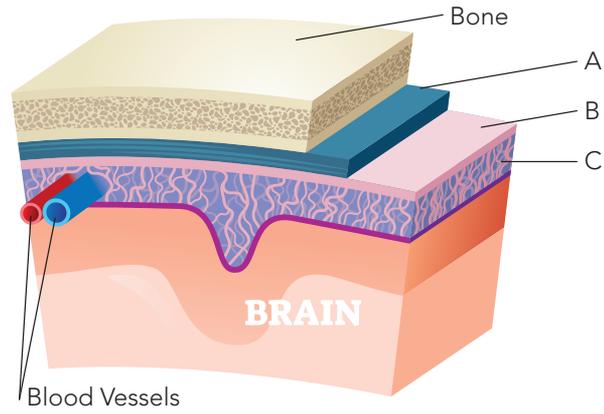
(c) Describe what happens when A diffuses across the space to C. [2 marks]

(d) When A has brought about the response at C, what happens to A? [1 mark]

(e) This table contains information on two neurotoxins produced by different organisms and the effects they have on their victims' nervous systems. State the likely symptoms of victims of these two poisons. [2 marks]

Animal	Effect	Symptoms in victim
Cyanobacteria (algal blooms)	Stimulation of acetylcholine receptors	
Funnel web spider	Blocks calcium channels	

5. This diagram shows a cross section through the skull into the brain.



- (a) Name the layers [3 marks]

A: _____

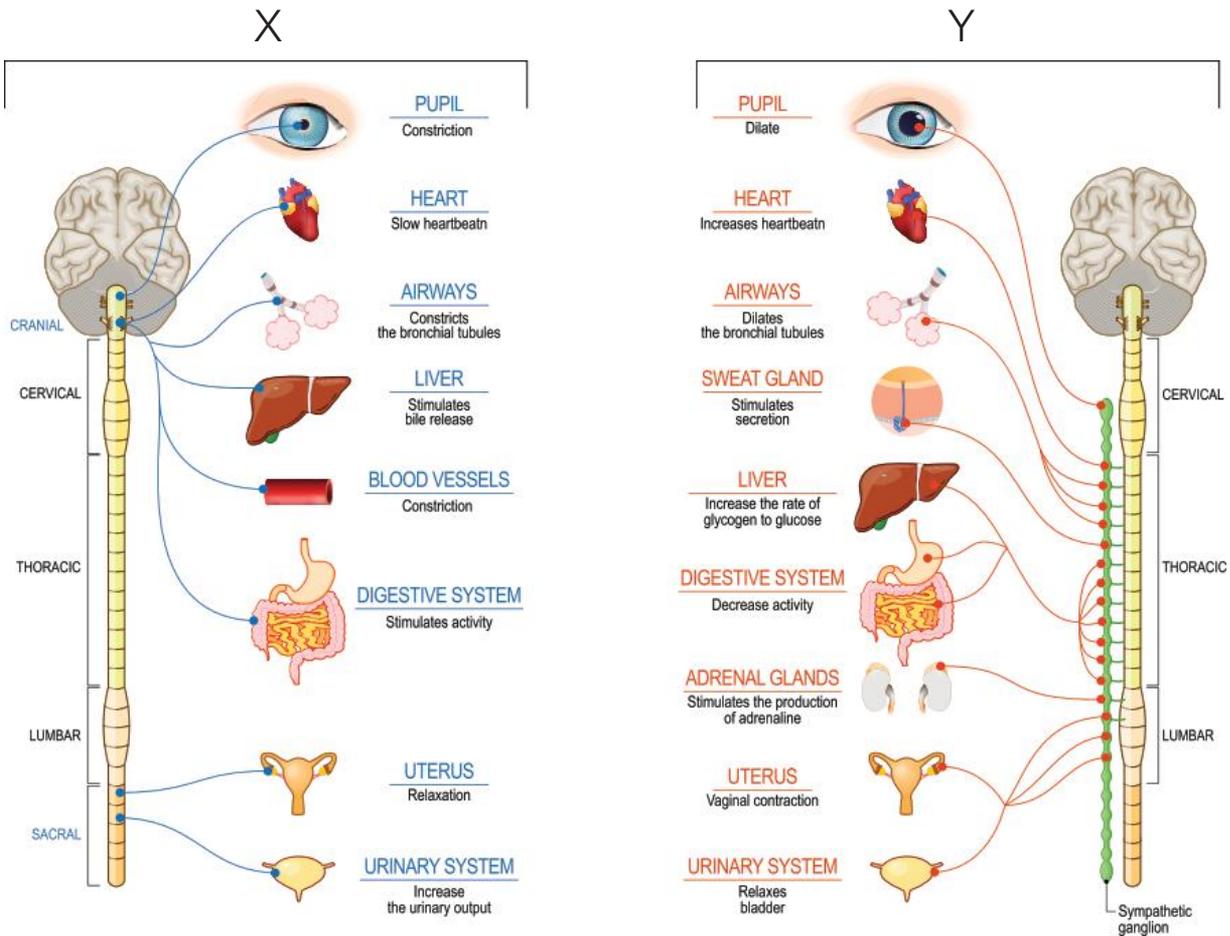
B: _____

C: _____

- (b) Describe the structure of layer C and how this aids in its function to protect the brain. [3 marks]

- (c) What is the name of the condition where these layers become infected and inflamed? [1 mark]

6. The graphic below shows the location and effects of the nerves of the autonomic nervous system.



(a) Name the divisions [2 marks]

X: _____

Y: _____

(b) Which division operates in stressful situations? [1 mark]

(c) Explain the changes in the body caused by division Y. [3 marks]

7. Complete the following table:

Type of receptor	Example	Stimulus
Chemoreceptor		presence of different chemicals
Mechanoreceptor	free nerve endings, Pacinian corpuscles	
Thermoreceptor		temperature changes
	retina of eye	light

[4 marks]

TRIAL TEST 4: HOMEOSTASIS



Time allowed: 60 minutes	Section One – Multiple Choice	10 marks
Total marks: 80	Section Two – Short Answer	50 marks
	Section Three – Extended Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. Which statements are true of feedback systems in the body?

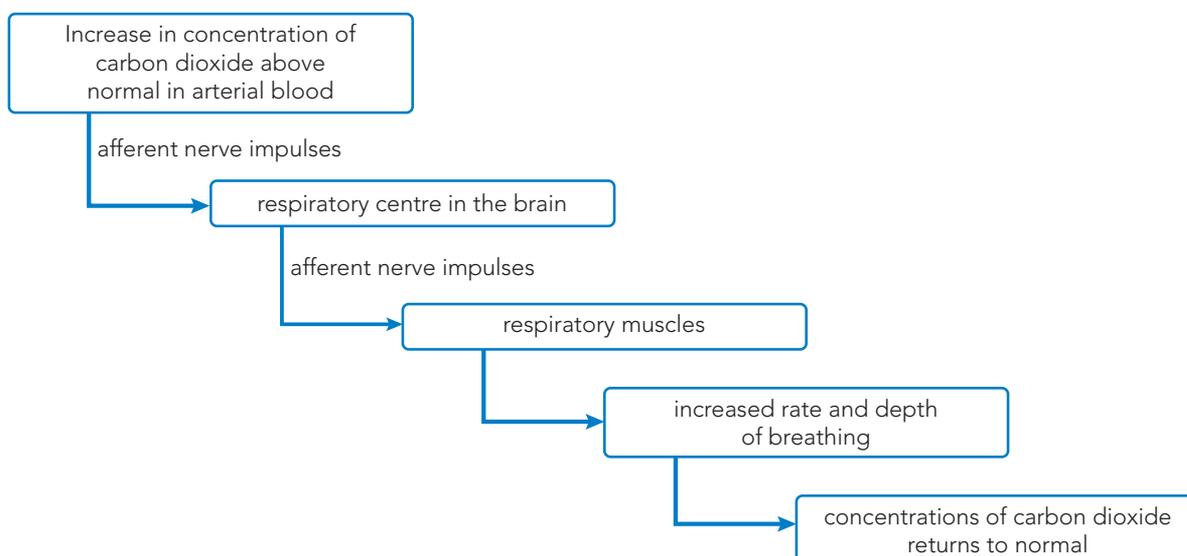
Statement 1: Negative feedback acts to compensate for a change.

Statement 2: Negative feedback occurs when tolerance limits are exceeded.

Statement 3: Positive feedback occurs by bringing about the production of a hormone.

- (a) 1, 2 and 3.
 - (b) Only 1 and 2.
 - (c) Only 2 and 3.
 - (d) Only 1.
2. Metabolic reactions in the body cells produce waste products that are detected by a variety of sensory receptors to maintain homeostasis. These wastes would be detected by
- (a) osmoreceptors, chemoreceptors and tactile receptors.
 - (b) carotid and aortic bodies, osmoreceptors and central chemoreceptors.
 - (c) thermoreceptors, osmoreceptors and pancreatic beta cells.
 - (d) peripheral and central chemoreceptors.
3. The thirst reflex is caused by the:
- (a) increase in osmotic pressure of the blood.
 - (b) decrease in osmotic pressure of the blood.
 - (c) decrease in volume of extracellular fluid.
 - (d) increase in volume of extracellular fluid.

The next two questions refer to the following flow chart showing the actions involved when carbon dioxide levels increase in arterial blood.



4. The effector in the regulation of carbon dioxide concentration is the:
 - (a) respiratory muscles.
 - (b) efferent nerve impulses.
 - (c) respiratory centre in brain.
 - (d) afferent nerve impulses.

5. The location of the respiratory centre in the brain is in the:
 - (a) cerebellum.
 - (b) medulla.
 - (c) cerebrum
 - (d) corpus callosum.

6. pH of the blood decreases when:
 - (a) the metabolic rate decreases causing less carbon dioxide to enter the blood.
 - (b) the breathing rate increases causing carbon dioxide to be removed from the lungs at a greater rate.
 - (c) the respiration rate of cells increases producing more carbon dioxide that needs to be removed via the blood.
 - (d) carbon dioxide reacts with oxygen in the blood producing carbon monoxide.

7. The role of the modulator in a feedback system is to:
 - (a) activate the effector if necessary.
 - (b) return the system to its optimal state.
 - (c) detect changes in the environment.
 - (d) respond to the stimulus.

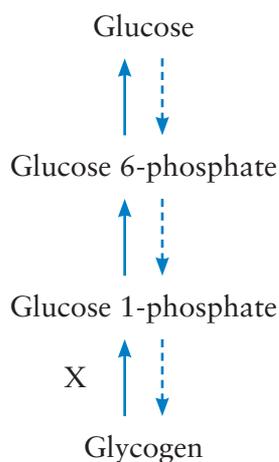
8. The advantage of excreting urea rather than ammonia as waste is that:
 - (a) urea production requires less energy than ammonia production.
 - (b) urea requires more water for excretion than ammonia.
 - (c) urea is very insoluble compared to the high solubility of ammonia.
 - (d) urea is less toxic than ammonia so can be held at higher concentrations.

9. The main systems which need to be co-ordinated in the body's 'flight or fight' response are:
 - (a) nervous, endocrine, respiratory, muscular and circulatory
 - (b) muscular, digestive, central nervous and excretory
 - (c) cardiovascular, neuromuscular, central and peripheral systems
 - (d) endocrine, excretory, digestive, respiratory and muscular

10. A footballer came from the field of play with a blood nose. An ice pack was placed on the back of his neck and soon the blood flow from his nose reduced considerably. This occurred because the ice pack:
 - (a) cooled the blood flowing through the pituitary reducing the heart rate
 - (b) caused the veins in the nose to contract reducing the amount of blood going to the nose
 - (c) reduces blood flow through the medulla so reducing its activity in controlling blood flow
 - (d) reduces the temperature of the blood flowing to the medulla which causes reduced peripheral blood flow to the nose.

SECTION 2 – SHORT ANSWER (50 MARKS)

1. The liver is important in balancing the processes of glycogenesis and glycogenolysis. These two processes help in the regulation of blood glucose levels.



- (a) Name the processes occurring at: [4 marks]

→ Pathway A _____ promoted by the hormone _____

--- Pathway B _____ promoted by the hormone _____

- (b) Pathway B occurs in the liver and _____ [1 mark]

- (c) Explain why glycogen is suitable for energy storage in cells. [2 marks]

- (d) In liver cells, the enzymes working at point X in these processes are glycogen synthetase and glycogen phosphorylase. The rates of activity of these enzymes are controlled by the concentration of glucose in the cells.

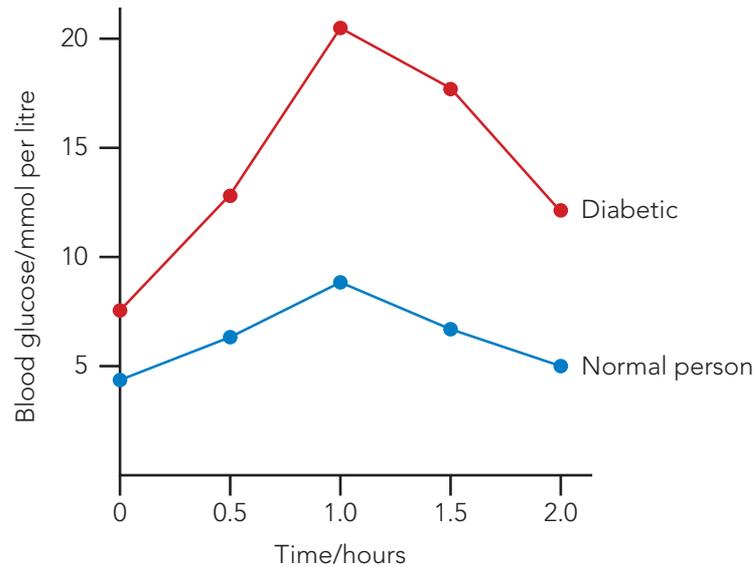
This table shows the rates of activity of these enzymes in the liver after drinking a concentrated glucose solution.

time after addition of glucose solution/s	rate of activity of glycogen synthetase / arbitrary units	rate of activity of glycogen phosphorylase / arbitrary units
0	28	410
30	28	280
60	32	140
90	49	65
120	94	42
150	136	40
180	189	40
210	272	40

- (i) State the relationship between activity of the two enzymes. [1 mark]

- (ii) Explain the changes in the activity of the two enzymes following the consumption of a glucose meal. [2 marks]

- (e) The graph shows changes in blood sugar levels in a normal person and a diabetic person. Before the data was collected both were instructed not to eat and only drink water for 12 hours. They were both given a glucose drink containing glucose. Blood samples and urine samples were taken immediately before and every 30 minutes for 2 hours after they drank the glucose solution.



- (i) State the blood glucose levels before drinking the glucose solution. [2 marks]

Normal person: _____

Diabetic person: _____

- (ii) Explain the changes taking place in the normal person during the first hour after the glucose intake. [2 marks]

- (iii) Blood sugar levels above 10 mmol/L causes glucose to appear in the urine. At what time would glucose be detected in the urine of the diabetic person? [1 mark]

- (iv) State the hormone and its effects acting during the second hour of the investigation. [2 marks]

- (f) After a prolonged period of fasting, glycogen levels in the liver are depleted. However, the liver can still produce glucose. Describe one way in which this is done.

[2 marks]

- (g) State two ways in which the glucose levels in cells can be reduced.

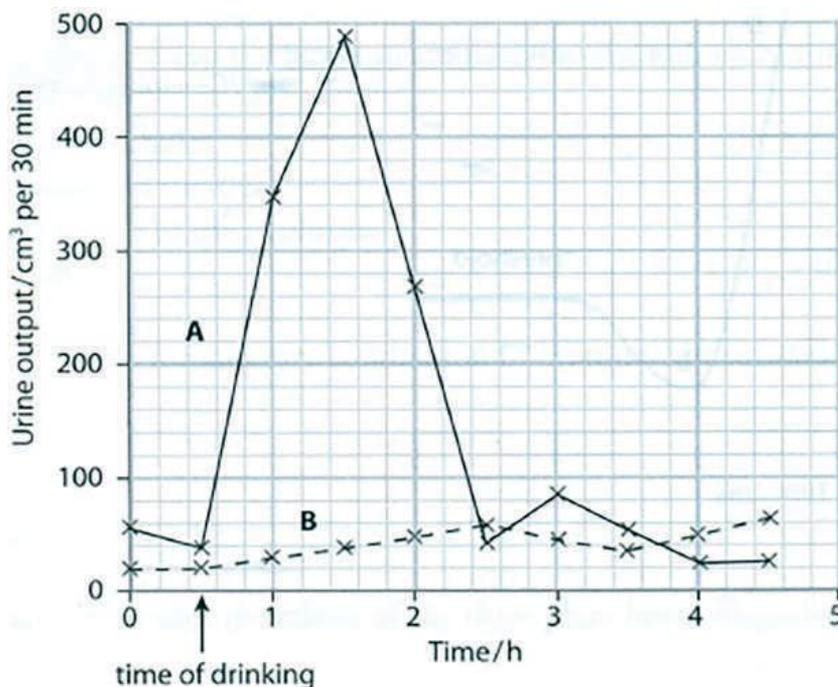
[2 marks]

2. Complete the following table.

[3 marks]

Organ	Involvement in excretion
Liver	
Lungs	
Skin	

3. Students conducted an investigation into the influence type of water intake on urine production. Person A drank one litre of water. Urine was collected at half-hourly intervals for four hours after drinking. Person B drank one litre of a dilute salt solution and the urine was collected in the same way. The dilute salt solution has about the same osmotic potential as blood plasma.



- (a) Calculate how much urine was produced by Person A during the first hour after drinking the litre of water.

[2 marks]

(b) Draw a line on the graph to show the changes in urine salt concentration over the time of the investigation. Assume that the normal salt levels of urine are at 300 on the graph. [2 marks]

(c) At what time did ADH start to act in Person A after drinking the litre of water? Use the information on the graph to explain your answer. [3 marks]

(d) Explain the results of Person B. [3 marks]

The table below shows the concentration of substances in the blood plasma compared with urine concentrations, in g/L.

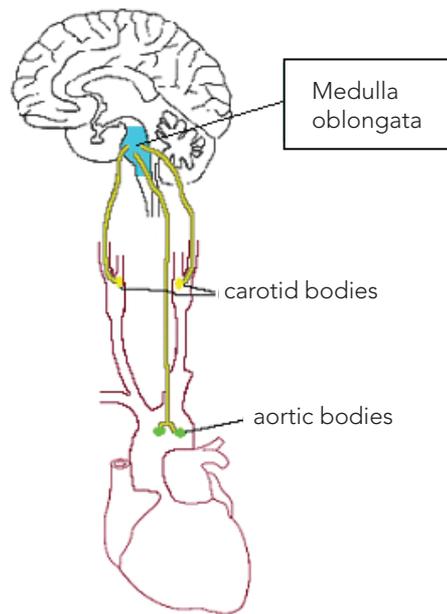
Substance	Plasma	Urine
Proteins	0.8	0
Urea	0.3	20
Glucose	1	0
Sodium Chloride	7.0	6.5

(e) Proteins and glucose do not appear in the urine. Compare the processes by which this occurs. [4 marks]

- (f) Explain the processes occurring in the nephron that produce a higher concentration of urea in urine than in the plasma. [4 marks]

4. Gas concentrations are controlled by balancing the intake of oxygen and the removal of carbon dioxide. The diagram below indicates 3 areas that detect gas concentrations.

- (a) Draw a flow diagram to show the control of breathing as a result of detecting changes in gas concentrations at these three locations. [5 marks]



- (b) Outline the role of the heart in controlling gas concentrations during exercise. [3 marks]

- (c) Explain the relationship between carbon dioxide and pH. [2 marks]

TRIAL TEST 5: RESPONSE TO INFECTION



Time allowed: 60 minutes	Section One – Multiple Choice	10 marks
Total marks: 80	Section Two – Short Answer	50 marks
	Section Three – Extended Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

- The time between exposure to a pathogen and the appearance of symptoms is called the:
 - virulent period
 - contagious interval
 - incubation period
 - infectious period
- The human skin:
 - has specific defence mechanisms against all pathogens.
 - has colonies of beneficial bacteria to help combat infections.
 - acts on specific antigens after the person has been vaccinated against them.
 - acts as a non-specific, waterproof barrier to a range of antigens.
- Transmission of disease by a vector is best illustrated by:
 - the use of shared needles spreading hepatitis in drug addicts.
 - migrating birds carrying bird flu from South East Asia to Australia.
 - the inheritance of cystic fibrosis from parents to offspring.
 - use a common drinking fountain spreading throat infection through a group of pre-school students.
- In 2021, the elderly members of the community have been strongly encouraged to get both the influenza vaccine and the vaccine to protect against Covid-19. This is because
 - the influenza vaccine can help boost the effectiveness of the Covid-19 vaccine.
 - the Covid-19 vaccine will not work without the influenza vaccine.
 - each vaccine works on different pathogens for which the elderly have a high risk of infection and harmful outcomes.
 - the elderly have lost the ability to produce antibodies to these types of pathogens.
- The stem cells that produce B and T cells are found in:
 - lymph nodes
 - the spleen
 - the liver
 - bone marrow
- Vancomycin is a commonly used antibiotic prescribed by doctors. Which of the following conditions would it be LEAST effective against?
 - Vomiting and diarrhoea caused by food poisoning
 - An infection as a result of a scratch from a garden spike
 - Headache and muscle soreness from influenza
 - Ear ache resulting from swimming in sewage-polluted water.

7. The cells that form pus at the site of an infection are:
- (a) thrombocytes.
 - (b) phagocytes.
 - (c) lymphocytes.
 - (d) erythrocytes.
8. When a virus is injected into an animal, antibodies are produced specifically for that virus. The antibodies can be separated from blood collected from the animal. These antibodies can be used to treat humans infected with the same virus. This is an example of which type of immunity?
- (a) natural
 - (b) passive
 - (c) innate
 - (d) active
9. These statements are about the immune system of a new-born baby. Which of these is correct?
- (a) The baby is protected from many antigens that the mother has produced antibodies against.
 - (b) The immune system of the newborn baby has developed specific antibodies with the help of the mother's immune system.
 - (c) Antibodies cross the placenta to give the new born baby active immunity.
 - (d) Antigens can cross the placenta producing active immunity in the newborn baby.
10. The body has been infected by a pathogen for the first time. Which of the following cells would not be part of the immune response?
- (a) Macrophages
 - (b) Neutrophils
 - (c) T-cells
 - (d) Monocytes

SECTION 2 – SHORT ANSWER (50 MARKS)

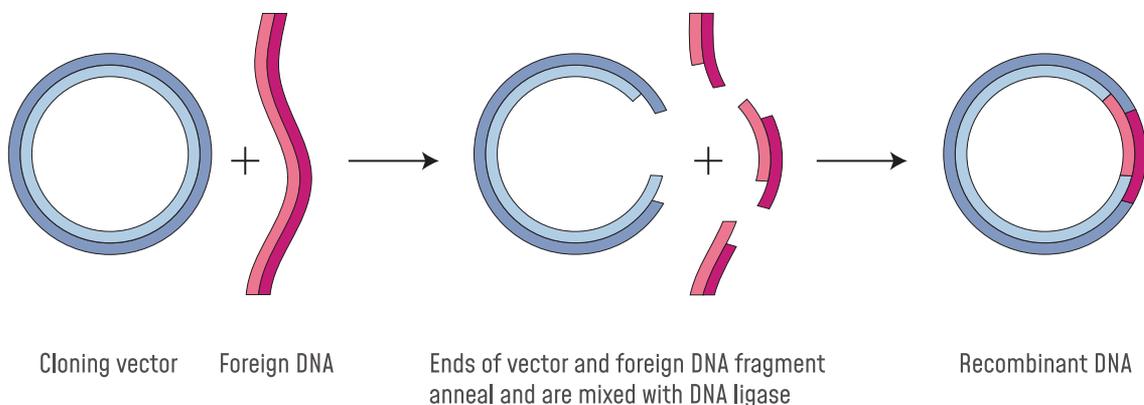
In 1995 a new variety of influenza appeared in Thailand. It began to spread around the world quickly. In many laboratories around the world potential vaccines were being developed, investigated and trials performed to assess their effectiveness.

1. (a) Identify **three** factors that would need to be controlled in the selection of subjects for this experiment. [3 marks]

- (b) What measurement could be taken to assess the effectiveness of the response to the vaccine? [1 mark]

- (c) What other factors need to be considered when assessing the efficacy of a vaccine? [2 marks]

- (d) One method by which the vaccines could be developed is using recombinant DNA biotechnology.



- (i) What is the cloning vector in this configuration called? Where does it come from? [2 marks]

- (ii) Why are the vector and foreign DNA cut with the same restriction enzyme? [2 marks]

(iii) Why are the cut ends of the DNA staggered rather than being cut straight across? [2 marks]

(iv) What happens to the recombinant DNA structure once it has been formed? [2 marks]

2. The body has barriers to infection where the internal meets the external at exchange surfaces.

(a) Complete the following chart with respect to the mechanisms used as barriers to infection. [4 marks]

Site	Defence mechanism
Mouth	
Stomach	
Trachea	
Eyes	

(b) Complete the following table to describe the role of each in the inflammatory response. [3 marks]

	Role in the inflammatory response
Histamine	
Mast cells	
Phagocytes	

(c) Explain how each of these actions can reduce the risk of transmission of pathogens. [3 marks]

(i) Wearing a mask.

(ii) Regular hand washing or sanitising.

(iii) Not sharing drink bottles.

3. (a) Describe TWO ways that antibiotics destroy bacterial cells. [2 marks]

(b) How can antibiotics distinguish between pathogens and normal body cells? [2 marks]

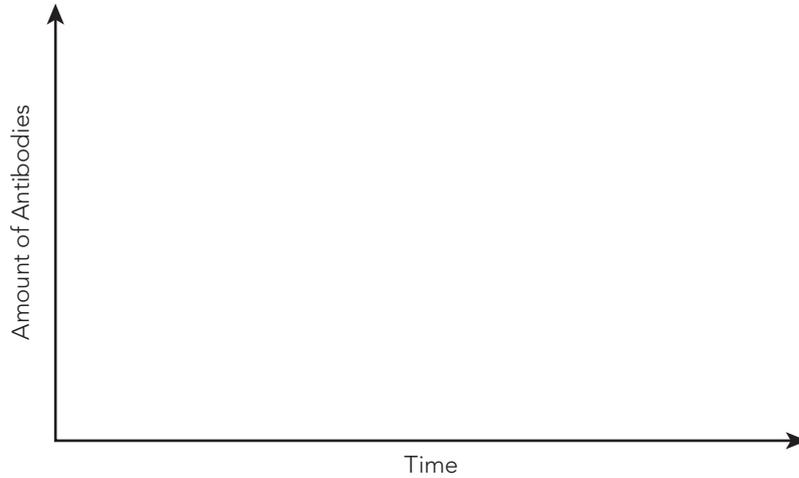
(c) Explain why antibiotics are ineffective against viruses. [2 marks]

(d) Why is it important that a person prescribed a course of antibiotics finishes the whole course, even if they are feeling totally recovered? [2 marks]

(e) Explain two ways antiviral medications reduce the effects of viruses. [2 marks]

4. School aged children are being encouraged to be vaccinated with measles, mumps and rubella (MMR) vaccines due to the increase in numbers being infected with these diseases over the last decade. A child received the vaccine and then three months later was exposed to the measles pathogen.

- (a) On the grid below, draw and clearly annotate the antibody response for a student when they received the vaccine and when they were subsequently exposed to the pathogen. [6 marks]



- (b) The AstraZeneca vaccine against the Covid-19 virus requires two doses delivered about 12 weeks apart. The Johnson & Johnson Covid-19 vaccine requires only one dose. Suggest why the difference in terms of the effectiveness of the vaccines. [2 marks]

- (c) When the vaccine is injected into the body, what cells recognise them as 'non-self'? [1 mark]

- (d) When the second dose of AstraZeneca vaccine is injected, what cells recognise the pathogen? [1 mark]

- (e) Vaccines can be made in different ways. Complete the following table to compare vaccine production methods. [3 marks]

Vaccine type	Method of production
Attenuated or inactivated virus vaccine	
	Synthesise, using biotechnological methods, the RNA sequence that encodes the spike protein of the virus. This is mixed with lipid droplets producing the vaccine. No cells or viruses are involved in the making of this type of vaccine.
Viral-vectored vaccine	

- (f) Suggest how social and cultural contexts influence the decision by people to have the vaccination against Covid-19. [3 marks]

TRIAL TEST 6: MUTATIONS



Time allowed: 60 minutes	Section One – Multiple Choice	10 marks
Total marks: 80	Section Two – Short Answer	50 marks
	Section Three – Extended Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

- During which phase of meiosis would a mutation lead to the formation of a new allele?
 - DNA replication in the nucleus
 - Pairing of homologous chromosomes
 - Separating of chromatids
 - Crossing over between homologous chromosomes
- A mutation has produced a dominant allele. As a result, which of the following is true?
 - Death would be expected for those with the new allele.
 - Only homozygous individuals would die.
 - An individual with one new allele will show the new phenotype.
 - A homozygous genotype is required for the new phenotype to be expressed.
- Point mutations are produced when:
 - one base pair in the DNA sequence is altered.
 - crossing over occurs at a particular point on the chromosome.
 - single genes are deleted from the chromosomes.
 - genetic code is added to a specific point in a chromosome.
- Which of the materials listed do **not** have a mutagenic effect?
 - Heavy metals such as nickel and arsenic
 - Caffeine
 - Ultra violet light
 - Viruses
- Sometimes, mutations do not have any effect on the phenotype of a person. This is because the mutation
 - does not change the protein produced.
 - can't be read by the RNA.
 - produces different proteins with the same function.
 - will only impact the phenotype not the genotype.
- What is the relationship among DNA, alleles, genes and chromosomes?
 - A gene contains hundreds of chromosomes, which form from paired alleles made of DNA.
 - A chromosome contains hundreds of genes that can be of different forms called alleles, which are composed of DNA.
 - DNA forms genes which combine together as alleles found along the chromosome.
 - A gene is composed of DNA, but there is no relationship to chromosomes or alleles.

7. The survival rates of people who have the sickle-cell gene differ from those who do not, in parts of the world where malaria is prevalent. People who are homozygous normal (SS) are less likely to survive than those who have the sickle-cell allele (Ss). People who have sickle-cell anaemia (ss) are less likely to survive than either of these two groups as they need frequent blood transfusions, which are not available to most people in developing countries.

The description above can best be described as:

- (a) adaptive variation.
- (b) genetic competition.
- (c) differential survival.
- (d) mutant survival.

8. A segment of one of the strands of DNA contains the nucleotide sequence below.

A C G T A C G C A C C A T C A

Which one of the following nucleotide sequences would **not** be in the mRNA sequence?

- (a) C A C C A U G A
- (b) A C G C A C C A
- (c) C A U C G G U G
- (d) G A G G A T G A

9. The condition of Down's Syndrome in which the person has 3 copies of chromosome 21 is due to:

- (a) translocation of chromosomes during fertilization.
- (b) extra copying of the chromosomes during meiosis.
- (c) duplication of the chromosome 21 during crossing over.
- (d) non-disjunction of chromosomes during meiosis.

10. A hereditary condition that is never passed from father to son is due to the controlling alleles being

- (a) Autosomal.
- (b) X linked.
- (c) Y linked.
- (d) Somatic.

SECTION 2 – SHORT ANSWER (50 MARKS)

1. The table below shows the codons required to code for different amino acids during protein manufacture.

Base triplets found in messenger RNA

		Second base				
		U	C	A	G	
First base	U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C	
	Phe	Ser	Stop	Stop	A	
	Phe	Ser	Stop	Trp	G	
C	Leu	Pro	His	Arg	U	
Leu	Pro	His	Arg	C		
Leu	Pro	Gln	Arg	A		
Leu	Pro	Gln	Arg	G		
A	Ile	Thr	Asn	Ser	U	
Ile	Thr	Asn	Ser	C		
Ile	Thr	Lys	Arg	A		
Met	Thr	Lys	Arg	G		
G	Val	Ala	Asp	Gly	U	
Val	Ala	Asp	Gly	C		
Val	Ala	Glu	Gly	A		
Val	Ala	Glu	Gly	G		

- (a) Describe the common features of STOP codons. [1 mark]

- (b) The sequence of amino acids is

Met – Cys – Glu

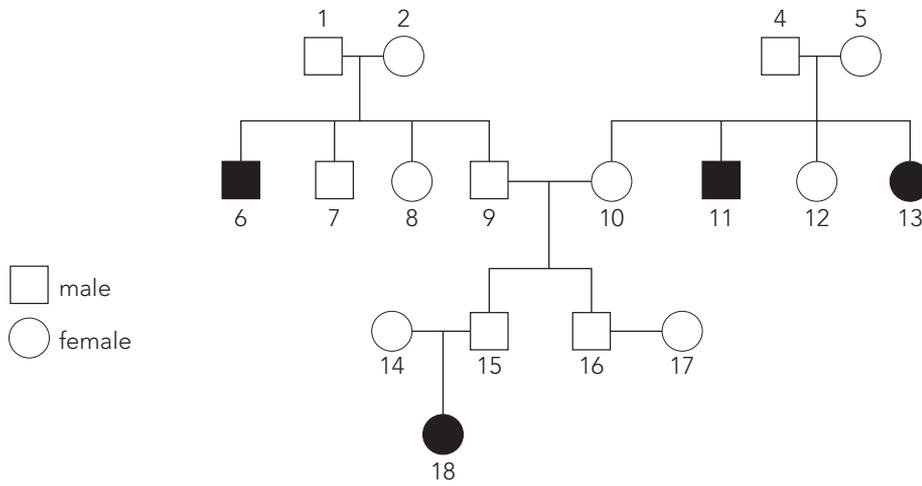
What are the possible RNA sequences that will code for this amino acid chain?

[4 marks]

- (c) During DNA replication, a mutation caused a change from AGT to ACT in the DNA sequence. Use the information in the table to explain the impact of this change. [4 marks]

[4 marks]

2.

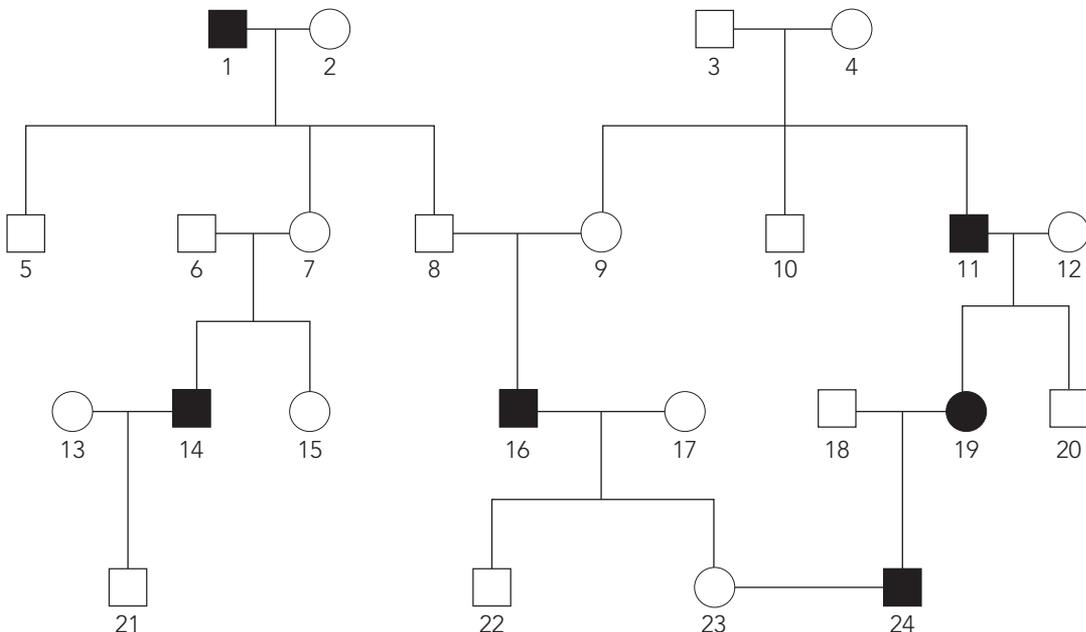


(a) From the evidence in the pedigree above, state whether this condition is most likely to be transmitted on an autosomal chromosome or a sex chromosome. [1 mark]

(b) Explain how you arrived at your answer to (a). [2 marks]

(c) Decide whether this condition is due to a dominant or a recessive allele. Use evidence from the pedigree in support of your answer. [3 mark]

In another family, the incidence of an X linked condition is indicated in the pedigree shown below.



(d) How many generations are depicted in this pedigree? [1 mark]

(e) State which numbers are carrier mothers and give your reasons for your answer. [3 marks]

(f) Explain the phenotypes of Individuals 18 and 19. [4 marks]

(g) (i) Using the letter **B** to indicate dominant, and **b** to denote recessive alleles, state the genotypes of Individuals 1 and 2. [2 marks]

(ii) 23 and 24 are due to have a child. Calculate the probability of this child being a boy with the condition. Show your working out. [4 marks]

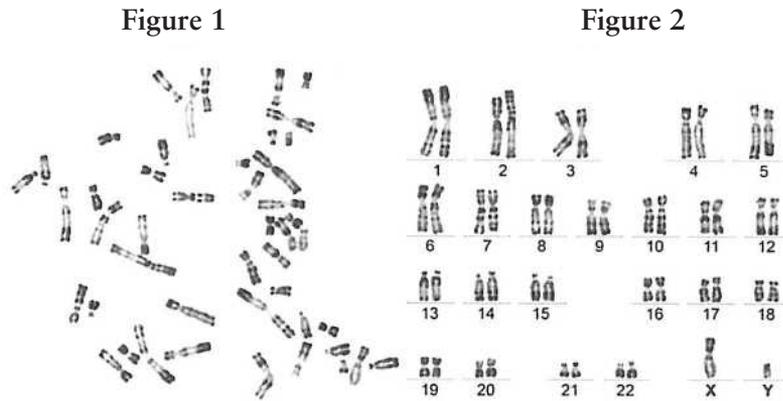
3. Among native Americans, two types of cerumen (ear wax) are seen, dry and sticky. A geneticist assigned to study the inheritance of this trait observed the offspring produced by different kinds of matings. The results were:

Parents	Number of mating pairs	Offspring	
		Sticky	Dry
Sticky x Sticky	10	32	6
Sticky x Dry	8	21	9
Dry x Dry	12	0	42

(a) Explain how earwax type is inherited. [2 marks]

- (b) Explain why there are no 3:1 or 1:1 ratios in the data as may be expected according to Mendelian rules. [2 marks]

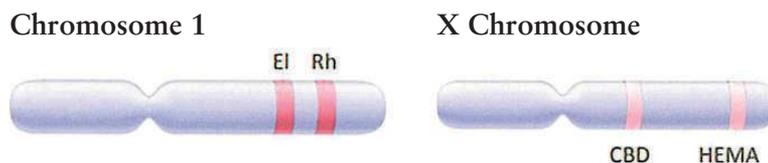
4. Figure 1 shows the chromosomes present in a human cell during mitosis. Figure 2 shows the same chromosomes arranged in homologous pairs.



- (a) Give one piece of evidence from Figure 1 that indicates this cell was undergoing mitosis and not meiosis. [1 mark]

- (b) Suggest the types of gametes that could be produced by person whose chromosomes are shown in these figures. [2 marks]

Some of the genes located on chromosomes 1 and X have been mapped and shown in the diagram below.

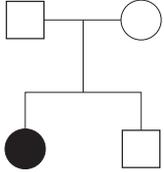


- (c) Crossing over occurs between homologous chromosomes. Explain which homologous pair, Chromosome 1 or X, would most likely have the two genes swapped if crossing was to occur. [2 marks]

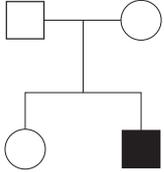
5. The key for the following diagrams is:



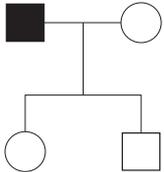
For each of the family trees A – D, indicate the possible mode(s) of inheritance stating your reasons with evidence from the diagrams.

(a) 

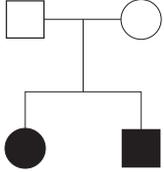
[3 marks]

(b) 

[3 marks]

(c) 

[3 marks]

(d) 

[3 marks]

TRIAL TEST 7: GENE POOLS



Time allowed: 60 minutes	Section One – Multiple Choice	10 marks
Total marks: 80	Section Two – Short Answer	50 marks
	Section Three – Extended Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

- The species gene pool:
 - continually gains and loses alleles.
 - stays constant over time.
 - is changed by evolution.
 - is the same as that of other species.
- Harmful mutations are assumed to be eliminated from the gene pool, but for some harmful mutations this is not the case. This is most likely because:
 - These mutations may have some survival value in particular conditions.
 - They are recessive and can be maintained in the population by heterozygous individuals who may not even know they carry the allele.
 - They are dominant and occur at a greater rate in the population than they are removed.
 - Genetic drift and sexual selection maintain them in the population.
- In a population of a remote region, the frequencies of genotypes for gene H/h differed significantly from the frequencies expected according to the proportions of alleles in the population. Which reason could explain this difference?
 - There was a mutation associated with the expression of the H allele
 - No migration occurred into or out of this area.
 - Mating was not random in this isolated population.
 - There were no natural selection pressures that favoured either allele.
- A genetic bottle neck occurs when:
 - the genetic variation in a population is significantly changed over time.
 - the population size has been suddenly reduced, decreasing genetic diversity.
 - the influence of selection pressures reduces the population diversity.
 - the genetic variation has been significantly impacted by neighbouring populations.
- Natural selection is not similar to artificial selection because:
 - The selection in nature depends on the natural pressures in the environment; whereas in artificial selection, the selection is intentional.
 - Variation is important in natural selection but not in artificial selection.
 - Natural selection acts within species, artificial selection acts within populations.
 - The amount of change caused by natural selection is small compared with that of artificial selection.

6. Some bacteria in hospital situations have become resistant to many types of antibiotics. Which of the following best describes the development of antibiotic resistance in these bacteria?
- Individual bacteria slowly adapt to the presence of the chemical by striving to meet the new challenge.
 - All bacteria exposed to the antibiotics activate a usually silent gene to produce an enzyme that breaks down the antibiotic molecules.
 - Bacteria are affected by the behaviour of others that survive treatment with antibiotics and learn to do the same.
 - Bacteria with genetic resistance to the antibiotics make up more of the population as the susceptible bacteria die.
7. The genetic variation is greatest in offspring of which of the following?
- Asexual reproduction of bacteria
 - Viruses replicating in human cells
 - Liver cells produced by mitosis
 - Zygotes produced from two IVF treatments
8. Two populations exist: one on each side of a low mountain range. During the late 1800s a road was built between the two areas where the populations lived. Migration could freely occur between the two locations. The effect this would have on the populations is
- Loss of one or more alleles from both populations.
 - The levelling out of genetic differences
 - Increase the genetic diversity between the populations
 - Increase the frequency of homozygous recessive conditions.
9. A study of the Hopi, a Native American tribe of central Arizona, found 26 albino individuals in a total population of 6000. The occurrence rate for albinism across the world is about 1 in 3000. This form of albinism is controlled by a single gene with two alleles: albinism is recessive to normal skin colouration. Which is the most likely explanation for the rate of albinism in the Hopi tribe being far greater than in the general population?
- Albinism has beneficial effects for the individual so they survive at a greater rate than those with normal skin colouration.
 - Migration of albino allele carrying individuals into the tribe in recent times has produced large numbers of children with albinism.
 - The population is small and there is a high rate of intermarriage between families carrying the albinism allele.
 - The tribal leader carries the albinism allele and so passes it onto members of the tribe.
10. Blood tests of a population of Inuit in Arctic Europe, produced the following data for M and N blood groups. M/N blood groups is controlled by two codominant alleles.

Blood type	M	MN	N	Total
Number of people	61	64	27	152

- The total number of alleles in this gene pool is 152.
- The number of N alleles in this gene pool is 128.
- The N alleles account for about one third of the total gene pool.
- As there are only two alleles and they account for half each in the gene pool.

SECTION 2 – SHORT ANSWER (50 MARKS)

1. Tay-Sachs disease is caused by an autosomal recessive allele (**t**). Symptoms begin to appear at six months of age when babies begin to suffer from problems in the brain and nervous system and lose skills. Children with Tay-Sachs disease usually die by age five.

The carrier rate for the general population is $1/250$. Some evidence suggests people of Irish descent have an increased rate over the general population between $1/50$ to $1/150$. French Canadians, Louisiana Cajuns and Ashkenazi Jews are all considered high risk with a carrier rate of $1/27$.

- (a) Explain three factors that could influence different populations having different carrier rate of the **t** allele. [3 marks]

- (b) Explain how Tay-Sachs in French Canadians could be an example of the Founder effect. [3 marks]

- (c) Explain how the use of DNA technology could reduce the frequency of Tay-Sachs in the population of Ashkenazi Jews living in Australia today. [3 marks]

- (d) Tay-Sachs appears to have its origins in a small location in eastern Europe about 300 years ago.

- (i) Suggest how it came about. [3 marks]

- (ii) Explain why it didn't become a worldwide disease until the late 1770's. [1 mark]

- (e) It has been discovered that people who are heterozygous for Tay-Sachs have a greater resistance to tuberculosis (TB). In the recent past, the Ashkenazim people lived mainly in cities and towns where TB was a common disease. Using this information, explain why Tay-Sachs has continued to exist in the Ashkenazi people.

[2 marks]

2. Thalassaemia is caused by mutations to the DNA that makes haemoglobin: the more mutated alleles the more severe is the thalassaemia. Beta-thalassaemia is caused by a mutated allele involved in making the beta haemoglobin chain. If one mutated allele is inherited, then mild symptoms will occur. If two mutated alleles are inherited, the signs and symptoms will be moderate to severe. Homozygous recessive children are usually healthy at birth but develop signs and symptoms within the first two years of life, leading to greater risks of early death. Thalassaemia is thought to give some resistance to malaria.

Beta-thalassaemia is common in people of Italian, Greek, Middle Eastern, Asian and African descent from areas where malaria is prevalent.

- (a) Why might the frequency of the defective gene be more common in these people than the rest of the population? [2 marks]

- (b) Explain how migration can change the incidence of thalassaemia in the countries accepting migrants. [2 marks]

- (c) Explain how the frequency of thalassaemia alleles would change in populations living in areas where there is no malaria. [2 marks]

- (d) Migrants tend to be younger members of the old countries population. Explain how could this selective migration change the incidence of thalassemia in the country to which migrants move. [3 marks]

3. Tibetans have a way of coping with low oxygen content at high altitudes as a result of a gene mutation that helps them use the low amount of oxygen more efficiently. This mutant allele is found in 87% of Tibetans but in only 3% of the Han population that live at a lower altitude in the same region.

- (a) State three sources of variation within a population. [3 marks]

- (b) State the selection pressure that has caused the allele frequency difference between the Tibetan and Han populations. [1 mark]

- (c) Is this mutant allele dominant or recessive? What observations or evidence would be required to know this? [4 marks]

- (d) The Tibetan population living in low-lying areas does not have the same high frequency of the mutant allele as the population that live in high altitudes. Suggest why this happens. [3 marks]

4. Outline the importance of the following in the process of natural selection.

(a) Struggle for existence [2 marks]

(b) Differential selection [2 marks]

5. A long time ago, a small group of people from a large coastal city moved to an isolated area in a mountainous region of the country. This population consisted of a few interrelated families that had a high frequency of the sickle cell anaemia allele.

(a) What impact would a change of location make on the frequency of this allele in the population? Explain your answer. [3 marks]

(b) After a few generations of living in this area, a non-related migrant family settled in the community. This family tended to have a large number of children in each generation. Explain how this would change the frequency of the sickle cell anaemia allele in the community. [2 marks]

(c) In the generation after the arrival of the migrants, several cases of another non-lethal genetic condition were observed. In subsequent generations more and more individuals were born with the condition. Explain how this increase in allele frequency could have occurred. [4 marks]

(d) Why is a small population more susceptible to genetic drift than larger populations? [1 mark]



TRIAL TEST 8: EVIDENCE FOR EVOLUTION

Time allowed: 60 minutes

Total marks: 80

Section One – Multiple Choice

Section Two – Short Answer

Section Three – Extended Answer

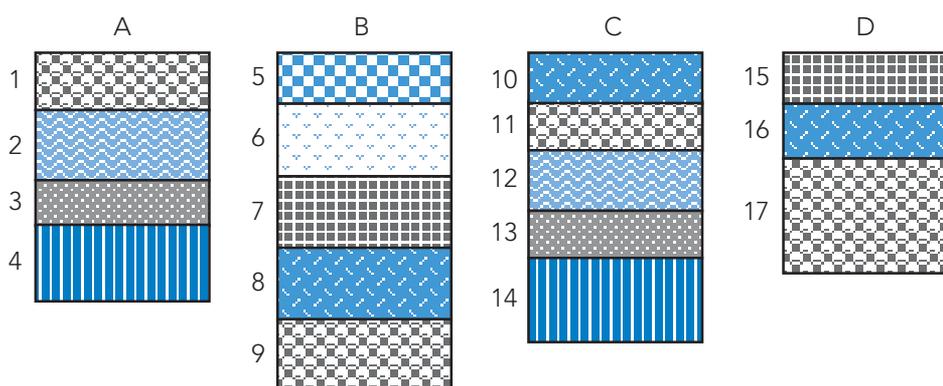
10 marks

50 marks

20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

- Which of the following is correct concerning carbon-14 dating?
 - A sample with radioactivity of 9 nuclei per second per gram is older than one of 6 nuclei per second per gram.
 - Carbon-14 dating can be used on animal remains but not on plant remains.
 - Carbon-14 is not taken up once a living thing dies so the radioactive decay rate gives dating information.
 - Carbon-14 can be used on all inorganic materials up to 50,000 years old.
- Refer to the diagrams of strata (layers) below.



Which of the following statements is correct?

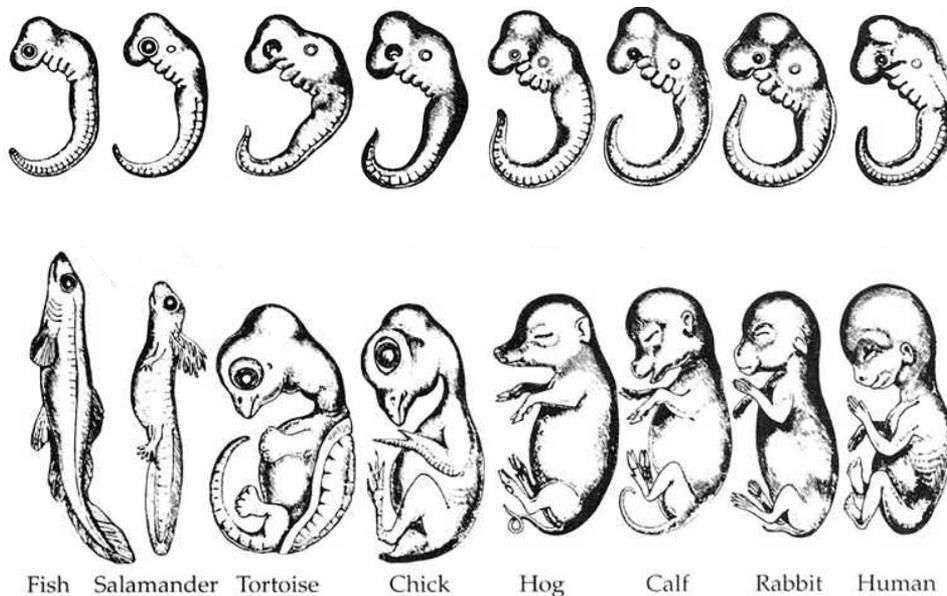
- B8 is younger than D15.
 - A4 is older than C14.
 - A1 is the same age as B9.
 - D15 is the same as B6.
- In a cave in China archaeologists have found some stone and bone tools, human skull bones and burnt bones of animal remains. Which of the following techniques could be used to give some information regarding the age of these fossils?
 - The bone tools can be dated by using potassium 40 to give a relative date.
 - The burnt bones can be radioactive carbon dated to give an absolute date.
 - Fluorine dating could be used on the bones to give an absolute date.
 - The bones could be arranged from oldest to youngest by size and colour.
 - Analysis of DNA sequences from two individuals of the same species provides a more accurate analysis of the genetic variability between them than analysis of amino acids sequences from the same individuals because:
 - different DNA sequences can code for the same amino acid.
 - DNA sequencing is more reliable than protein electrophoresis.
 - proteins are more heat sensitive than DNA.
 - proteins are more easily damaged than DNA.

5. The table below shows the number of nucleotide differences between a section of mitochondrial DNA in modern humans, chimpanzees and a Neanderthal fossil.

	Neanderthal	Chimpanzee 2	Chimpanzee 1	Human 2
Human 1	21	76	77	14
Human 2	27	79	80	–
Chimpanzee 1	72	22	–	–
Chimpanzee 2	70	–	–	–
Neanderthal	–	–	–	–

Based on the data in the table, which individual is related most closely to the Neanderthal?

- Human 1.
 - Human 2.
 - Chimpanzee 1.
 - Chimpanzee 2.
6. Only minute amounts of DNA have been extracted from fossils of Neanderthals. What process can be used to produce testable amounts for the study of the DNA?
- Gel electrophoresis
 - Polymerase chain reaction
 - DNA profiling
 - Sanger replication
7. These drawings show the early and late embryonic development stages of different vertebrate animals.



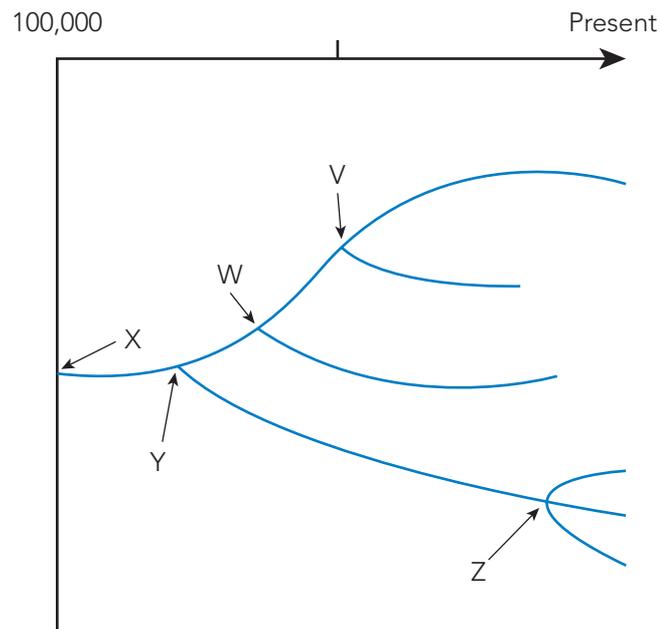
The early embryos of vertebrates are characterised by the absence of paired appendages and the presence of a well-developed tail and gill slits. Which of the following supports the theory of evolution?

- The embryos have all the features but in undeveloped form that develop into the fully formed features in the adult.
- Many features in embryos do not occur in the adult form due to the influence of the maternal environment.
- All features in the embryo can be recognised the adult form but each very modified due to the species genetic influence.
- The features at the embryonic stage are not found in any of the fully formed adult

vertebrates.

Questions 8 and 9 refer to the phylogenetic tree below.

The tree's horizontal axis is a timeline that extends from 100,000 years ago to the present.



The labelled branch points on the tree (V—Z) represent various common ancestors. The tips of the lineages on this tree represent distinct species.

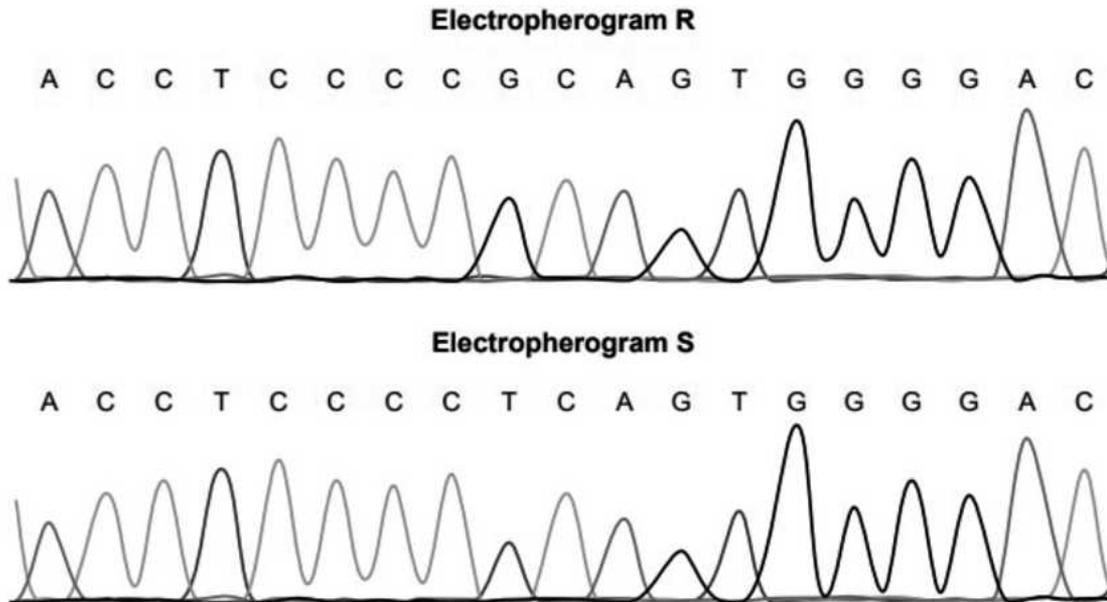
8. According to this tree, what percent of the species seem to be extant (i.e., not extinct)?
 - (a) 25%
 - (b) 33%
 - (c) 50%
 - (d) 66%

9. Which of the common ancestors shown in the tree, has given rise to the greatest number of species, both extant and extinct?
 - (a) V
 - (b) W
 - (c) X
 - (d) Y

10. The theory of evolution is most accurately described as
 - (a) one possible explanation, among several scientific alternatives, about how species have come into existence.
 - (b) an opinion that some scientists hold about how living things change over time.
 - (c) an overarching explanation, supported by much evidence, for how populations change over time.
 - (d) an idea about how acquired characteristics are passed on to subsequent generations.

SECTION 2 – SHORT ANSWER (50 MARKS)

1. Scientists were investigating the genetic differences between people with a severe inherited condition. The diagrams below show electropherograms of a segment of a gene that is required for the enzyme that controls the production of the required protein. Mutations in this gene have been linked to the ability of individuals to produce this protein. Electropherogram R shows the nucleotide sequence of a gene in an enzyme-producing person and electropherogram S shows the nucleotide sequence of the same gene in a non-enzyme-producing person.



Source: Adapted from Marzooq, AAL 2015, 'Discovery of novel DNA variants in Jordanian population by re-genotyping affymetrix DMET arrays data using DNA sequencing', *Molecular biology*, vol. 4, no. 3, figure 4.73 (CC BY 4.0)

- (a) What is the name of the technique used to produce an electropherogram? [1 mark]

- (b) Mark **on the electropherograms** the point where the sequences differ. [1 mark]

- (c) Electropherogram T was done on DNA from another person showed the following change:

ACCTCCGCTCAGTGGGGAC

- (i) What phenotype would this person show? Explain your answer. [2 marks]

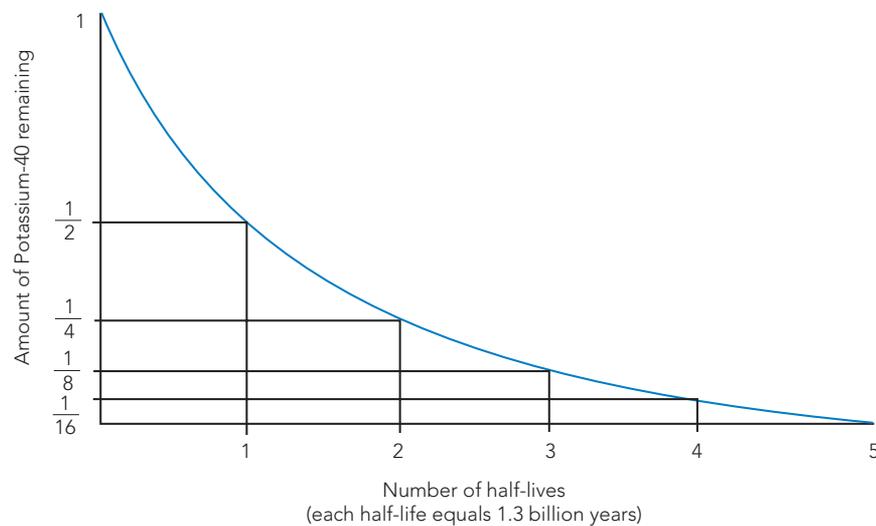
- (ii) The researchers were surprised to find the difference in electropherogram T person as they did not show any other phenotypic difference. Explain why. [3 marks]

- (d) Explain which mutation shown in these electropherograms is the most recent. [3 marks]

- (e) Outline why this process carried out on people with a family history of an inherited condition can have ethical implications. [2 marks]

- (f) Explain why the comparison of proteins between groups may not give the same results as comparing DNA sequences. [2 marks]

2. This graphic shows the radioactive decay rate of potassium-40.



- (a) State the radioactive decay product from the breakdown of potassium-40. [1 mark]

(b) A rock specimen found in the archaeology department of a university was found to contain 12.5% potassium-40. Calculate the approximate age of the rock.

[3 marks]

(c) Explain two limitations on the use of potassium-40 decay rate in determining the age of specimens?

[4 marks]

(d) Another method of dating specimens uses Carbon-14. It has a half-life of 5730 years. A fossil was determined to be approximately 27,000 years old. Calculate the amount of carbon-14 content in the fossil.

[3 marks]

(e) Explain why radiocarbon dating is not reliable for fossils older than about 50,000 years.

[2 marks]

3. (a) Define the term 'index fossils'. [2 marks]

(b) Describe the use of index fossils in interpreting an archaeological site. [3 marks]

(c) State the type of rock that fossils are most likely to be found in. [1 mark]

- (d) Explain why there are more marine organisms in the fossil record than tropical, terrestrial organisms. [3 marks]

- (e) Describe how fossils are revealed at the earth's surface after being located very deep in the rock strata. [3 marks]

4. (a) State where mtDNA is found in the cell. [1 mark]

- (b) Explain why the mtDNA of cells is almost exclusively from the maternal parent. [2 marks]

- (c) Explain why mtDNA has become increasingly important in evolutionary studies. [2 marks]

5. Use the following chart to make interpretations about geological time.

Eras	Periods	Epochs	Millions of Years BP
Cainozoic	Quarternary	Recent Pleistocene	0.005 (5000 years) 1.8
	Tertiary	Pliocene Miocene Oligocene Eocene Palaeocene	7 26 38 54 68
Mesozoic	Cretaceous Jurassic Triassic		136 190 225
Palaeozoic	Permian Carboniferous Devonian Silurian Ordovician Cambrian		280 345 395 430 500 570
Pre-Cambrian			4700

(a) The great extinction event that wiped out the dinosaurs occurred about 60 million years ago. In what time period did this happen? [1 mark]

(b) During which era did humans first appear in the fossil record? [1 mark]

6. Comparative anatomy: For each, circle one of each of the **highlighted** phrases to complete a correct statement. [4 marks]

- (a) Vestigial structures in an organism have **no purpose** / **an important purpose**.
- (b) Vestigial structures in an organism are **increased** / **reduced** in size.
- (c) Homologous structures have a **similar** / **different** structure and a **similar** / **different** function.
- (d) Homologous structures can be found in organisms that are **related** / **not related** and have adapted to **similar** / **different** environments.

TRIAL TEST 9: EVOLUTIONARY TRENDS IN HOMINIDS



Time allowed: 60 minutes	Section One – Multiple Choice	10 marks
Total marks: 80	Section Two – Short Answer	50 marks
	Section Three – Extended Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

- Which of the following features would NOT indicate that a fossil belonged to *Homo erectus*?
 - Dated to be 1.3 million years old.
 - Height of 1.45m, stocky stature.
 - Prognathic jaw, no chin.
 - Cranial capacity of 750cm³, thick brow ridge.
- If a hominid skull had an obvious sagittal crest, it would suggest that the hominid:
 - was very large in stature and bipedal.
 - was more likely to use tools for defence.
 - had a large cranial capacity and was quadrupedal.
 - had large molars and a prognathic jaw.
- This cave painting was found in Europe.



The most likely hominid to have created this was

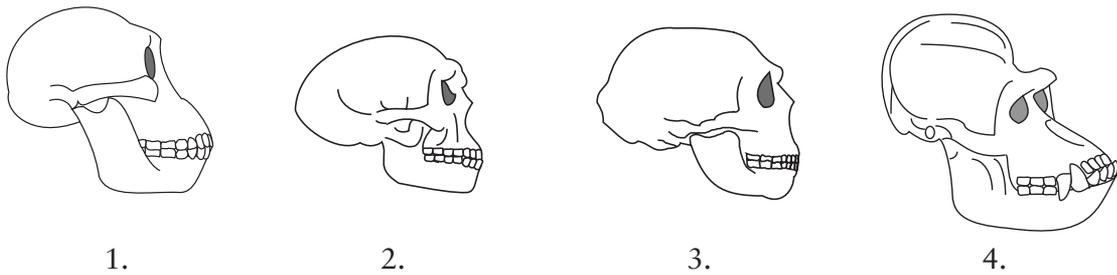
- Homo habilis*.
- Homo erectus*.
- Homo neanderthalensis*.
- Homo sapiens*.

4. Place the following in the most likely sequence in which they have developed (from earliest to the most recent).

M pottery
 N domesticated animals
 O nomadic hunting
 P writing

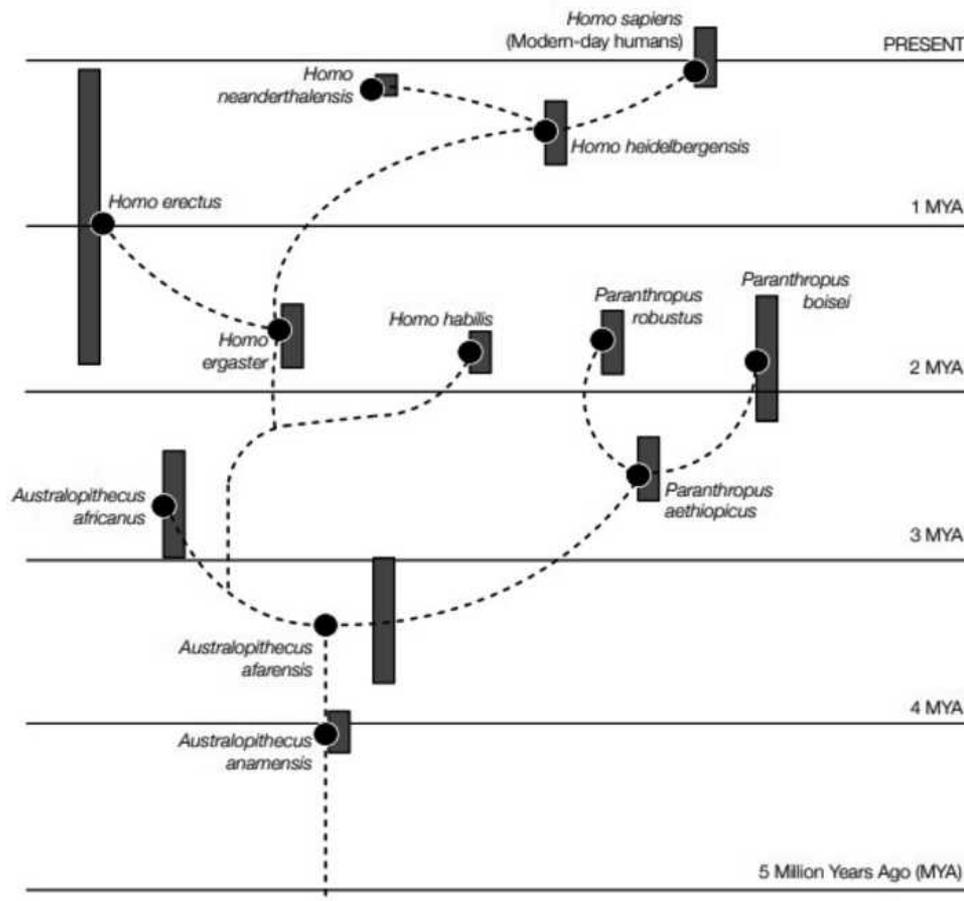
- (a) M, N, O, P
 (b) P, M, N, O
 (c) O, N, M, P
 (d) N, M, P, O

5. The skulls in order from 1 to 4 are:



- (a) ape, *Australopithecus africanus*, *Homo erectus*, *Homo neanderthalensis*.
 (b) *Australopithecus africanus*, *Homo erectus*, *Homo neanderthalensis*, ape.
 (c) *Homo erectus*, *Homo neanderthalensis*, ape, *Australopithecus africanus*.
 (d) *Homo neanderthalensis*, *Homo erectus*, *Australopithecus africanus*, ape

6. This diagram illustrates one interpretation of the origin of humans. The dotted lines indicate the possible evolutionary relationships, and the vertical bars show the period from which fossils are known from each species.



This diagram suggests that

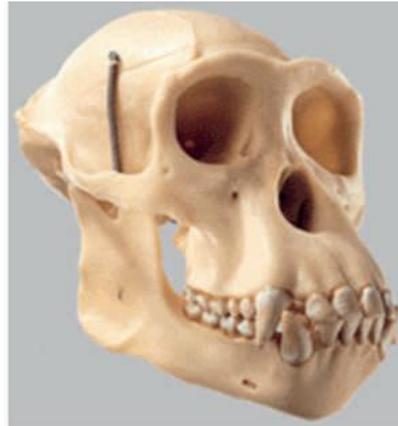
- (a) *Homo habilis* is an ancestor of modern humans.
- (b) *Homo sapiens* is descended from *Paranthropus aethiopicus*
- (c) *Homo erectus* became extinct before modern human appeared.
- (d) *Australopithecus* species may have given rise to modern humans.

7. Brachiation means

- (a) using the forelimbs to swing from branch to branch.
- (b) a clinging and climbing action using all four limbs.
- (c) using the limbs to grasp objects.
- (d) five digits on each limb.

Questions 8 and 9 refer to the this specimen.

┌
└ 3 cm



8. Which of the following sets of features would be present in the group of which this skull is representative?
- (a) cranial capacity of less than 600 cc, large canine teeth, central foramen magnum;
 - (b) large canine teeth, sagittal crest, prognathic face;
 - (c) large canine teeth, sagittal crest, prominent brow ridges;
 - (d) cranial capacity of less than 600 cc, large canine teeth, and prognathic face.
9. Which of the following anatomical features in the above specimen could be used to distinguish this group from humans?
- (a) canine teeth, cranial capacity, molar teeth, and foramen magnum;
 - (b) cranial capacity, molar teeth, and mandible shape;
 - (c) cranial capacity, mandible shape, and foramen magnum;
 - (d) cranial capacity, molar shape, and sagittal crest.
10. This tool would best be dated to an absolute date by



- (a) measuring the amount of fluorine left in the tool.
- (b) stratigraphy in which the bones associated with the tool are compared to similar bones in other areas.
- (c) using radiocarbon dating on the bones associated with the tool.
- (d) using potassium-argon dating on the soil layers surrounding the tool.

SECTION 2 – SHORT ANSWER (50 MARKS)

1. Paleo-anthropologists classify fossil finds into the various groups of hominids and hominins.

(a) Distinguish between hominids and hominins. Give examples of each group. [4 marks]

(b) Evaluate the impact of age and gender of the individual whose remains were fossilised on the possible range of measurements of fossil hominin skulls. [3 marks]

(c) Explain TWO problems of human variations in making inferences on the classification of fossilised hominin bones. [3 marks]

(d) Different palaeo-anthropologists have classified the same hominin fossils into different groups. Explain why this can occur. [3 marks]

2. The discovery and use of fire were significant in human cultural evolution.

(a) What is meant by the term **cultural evolution**? [2 marks]

- (b) Explain how fire enhanced the survival of the hominids that first used it. [3 marks]

3. Consider the following illustrations:



A. anamensis

H. habilis

H. s. neanderthalensis

- (a) Describe two aspects of these illustrations that are based on known facts of palaeoanthropology/archaeology. [2 marks]

- (b) Explain one aspect that has been extrapolated from known facts. [2 marks]

- (c) Describe an aspect that is not based on known facts. What is the basis for this being used in the illustrations? [2 marks]

4. (a) Compare and contrast a chimpanzee skull with those of an Australopithecine and a modern human, by completing the table below. [4 marks]

	Chimpanzee	Australopithecine	Human
Shape of Dental Arcade	U-shaped		
Cranial Capacity (cc)	320–480		

(b) Describe the features of the feet of a bipedal hominin. [3 marks]

(c) Describe two other features of the bodies of modern humans that differ from that of an Australopithecine. (do not include skulls and feet.) [2 marks]

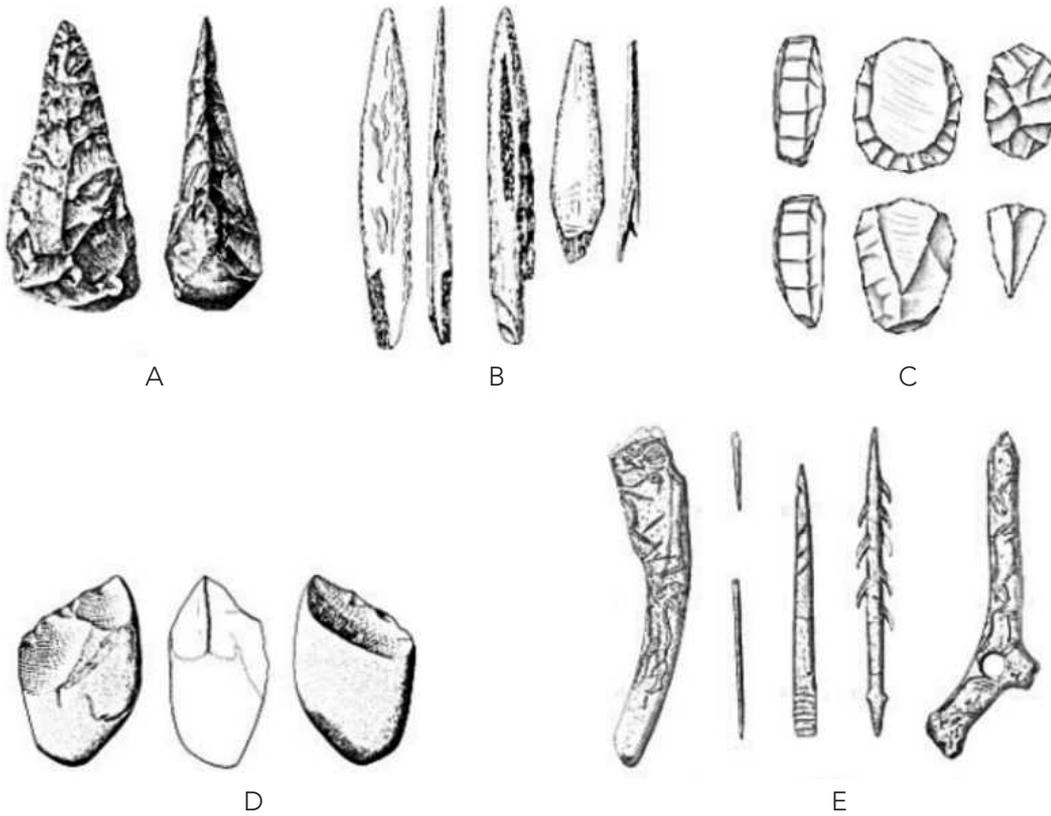
(d) Explain the relationship between change in cranial capacity and cognitive abilities. [2 marks]

Laetoli footprints (pictured below) are a set of fossil footprints found in volcanic ash in Tanzania which are 3.56 million years old and are believed to have been made by *Australopithecus afarensis*.



(e) State two pieces of evidence from this specimen that indicates this Hominin was bipedal. [2 marks]

5. Tools associated with different human ancestral groups.



(a) Complete the table below with reference to the tool kits shown above. [7 marks]

Tool Kit	Cultural Period	Hominin group associated with the tool kit	Complexity and manufacture of the tools
A			
C	Mousterian culture		
D			larger, crude working of cores with some parts of the cores remain unworked to produce simple tools of little variation

(b) Tool kits B and E were made by *Homo sapiens*. Explain how they differ in manufacture and use from the other tool kits. [4 marks]



ANSWERS TO REVIEW QUESTIONS

1: SCIENCE INQUIRY SKILLS 1

Review Questions

1.
 - (a) *Biology, chemistry, physics, mathematics, geology, biotechnology and many more.*
 - (b) *Palaeontology, archaeology, veterinary, medicine, child or aged care, sports coaching and support, counselling, teaching, parenting and many others.*
 - (c) *Developments in technology have made it possible to observe changes at microscopic levels and understand the chemical nature of humans during disease, reproduction and normal activity as well as how individuals can impact the next generation through genetics and behaviour.*
2.
 - (a) *Either (i) the diet of Pacific Islanders is a contributing factor, i.e. their diet has changed from a traditional one to a western diet/lifestyle (fast foods, alcohol, high GI food, low seafood, poor exercise levels, etc.), or (ii) it is genetic.*
 - (b) *Surveys or questionnaires, blood tests, medical records.*
 - (c) *If people of only one sex or age group were used, sample sizes were very small, collected from a limited population and time.*
 - (d) *Use of racially based groups, making racially biased conclusions, who is included in the study; use of medical records; consent.*
3.
 - (a) *Sample size, accuracy of the instruments/equipment used, misuse of equipment, poor or inappropriate method, whether all variables were controlled, use of repeats, sufficient data collected, validity of experiment, etc.*
 - (b) *Reliability or consistency of results would include points from (a) and personal perspectives of the researchers in the choices made.*
 - (c) *Validity – is this research measuring what it set out to measure? Or do other factors influence the outcomes? Maximising validity – interrogating the sources of information, the design of the research tools and methods, widen the sample selection and sample size, use appropriate statistical analysis of data.*
4.
 - (a) *People living in Goodteef have fewer tooth cavities than people in other towns.*
 - (b) *Dental records, Medicare or other health funds records, direct surveys of people, talking to dentists.*
 - (c) *The water in the spring has a high level of natural fluoride compared to the river water or collected rainwater.*
 - (d) *Measurement of mineral levels in the water supplies of all the towns in the survey would need to be compared for fluoride content. The spring water would need to have the highest level of fluoride.*
 - (e) *If the concentration of fluoride was the same or very similar in all water samples.*
 - (f) *Collect sufficient samples, test more than once, use reputable testing methods.*
5.
 - (a) *Aim, hypothesis, introduction/background information, method, recorded data, processed data as graphs or tables, discussion, conclusion, bibliography.*
 - (b) *Peer review*
6. *No, it only explains the current level of knowledge. A theory can be overturned by new evidence (leading to a new theory) or upgraded in the light of new evidence.*
7.
 - (a) *In a double blind test neither the test subjects nor the testers know who is in the control group and who is in the experimental group. It is conducted by an independent administrator. Subjects are randomly allocated to each group and the results are passed on after proper statistical analysis.*
 - (b) *Because the test subject is unaware of which treatment group they belong to, the “placebo effect” may be exposed and can be taken into account when the results are analysed. The idea behind a double-blind test is to reduce the possibility of bias being introduced into the results by the subjects, who, by knowing the details of the treatment, could respond to psychosomatic inputs, or by the unintentional influence of the tester through suggestive comments or undue interest in the subject’s welfare.*
 - (c) *Used to test the effect of new drugs or treatments in humans.*
 - (d) *That subjects are not harmed or denied the medical support they need.*
 - (e) *To help understand what effect a new drug or some other treatment might have on a particular condition rather than the impact of just taking a medication or being involved in the treatment.*

- (f) The 'placebo effect' is about positive thinking – believing a treatment or procedure will work so it does.
- (g) Efficacy refers to the ability of a product or treatment to provide a beneficial effect compared to a group that has not taken the treatment.

8.

- (a) Quantitative data can be counted, measured, and expressed using numbers. Qualitative data is descriptive and conceptual or can be categorized based on traits and characteristic.
- (b) Discrete data is information that can only take certain fixed values; Continuous data is data that can take any value on the scale. Discrete: shoe sizes, number of fingers, colours of cars. Continuous: birth lengths and weights, time to do a task.

9.

- (a) Table 1: heart rates of people before and after exercise

Person	Heart rate before exercise	Heart rate after exercise
A		
B		
C		
D		

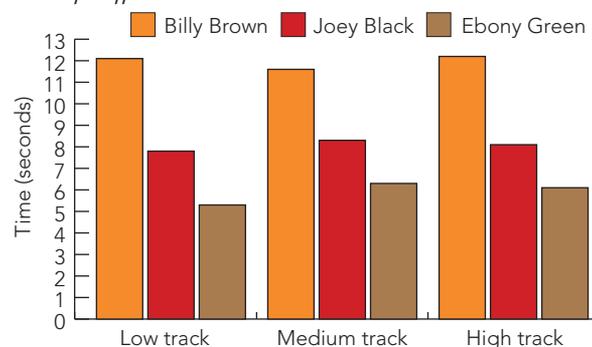
- (b) Time taken on different track levels by cars of different colours.

Car colour and Driver	Low track time (s)	Medium track time (s)	High track time (s)
Orange (Billy Brown)	12.1	7.8	5.3
Red (Joey Black)	11.6	8.3	6.3
Brown (Ebony Green)	12.2	8.1	6.1

- (c) Identifies of the IV and DV, indicates discrete or continuous data, indicates the scale required to include all data points, states the information for labels on X and Y axes, legend and titles.

10.

- (a) (i) Bar or column graph (ii) Line graph or histogram (iii) Pie charts are used to compare parts of the whole. It is divided into sectors that are equal in size to the quantity represented.
- (b) Time taken on different track levels by cars of different colours.



2: ENDOCRINE SYSTEM

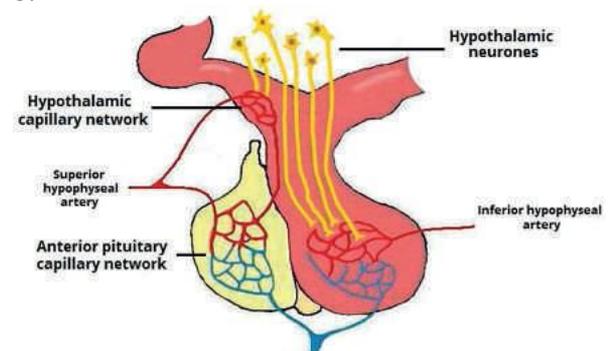
Review Questions

- Exocrine glands secrete their products through ducts to the location where they become active; endocrine glands secrete their hormones into the circulation system where it is taken to the target organs.
- Reproductive system
- Digestive system
- The secretions of the gland are taken by the circulation system to where they are active so don't need to be close to the target organ.
- A – pineal gland; B – hypothalamus; C – pituitary gland; D – thyroid; E – thymus; F – pancreas; G – adrenal glands; H – testes; I – ovaries; J – placenta.
 - Placenta during pregnancy; secretes progesterone, estrogen, chorionic gonadotrophin.
- Lipid-soluble hormone:** A lipophilic hormone that passes through the plasma membrane of a cell, binds to an intracellular receptor, and changes gene expression. **Water-soluble hormone:** A lipophobic hormone that binds to a receptor on, or within, the plasma membrane, to initiate an intracellular signalling cascade.

7.

Lipid-soluble hormones	Water-soluble hormones
Cortisol	Anti-diuretic hormone
Aldosterone	Oxytocin
Progesterone	Adrenalin
Testosterone	Thyroid stimulating hormone
Estrogens	Human growth hormone
Thyroxine	

8.



- Releasing factors are hormones that are produced in the hypothalamus and transported to the anterior pituitary via the hypophyseal portal system that stimulate or inhibit hormone production in the anterior pituitary.
- The cell bodies of the neuro-secretory cells are located in the hypothalamus, but their axons descend through the infundibulum and end in the posterior pituitary. The axons transport the hormones produced in the cell

bodies (in the hypothalamus) to the axon terminals in the posterior pituitary where they are stored until required.

11. The circulating hormones are broken down and excreted by the body. They are either destroyed by the liver or the actual tissues of the target organs. They are then removed by the kidneys. When the hormone binds to

its receptor, it causes a biological response within the cell. The cell does not require constant stimulation from the hormone.

12. The hormone's target cells have specific receptors for that hormone on the cell membrane or receptors in the cytoplasm or nucleus which will produce a response when the hormone is present.

13.

Endocrine gland	Hormone	Target organ	Function
Pituitary – anterior lobe	Growth Hormone	Most cells e.g. bone, muscle, liver, adipose, etc.	Stimulates general body growth and regulates aspects of metabolism such as protein synthesis and lipolysis.
	Follicle stimulating hormone	Ovaries and testes	Stimulates maturation of ova in follicles, secretion of oestrogen by ovaries and production of sperm in testes.
	Luteinising hormone	Ovaries and testes	Ovulation in females, formation of corpus luteum, and secretion of testosterone in males.
	Thyroid stimulating hormone	Thyroid gland	Stimulates the thyroid to produce and release thyroxine.
	Adrenocorticotrophic hormone	Adrenal cortex	Stimulates the adrenal cortex to secrete hormones, mainly cortisol.
– posterior lobe	Antidiuretic hormone. Produced by vasopressin in the hypothalamus, stored in pituitary	Kidney	Increases the permeability of the collecting duct so that water is reabsorbed back into blood from nephron and urine production decreases.
	Oxytocin produced by the hypothalamus, stored in pituitary	Breasts, uterus	Causes contraction of smooth muscles of the uterus during childbirth and release of milk from breasts.
Hypothalamus	Releasing and inhibiting factors	Anterior pituitary	Controls the release of various hormones from the anterior pituitary.
Pineal gland	Melatonin (released into the cerebrospinal fluid and then into the blood)	The part of the brain that operates as a biological clock (the suprachiasmatic nucleus, SCN).	Biological rhythms related to reproduction, skin pigmentation. Light/dark cycles.
Thyroid gland	Thyroxine	Most cells	Stimulates metabolism (BMR), protein synthesis, lipolysis (triglyceride breakdown), use of glucose for ATP production, increases cholesterol excretion in bile (which reduces blood cholesterol level) and increases body growth especially of nervous tissue.
	Calcitonin	Bones	Lowers the levels of calcium and phosphates in the blood by increasing uptake by the bones (inhibits the activity of the osteoclasts).
Thymus	Parathormone (parathyroid hormone)	Bone and kidney	Affects the number and activity of osteoclasts (bone-destroying cells) causing an increase in the amount of calcium and magnesium ions in the blood and a decrease of phosphate ions in the blood.
	Thymosin	Stimulates T cells	Development of the immune system.
Pancreas – (beta cells in the Islets of Langerhans)	Insulin (released if concentration of glucose is high)	Most cells	Decreases blood sugar level by increasing sugar uptake by cells, changes sugar (glucose) into glycogen (glycogenesis), increases protein synthesis, and lipogenesis, decreases glycogenolysis and gluconeogenesis.

Pancreas – (alpha cells in the islets of Langerhans)	Glucagon (released if concentration of glucose is low)	Liver	Increases blood sugar level, decreases sugar uptake by cells, changes glycogen into glucose (glycogenolysis), forms glucose from amino acids and lipids (gluconeogenesis), and increases the release of sugar into the blood.
Adrenal cortex	Aldosterone	Kidney tubules	Increases reabsorption of sodium ions in kidney and increases excretion of potassium and hydrogen ions in filtrate (raises pH of blood).
	Cortisol	Mainly muscle cells, blood vessels and cells involved in the inflammatory response.	Helps to regulate metabolism and increases resistance to stress.
Adrenal medulla	Adrenalin (epinephrine) and noradrenalin (norepinephrine)	Mainly heart, lungs, digestive system and muscle cells.	Fight or flight response, i.e. increases heart rate, blood pressure and respiration rate etc.
Ovaries	Oestrogen	Ovaries, breasts, uterus, bones, hair follicles.	Develop and maintain female sexual organs and secondary sexual characteristics, development of breasts.
	Progesterone	Uterus, breasts, bone	Prepares endometrium for pregnancy and breasts for lactation.
Testes	Testosterone	Testes, penis, hair follicles, skeleton, muscles.	Develop and maintain male sexual characteristics, sperm production.

14.

- (a) A negative feedback system is regulatory system where the response to a stimulus reduces the stimulus. They are important to maintaining a stable state in the internal environment of the body.
- (b) Tolerance limits are the bounds within which the factors of the internal operate optimally. The width of the limits depends on the specific environmental requirements of the function or process to operate at optimal efficiency.

15.

Stimulus → receptor → modulator → effector → response



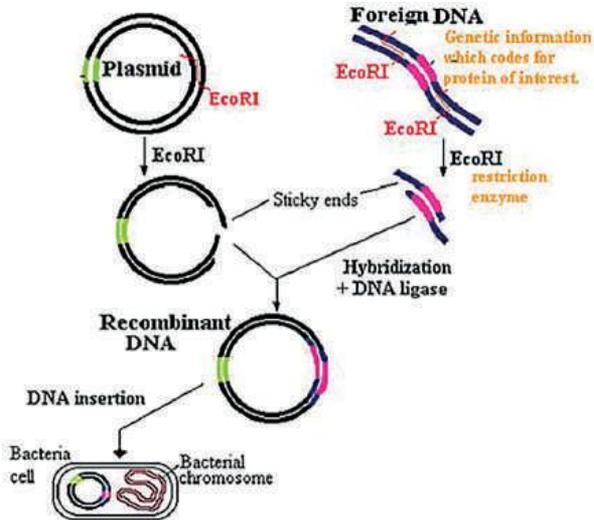
16. Beta cells of the pancreas in controlling blood glucose levels – receptor and modulator.
17. Hypothyroidism – tiredness, sensitive to cold, weight gain, constipation, slow movements and thoughts, muscles aches, weakness and cramps; hyperthyroidism – hyperactivity, nervousness and anxiety, difficulty sleeping, sensitive to heat, diarrhoea, weight loss.
18. Thyroid hormone, thyroxine, regulates body temperature by controlling basal metabolic rate by stimulating the breakdown of glucose (cellular respiration) and fatty acids to release heat.
19. Thyroxine chemical structure contains iodine. Low iodine levels in the diet causes the reduced production of thyroxine.
20. The use of manufactured hormones administered as tablets or injections that raise the levels of thyroxine to normal levels in the body. The manufacture of the

hormone can be from other animals or through biotechnological techniques.

21. Gene therapy involves the following steps: identification of the gene responsible for the production of the hormone; removal of the gene from the donor nucleus; duplication of the gene in vitro; insertion of the gene into a plasmid for carrying to recipient cells; insertion of the gene into the human genome of the recipient's cells.
- 22.
- (a) All DNA is made up of the same four nucleotides in all organisms with no differentiation due to the source of the nucleotides, so sequences of nucleotides (genes) can be transferred between organisms and species.
- (b) A vector is any factor, often a virus or a bacterial plasmid that is used to transport the desired DNA sequence into a host cell as part of a recombinant procedure.
- (c) The plasmids are the vectors or carriers of the identified DNA sequence between cells.
- (d) DNA restriction enzymes are used to cut DNA at specific location depending on the nucleotide sequence. If the same enzyme is used then it will cut at the same sequence location in the donor DNA and produce ends that can be joined easily.
- (e) Sticky ends are where the DNA is cut asymmetrically leaving one strand longer than the other. Blunt ends are when the DNA is cut straight across the two strands. It is easy to chemically bind sticky ends as the overhanging section provides a greater surface for bonding when two fragments interact.

(f) Insulin for human use can be derived from cows, horses or pigs. According the clinical studies there is very little if an difference between the efficacy of insulin from different sources. Other reasons for choosing insulin from DNA recombinant technologies are factors. eg. cost, availability, ethical treatment of animals, religious beliefs.

(g)



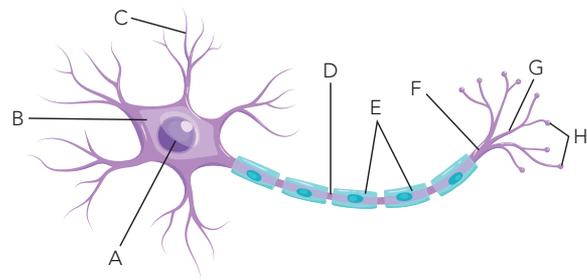
1. Remove the plasmid from bacterial source.
2. Cut the plasmid with a selected restriction enzyme.
3. Cut the DNA from the donor cell using the same restriction enzyme.
4. Combine the cut plasmids and donor DNA (gene) in the present of DNA ligase (enzyme for joining DNA strands).
5. Insert the plasmid with the new piece of DNA into bacterial cells.
6. Clone the bacteria in cultures.
7. The added genes will be expressed by the bacteria, producing the required hormone.

3: CENTRAL AND PERIPHERAL NERVOUS SYSTEM

Review Questions

1. Neuron
2. Cell body, axons, dendrites
3.
 - (a) Unipolar – are sensory neurons connecting receptors to the central nervous system.
 - (b) Bipolar – relatively rare and are sensory neurons associated with the ear, eye and nose.
 - (c) Pseudounipolar – All are sensory neurons. The ones found in the dorsal root ganglia, and majority of those in cranial nerve sensory ganglia carry information about touch, vibration, proprioception, pain and temperature.
 - (d) Multipolar – central nervous system (all motor neurons are multipolar).

4.



A nucleus, B nerve cell body, C dendrite, D node of Ranvier, E Schwann cell, F axon, G terminal branches, H axon terminal

5. Nerve cell body – contains the nucleus and other major organelles which determine the activities of the rest of the cell.

Axon – transmits nerve impulses in one direction only, away from the nerve cell body.

Dendrites – are extensions of the nerve cell body that receive impulses from other cells and direct them into the nerve cell body.

Myelin sheath – fatty outer covering of the axon. It insulates the axon and forces the impulse to jump from one node of Ranvier to the next. This results in fast transmission of impulses.

Schwann cell – produces the myelin sheath around axons.

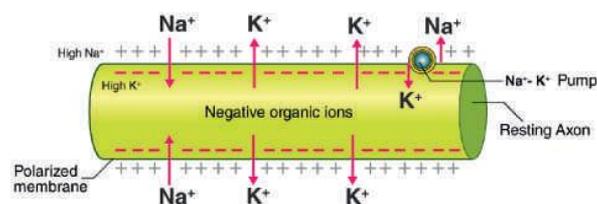
Nodes of Ranvier – the gaps in the myelin sheath that speed up nerve impulses because the nerve impulse ‘leaps’ from one node to the next.

Axon terminal – specialised to release neurotransmitter into the synapse or neuromuscular junction.

6.
 - (a) (i) Motor neurons; (ii) Sensory neurons; (iii) Interneurons; (iv) Afferent (towards the CNS); (v) Efferent (away from the CNS).
 - (b) An inter- (or association, or connector) neuron is found within the central nervous system. It carries nerve impulses from one neuron to another. Damage to interneuron areas would mean the information flow through the neural networks would not occur. Death will be the eventual result.

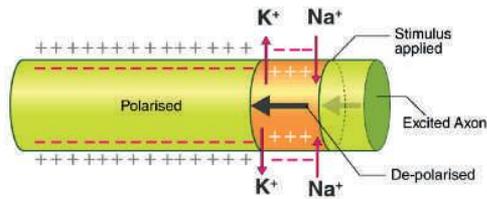
7.

- (a) Sodium (Na) and potassium (K) Na is higher on the outside, K is higher on the inside.



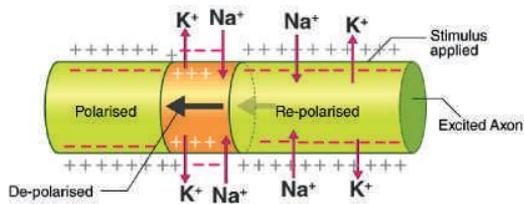
Na tend to move into the cell, K tend to move out of the cell due to the diffusion gradient across the membrane.

- (b) Na moves into the cell; K moves out of the cell.



Na and K movement with stimulus (depolarisation)

- (c) Active transport (Na/K pump) returns the ions to their resting state locations. Na is pumped out; K is pumped in. Due to concentrations differences, these ions tend to move in the opposite direction so the Na/K pump is always active to maintain the resting potential.



Na and K movement after the impulse has moved on (re-polarisation).

- (d) 1: Resting potential Na/K pump actively maintains the concentration differences of Na and K across the membrane. This creates a negative electrical difference across the membrane.

2: The stimulus opens the Na ion channels allowing the influx of Na ions across the membrane which causes the electrical potential to become positive. The Na ion channels close at the peak.

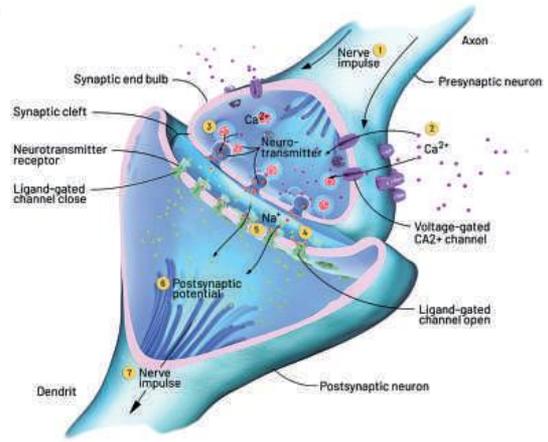
3: At the peak, the K ion channels open allowing the K ions to flow out causing the electrical potential to drop and become negative. The K ion channels close at about -80mV causing hyperpolarisation.

4: The Na/K pump causes the movement of the ions to then return the membrane to the resting potential.

- (e) If the stimulus is not strong enough to open enough Na channels, the depolarisation doesn't reach the level to the threshold, so no action potential is produced i.e. no nerve impulse is generated.

8.

- (a) A synapse is the gap between two neurons across which impulses pass by diffusion of neurotransmitters. A neuro-muscular junction is a synaptic connection between the terminal end of a motor nerve and a muscle – a specific type of synapse.



1. Nerve impulse/action potential arrives at the axon terminal.
2. Calcium ion channels open and Ca ions signal vesicles.

3. Vesicles move to the membrane to release neurotransmitters into the synapse.

4. Neurotransmitters diffuse across the synapse to the receptors on the membrane of the adjoining dendrite.

5. Na channels open causing the depolarisation of the dendrite.

6. An action potential is generated.

7. the nerve impulse travels along the dendrite.

- (c) Acetylcholine (somatic NS), noradrenaline (sympathetic NS), dopamine, serotonin and glutamate (brain).

- (d) Heroin and prescription opioids chemically resemble the brain's endorphins and stimulate specialised receptors. Marijuana mimics cannabinoid neurotransmitters. Nicotine attaches to acetylcholine receptors in the somatic nervous system. Cocaine attaches to the dopamine transporter molecule stopping the uptake of dopamine from the synapse. It builds up in the synapse, stimulating receiving-neuron receptors more copiously and producing much greater dopamine impact on the receiving neurons. Some drugs alter neurotransmission by enhancing neuron responses e.g. diazepam.

9. (a)

Part	Name	Function
A	dorsal root ganglion	contain cell bodies for sensory nerves that carry sensory information to the spinal cord
B	spinal nerve	carry motor, sensory, and autonomic information between the brain and spinal cord and the rest of the body.
C	ventral root	contains motor neurons that carry information from the CNS to the rest of the body
D	grey matter	contains neuron cell bodies and processes information from the sensory organs and areas
E	white matter	contains myelinated axons and connects the brain with the body's receptors and effectors

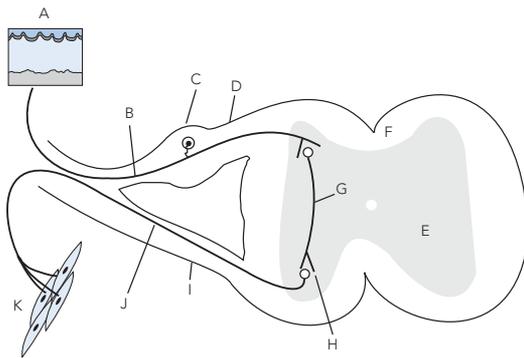
F	motor neurons	transmit impulses from the spinal cord to skeletal and smooth muscles and so directly control all muscle movement of the body
G	sensory neurons cell bodies	cell bodies of sensory neurons that transport information from receptors to the central nervous system

(b) Neuron cell bodies.

(c) Interneurons.

10. Voluntary actions require the involvement of the brain in conscious thought about the action. Reflex actions do not involve conscious thought. They are spontaneous and involuntary nerve-mediated actions.

11.



A: receptor – detects stimulus.

B: sensory (afferent) neuron – carries impulses to the Central Nervous System (CNS).

C: dorsal root ganglion – cell bodies of sensory neurons.

D: dorsal root – carries axons of sensory nerves into CNS.

E: grey matter – part of the brain and spinal cord made up of unmyelinated fibres and nerve cell bodies.

F: white matter – myelinated fibres.

G: interneuron – joins sensory neuron to motor neuron.

H: synapse – gap between two neurons.

I: ventral root – carries axons of motor neurons away from spinal cord.

J: motor (efferent) neuron – carries impulse to an effector.

K: neuro-muscular junction – the junction between the end of a motor nerve and a muscle fibre.

12. A voluntary action neural pathway would include connections to and from the brain via the spinal cord. A reflex action goes through the spinal cord via the interneurons. Information about the action will be sent to the brain after the action has happened.

13. The reflexes of newborns are tested to determine if the brain and nervous system are working well.

Reflex	Description
Moro	the test lets the baby's head drop backwards slightly, and then catches the head before it hits the pillow or mat behind it. If a baby's Moro reflex is present, the baby should appear startled and lift its palms upward, with its thumbs out. When the baby is caught, the baby will bring its arms back to its body.
Palmar grasp	should grasp the finger and may even maintain a firm grip on the finger when a finger is placed in the palm of the baby's hand
Babinski	stroking the underside of the baby's foot, from the top of the sole toward the heel. The baby's toes will fan out and the big toe will move upward
Rooting reflex	a baby's cheek is stroked, the baby will turn toward the cheek that was stroked and will make a sucking motion
Sucking reflex	When the roof of the baby's mouth is touched, the baby will start to suck
Tonic neck reflex	when the baby is lying down and the head is turned gently to the side it causes the baby, if the head is turned to the left, to flex the right arm and the left arm reaches straight away from the body with the hand slightly opened.
Step	holding the baby upright and gently touching the baby's feet to a surface. The baby will appear to step or dance

14. Adult reflexes

Reflex	Why they are useful
Stretch reflex	a muscle contraction in response to stretching within the muscle to maintain a muscle at a constant length
Withdrawal reflex	spinal reflex intended to protect the body from damaging stimuli eg. Taking your hand away from contact with a hot object
Pupil contraction with flash of light	closes the pupil so the light doesn't damage the retina
Blinking	elicited by an external stimulus such as a loud noise or flash of light or a tap on the forehead to protect the eye
Sneezing	occurs in response to irritants in the nose – clears the irritants which may cause adverse effects
Coughing	a rapid expulsion of air from the lungs after sudden opening of the glottis, and usually following irritation of the trachea helps clear the irritation

And many others.

15. Conditioned reflex is an automatic action to a selected, unrelated stimulus established by training. A conditioned reflex is learned and can differ between people ie. the same stimulus can produce a different response. Innate reflexes are the same for all and don't have to be learned.

16. The nervous system detects changes in our external and internal environments and responds appropriately to these changes.

It plays a major role in maintaining homeostasis as well as providing memory, rational thought, maintaining posture and coordinating conscious and unconscious (by smooth muscle) movement.

17. A: cerebrum (cerebral cortex), B: corpus callosum C: cerebellum, D: spinal cord, E: medulla oblongata, F: pons, G: pituitary gland, H: hypothalamus.

18.

Structure	Function
cerebral cortex (cerebrum)	receives all sensory information and enables perception of various sensations such as smell, touch, taste, sight and hearing, stores memories, enables abstract thought (planning and creativity), generates speech, sends out motor impulses to muscles and glands
cerebellum	controls balance, coordination and fine muscle control (e.g., walking and skilled movements). It also functions to maintain posture
medulla oblongata	controls breathing and heart rate via respiratory and cardiac centres, also controls swallowing, vomiting, coughing, sneezing, hiccupping, relays motor and sensory impulses between cerebral cortex and spinal cord, origin of some cranial nerves
corpus callosum	a bundle of nerve fibres (white matter) that connects the left and right hemispheres of the cerebrum
spinal cord	relays motor impulses from the brain to the rest of the body and relays sensory impulses from the rest of the body to the brain

19.

Meninges layer	Structure	Function
Dura mater	strong, thick dense fibrous tissue	protection against penetration of the brain; fibrous content to the cranium
Arachnoid layer	thin transparent membrane with filaments attaching it to the pia mater; subarachnoid space contains cerebrospinal fluid	provides some shock absorption during severe head movements
Pia mater	thin membrane made of fibrous tissue thought to be impermeable to fluids; contains blood vessels	separate the nervous tissue from the blood vessels forming the blood-brain barrier

20. Skull – hard outer casing, cerebro-spinal fluid – shock absorbing cushioning of the brain and spinal cord.

21.

- (a) Grey matter consists of nerve cell bodies; white matter consists of myelinated nerve fibres.
 (b) Brain – grey matter is in the cerebral cortex – outer layer of the brain; white matter internal spinal cord – white matter is the external layer; grey matter internal core.

22.

- (a) Cerebrum, cerebellum, thalamus, midbrain, brain stem and lower motor neurons in the spinal cord.
 (b) Cerebellum and brain stem.

23. (a)

Colour	Part	Function
Yellow	frontal lobe	concerned with emotions, reasoning, planning movement, speech as well as creativity, judgement and problem solving
Blue	parietal lobe	connected with processing impulses associated with the senses such as touch, pain, taste, pressure and temperature
Red	temporal lobe	responsible for hearing, memory, meaning and language
Green	occipital lobe	involved in the brain's ability to recognise objects; responsible for vision
Brown	cerebellum	controls movement, balance and co-ordination
Orange	brain stem	maintaining body functions and level of consciousness

(b) Central sulcus

- (c) To the front of the central sulcus is the primary motor area; on the rear is the primary sensory area.

24.

- (a) Decline of short term memory, judgement worsens, emotional outburst, language impairment, wandering behaviour, lose the ability to recognise people and to control bodily functions, memory becomes non-existent.
 (b) Cell replacement therapy: Stem cell treatment for Alzheimer's Disease aims to replace the damaged cells with healthy stem cells which can grow on their own, hence, creating new healthy brain cells. Stem cells have therapeutic effects using regeneration and substitution of cells and tissues themselves. The therapeutic strategy of stem cells has two directions. One is to induce the activation of endogenous stem cell, and the other is to regenerate the injured cell or tissues through stem cell transplantation.

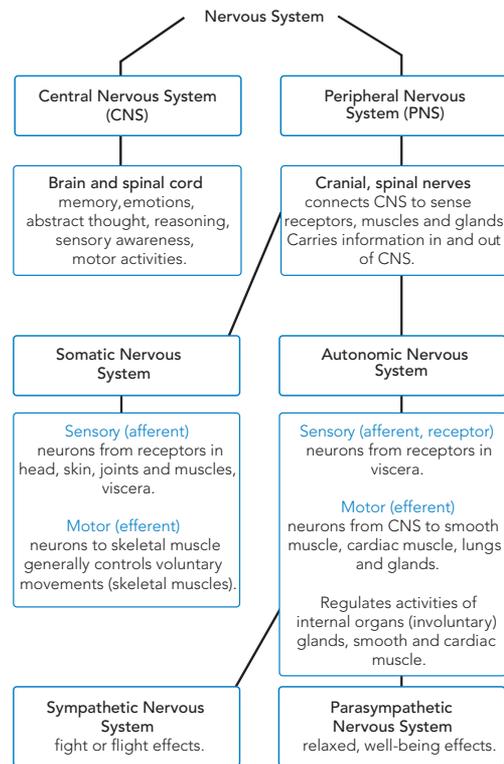
25.

- (a) Dopamine is a neurotransmitter responsible for relaying messages that plan and control body movement for co-ordination between brain and movements.
 (b) Gene therapy acts to prevent the death of dopamine-producing cells in the brain and help to revitalise dying cells in the early stages of the disease by inserting the dopamine gene via a vector in to certain brain cells. This allows these cells to produce dopamine to the required levels.
 (c) There may be side effects within the central nervous system that relate to long-term, high levels of exposure to therapeutic genes, or there may be an immune response to the

treatment which involved using viruses as vectors. Uncontrolled stem cells can cause cancers.

26. Stem cells are cells that have the ability or potential to differentiate into any of the cells that are found in a multicellular organism.
27. Two sources are:
- Embryonic cells taken from the blastocyst's inner cell mass which would normally form the tissues and organs of an individual.
 - Adult stem cells which occur in smaller numbers mainly in the bone marrow, blood and fat (adipose tissue), though they can be found elsewhere. These types of cells can also be obtained from the umbilical cord blood.
- 28.
- All stem cells are initially unspecialised.
 - They differentiate to become specialised cells.
- 29.
- A cell-based therapy is one in which stem cells are used to produce cells and tissues to replace those that are damaged in some way and need to be repaired or replaced. Also called tissue engineering.
 - Replacement of bone marrow cells for those patients who have had their bone marrow destroyed by chemotherapy; replacement of damaged cells due to heart attacks or spinal injuries; perhaps even in Alzheimer's, Parkinson's, Type 1 diabetes, strokes, burns or rheumatoid arthritis
- 30.
- Stem cells from an individual are used so there would be no problems with rejection. They have the potential to become any cell in the body so could replace, for example, damaged neurons or pancreatic cells. They could also be used to test a new drug on specific cells (such as cancer cells) before the drug was introduced into someone. Personalised medical treatment.
 - Concerns over their use are related to the source of the embryonic cells – to obtain them requires the death of the embryo, costs and chance of cancer.
31. The neurons and ganglia that lie outside the brain and spinal cord.
32. Cranial nerves are the nerves that emerge directly from the brain (including the brainstem). Spinal nerves emerge from the spinal cord between the vertebrae. Cranial nerves relay information between the brain and parts of the body, primarily to and from regions of the head and neck. Spinal nerves take nerve impulses to and from the central nervous system and the rest of the body.
33. Afferent; efferent
34. Somatic and autonomic
35. Sympathetic and parasympathetic

36.



37. Autonomic nervous system – part of the nervous system that is 'automatic'. The parts of the body that it controls are not under conscious thought, e.g. heart beat, contraction of smooth muscle, in blood vessels and digestive system.

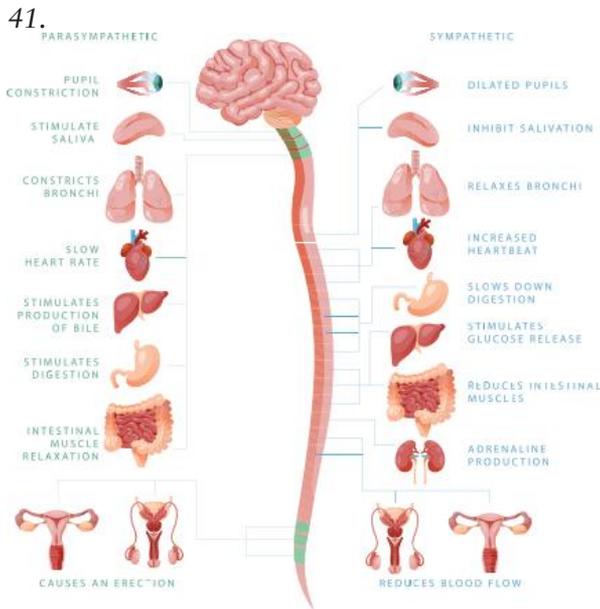
38.

- Nerve cell body
- Myelinated axon of neuron
- Acetylcholine in synapse in autonomic ganglion
- Post-ganglionic neuron
- Neurotransmitter (acetyl choline or noradrenalin)
- Effector – gland or muscle

39. Ganglion – an aggregation of nerve cell bodies occurring outside the central nervous system. Purpose: They function as a relay station where neurons form synapses.

40.

Sympathetic	Parasympathetic
Prepares body for action.	Prepares body for rest.
Neurons leave from the central area of the spinal cord (thoracic and lumbar areas).	Neurons leave from the lower end of the brain (midbrain and medulla) and the lower part of spinal cord (sacrum).
Ganglia are close to the CNS	Ganglia are close to effectors.
Releases noradrenalin or adrenalin at effectors.	Releases acetylcholine at effectors.



42.

	Somatic nervous system	Autonomic nervous system
Control	Voluntary	Involuntary
Innervates	Skeletal muscle	Smooth, cardiac muscle and some glands
Type of neurons	Motor	Motor
Number of neurons per path	One	Two (linked by ganglion outside the CNS)
Effect	Stimulates muscles	Stimulates or inhibits effectors (muscles and glands)
Neuro-transmitters	Acetylcholine	Acetylcholine and noradrenalin (norepinephrine)

43. Comparing nervous and hormonal actions and effects

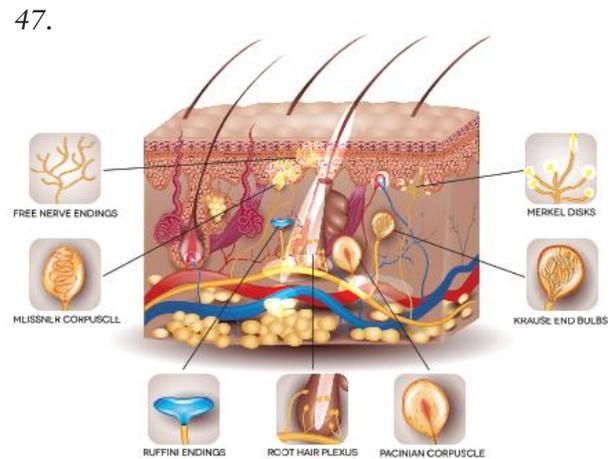
Action/Effect	Nerves	Hormones
type of message	electrochemical impulse	chemical
speed of action	fast response	slow response
duration of effects	immediate, short lasting effects	prolonged effects
transmission of information	via neurons	via the blood in circulation system
specificity of message	very specific target due to location of neurons; neurotransmitters have a general effect on any cell	has specific target cells due to specific receptors; can effect many tissues at the same time

44. To monitor changes in the internal or external environment of the body.

45. Receptors can be classified by the type of stimulus that generates a response: chemical (chemoreceptors), temperature (thermoreceptors), pressure (mechanoreceptors), light (photoreceptors), concentration of body fluids (osmoreceptors), sense of position (proprioceptors) Touch, taste, smell, sight, hearing, balance, movement, pressure, pain, temperature (warmth or cold) – these are receptors that detect changes in our external environment. The body has many different receptors to detect changes within the internal environment.

46.

Stimulus	Receptor
touch	free nerve ending
taste	chemoreceptor
stretch in a limb	proprioceptor
heat	thermoreceptor
pH of the blood	chemoreceptor
sound	mechanoreceptor
blood salt concentration	osmoreceptor



	Name	Function
1	Free nerve endings	sense pain, heat and cold
2	Meissner corpuscle	detects light touch and vibrations
3	Ruffini endings	detects pressure changes; detect skin stretch, and warmth
4	Root hair plexus	touch, hair movement above skin
5	Pacian corpuscle	senses deep pressure
6	Krause end bulbs	senses touch; detect cold
7	Merkel disks	respond to light pinpoint touch; found mostly in finger tips, tips and soles of feet

48.

Feature	Location of receptor
1. body temperature	free nerve endings in skin, liver, skeletal muscles and hypothalamus
2. Carbon dioxide level in the blood	respiratory centre (medulla) – detects changes in pH aortic body – detects changes in carbon dioxide but not pH carotid body – detects changes in Carbon dioxide and pH
3. Glucose levels in the blood	beta cells on the islets of Langerhans in the pancreas
4. Salt concentration in the blood	hypothalamus

4: HOMEOSTASIS

Review Questions

- Nervous system, endocrine system.
 - Nervous system is based on electrochemical signals and is fast acting; the endocrine systems is based on chemical signals and is usually slow and long lasting in effects.
- Homeostasis maintains a stable internal environment in a changing external environment. Homeostasis maintains the internal environment at optimal conditions for the efficient metabolism.
- Stable internal conditions provide optimal conditions for the enzymes that control the chemical reactions of metabolism to supply energy at the rate required to maintain body functions.
- Temperature, water level, pH, blood sugar levels, oxygen levels, ion concentrations.
- Tolerance limits define the range in which the body function or activity can operate at optimal rates. If the tolerance limits are exceeded the function or activity will not at the optimal rates. So may not provide requirements of the levels needed to sustain body functions.
- Stimulus – the change in the environment that alerts the system and initiates it to take action.

Receptor – detects the change in the internal or external environment, e.g. taste bud, osmoreceptor.

Regulator or modulator – is the control mechanism, it processes information from the receptor and directs the effector's action. Effector – is a structure which carries out an action counteracting the effect of the stimulus, e.g. muscle, endocrine gland.

Response – what the effector does, e.g. a muscle contracts, or a gland secretes more hormone.

Feedback – modifies the original stimulus in order to achieve a steady state.

7.

- Metabolic rate – amount of kilojoules of energy expended to maintain the body functions. This will change according to the amount of activity of the body. It is measured by oxygen consumption and carbon dioxide production used as an indirect measure of metabolic rate. This works because oxygen is used to break down food during cellular respiration, whilst water, carbon dioxide and energy are produced. Oxygen is not used in any other reaction in the body. The fuel used in the body has known kilojoule content and the amount of oxygen used can be measured to calculate the amount of energy released from that food.
 - Exercise, hormones, body temperature, age, ingestion of food, sex, stress, climate, sleep, malnutrition, illness (fever) can impact metabolic rate.
 - An increase in the metabolic rate causes an increase in the rate at which food is oxidised in the cells. This releases more heat energy and hence body temperature rises.
8. Hypothalamus

Thermoregulation

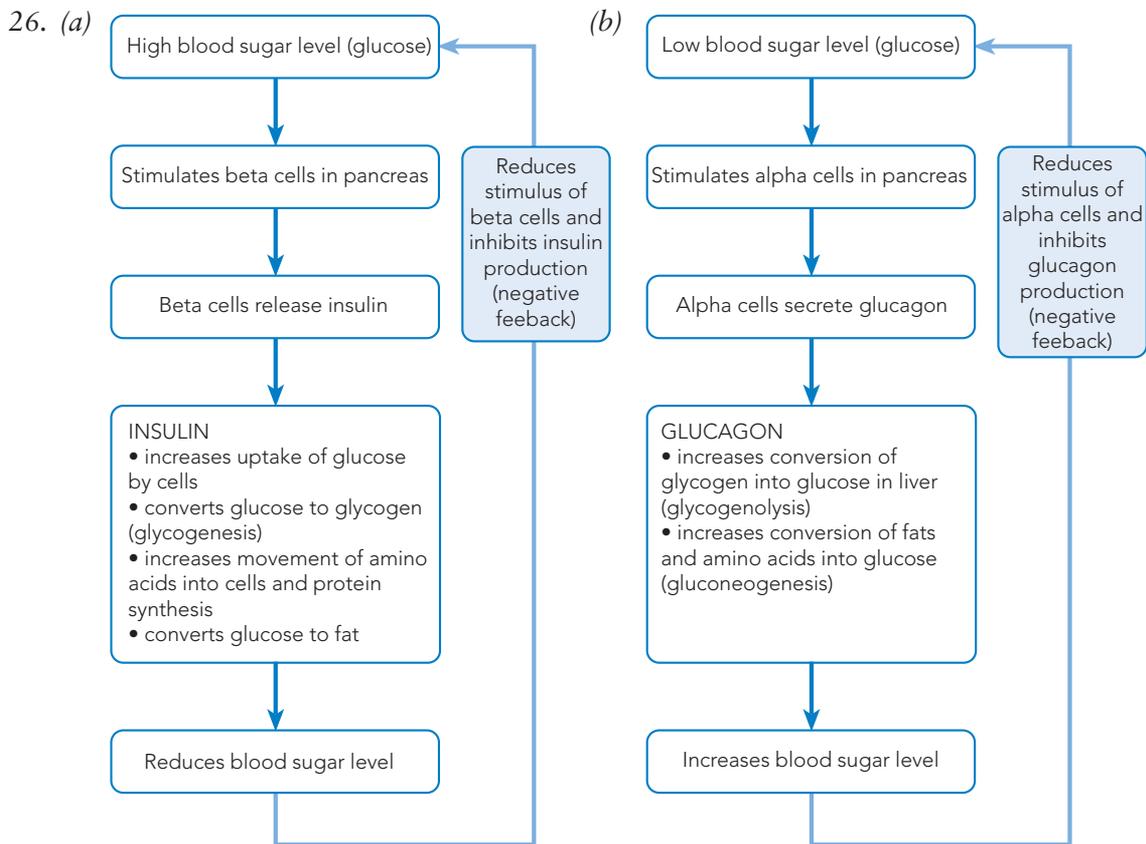
- Core body temperature is the temperature of the body's internal organs.
- 36.8–37°C
- Between 36.5 and 38.5°C: below 33.5°C (hypothermia) or above 41.5°C (hyperthermia) the body experiences a rapid decline in normal function causing severe damage to cells and ultimately resulting in death.
- Core temperature is usually 1–2 degrees higher than the temperature at the extremities but can vary widely according to the external temperature. Think about your hands and feet on a cold morning.
- The extremities can tolerate wider tolerance limits because, compared to body core, there are limited essential functions occurring there.
- (a)

Mechanisms to produce or retain heat	Mechanisms to lose heat
Shivering.	Sweating.
Vasoconstriction of blood vessels in skin.	Vasodilation of blood vessels in skin.
Increased metabolic reactions.	Behavioural, e.g. swimming, sitting in breeze.
Behavioural, e.g. wear more clothes, eat hot food.	Increase body SA:vol
Decrease body SA:vol	

- Behaviour can change the surface area to volume ratio of the body to the external environment to either increase or decrease

the rate of heat exchange eg. Rolling in a ball when it is cold or standing with the arms out when it is hot. Changing the environment – seeking shade instead of full sun when it is hot, standing next to a fire when it is cold – reducing the temperature difference between the body and the surroundings. Increasing or decreasing activity which is heat producing.

15.
 - (a) Sweating cools the body when the water evaporates from our skin. For water to evaporate heat is needed to change the water from a liquid to a gas. This heat is obtained from our skin and the body temperature drops.
 - (b) On humid days, the amount of water vapour already in the air is high. Therefore, water will not evaporate readily. Under these conditions you do not cool down efficiently and can feel quite uncomfortable. When conditions are dry, however, evaporation occurs rapidly, thus cooling the body quickly.
 16. Direct body contact with a warm surface (hand on heater and around warm coffee cup) increases conductive heat gain; insulating the body surface to reduce heat loss (hair, fleece coat with hood, fleece boots); reduced surface area to volume ratio by squatting reduces body surface where heat loss can occur; located very close to a heat source to decrease the temperature difference between the body and the external environment.
 17. Vasodilation – blood vessels in skin (arterioles) expand because smooth muscles relax and blood flow through them is increased – skin goes red. Vasoconstriction – blood vessels in skin (arterioles) reduce in size because smooth muscles contract (diameter decreases) and blood flow through them is reduced. Skin turns pale. Vasodilation when the body needs to lose heat; vasoconstriction when the body needs to retain heat.
 18. Shivering is the very rapid contraction and relaxation of skeletal muscles. It is initiated by the hypothalamus. These contractions are not used in moving parts of the body so the heat generated by the metabolic reactions involved contributes to the internal heat of the body.
 19. Piloerection is caused by a contraction of muscles that are attached to each hair. In animals with a thick hair coat this rising of hair expands the layer of air that serves as insulation. The thicker the hair layer, the more heat is retained. In people this reaction is useless because we do not have a hair coat.
- ## Control of Blood Sugar Levels
20. Diet, exercise, level of insulin, side effects of medication, stress, illness
 21.
 - (a) Insulin promotes the uptake of glucose into cells, stimulates formation of glycogen from glucose, converts glucose into fat, increases protein synthesis. (Insulin – glucose into cell)
 - (b) Glucagon – stimulates breakdown of glycogen to glucose, stimulates gluconeogenesis. (Glucagon – glucose has gone and more needs to be produced or released)
 22. The liver stores glycogen and converts it to glucose when required; pancreas produces insulin (from the beta cells in the islets of Langerhans), also produces glucagon (from the alpha cells in the islets of Langerhans); muscles – because of its mass, muscle contains almost four times as much glycogen as the liver. Muscle glycogen is not directly available as a source of blood glucose because muscle lacks glucose-6-phosphatase (enzyme to break down glucose). During muscular activity, glycogen is converted to lactate and then into blood glucose in the liver.
 23.
 - (a) Glycogenesis – formation of glycogen from glucose. (genesis – making)
 - (b) Glycogenolysis – the breakdown of glycogen into glucose (occurs in the liver). (lysis – breakdown)
 - (c) Gluconeogenesis – the synthesis of glucose from lipids and amino acids (occurs in the liver). (neo – new; genesis – making)
 24. Carbohydrates, fats – when glycogen levels are low, fats are metabolised to glucose; when fats are used, then the body metabolises proteins to produce glucose.
 25.
 - (a) Low
 - (b) High (because stored glycogen is released over the night).



27. and 28. Differences between Diabetes Types 1 and 2

	Type 1 diabetes	Type 2 diabetes
Why	the body is no longer able to produce insulin	the body still makes insulin but not sufficient or efficiently enough
Age of onset	usually develops during childhood, but can develop at any age	can develop at any age but most commonly in adults over 45
Risk factor	family history/genetic inheritance	overweight and/or inactive, family history, high blood pressure
Symptoms	blurry vision, frequent urination, increased appetite and thirst, mood changes, unexplained weight loss	increased appetite and thirst, dark patches on armpits or neck, frequent urination, blurry vision, unexplained weight loss
Prevention	none known	healthy lifestyle
Treatment	insulin injections	healthy living, insulin support

29. *Diabetes mellitus* – insulin deficiency; *Diabetes insipidus* – decreased release of antidiuretic hormone or decreased response to ADH.

30.

(a) Hypoglycaemia – when blood glucose levels are lower than normal caused by too much medication, eating less than normal, skipping meals, intense exercise.

(b) Blurry vision, rapid heart rate, dizziness, shaking.

(c) Call 000 or their doctor. While you are waiting, get the person to drink a sweet juice drink, have a teaspoon of honey, eat 3–4 pieces of toffee or a teaspoon of sugar.

Osmoregulation

31.

(a) Plasma is the liquid portion of the blood and is found in blood vessels. Lymph is a

liquid found inside lymph vessels. It does not contain red blood cells or platelets and usually has a low protein concentration.

(b) Intracellular fluid is the fluid inside cells (about 50% of our body weight). Extracellular fluid is all the fluid found in the body outside cells, e.g. tissue fluid, plasma, lymph, cerebrospinal fluid, etc. (about 20% of our body weight).

32. Plasma, lymph and intercellular fluid (also called interstitial or tissue fluid).

33. Urine is the fluid that is produced by the kidneys. It contains unwanted or excess water and other substances such as urea, creatinine, uric acid, vitamins and inorganic ions such as sodium, chloride, potassium, sulfates, hydrogen, phosphates, ammonium, magnesium and calcium. It is approximately 96% H₂O, 2% urea and 2% salts.

34. Plasma contains all the substances listed above as well as proteins such as fibrinogen, antibodies, enzymes and hormones; nutrients, vitamins and gases.

35.

(a) The movement of water through a semi-permeable (differentially-permeable) membrane creates a pressure or force called the osmotic pressure. It is due to a difference in concentration of solute on either side of the membrane. The greater the difference in concentration across the membrane the greater the osmotic pressure.

(b) Drinking lots of dilute (not sugary drinks) liquid or the absence of antidiuretic hormone (ADH).

(c) Increased sweating due to exercise, loss of fluids due to bleeding, burns, diarrhoea, drinking sugary drinks.

36. Diuretics are substances that increase urine production and therefore water loss from the body, e.g. caffeine – inhibits the reabsorption of sodium ions; alcohol – inhibits the secretion of antidiuretic hormone.

37.

(a) An average around 180 L (125–130 mL/minute).

(b) 800–2000 mL/day – depending on factors such as amount of fluid intake and sweating.

(c) It is reabsorbed back into the body via the nephrons and collecting duct.

38.

(a) From the food we eat and also from the process of cellular respiration (metabolic water).

(b) The body needs to get rid of nitrogenous wastes as they are poisonous at high concentrations in the body fluids.

39. Urea is a nitrogenous waste formed in the liver. There the deamination of amino acids produces the highly toxic substance, ammonia. Carbon dioxide combines with it to form the much less poisonous substance, urea, which is a soluble organic salt of small molecular size easily transported in the blood and eliminated via the kidneys.

40.

(a) Increases osmotic pressure

(b) Hypothalamus

(c) Thirst

(d) Thirst reflex, increased secretion of antidiuretic hormone (ADH), and increased urge to drink.

41.

Metabolic waste	Excretory organ
carbon dioxide	lungs
water	kidneys, skin, lungs
nitrogenous wastes (urea, creatinine)	kidneys, skin
inorganic salts	kidneys, skin
heat	skin, lungs, kidneys

42. The kidneys regulate the composition and volume of blood. Wastes are removed in the form of urine. Wastes include excess water, nitrogenous substances from protein catabolism (such as urea), hydrogen ions, and inorganic ions (electrolytes) such as sodium, chloride and potassium and hormones.

43.

(a) a. Renal artery

b. Right kidney

c. Renal vein

d. Vena cava

e. Ureter

f. Bladder

g. Aorta

h. Left kidney

i. Adrenal gland

j. Urethra

k. Renal pyramid in medulla

l. Renal capsule

m. Renal pelvis/calyx

n. Renal cortex

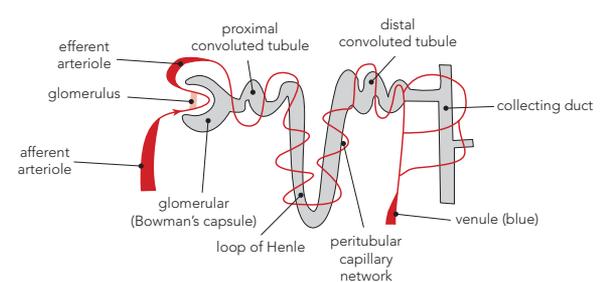
(b) Glucose

(c) Urea

(d) Urine

(e) Increase in volume, decrease in concentration.

44.



45. Blood vessel going into the glomerulus is an arteriole (red) Once the blood has been past the Loop of Henle it is carried in venules (blue).

46. Glomerular (Bowman's) capsule, proximal convoluted tubule, loop of Henle, distal convoluted tubule, collecting duct.

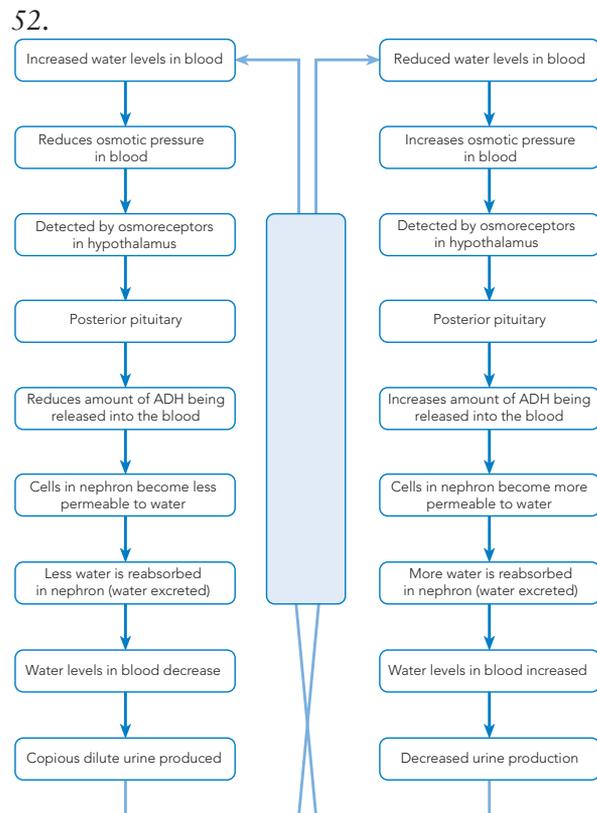
47. The glomerulus consists of many capillaries that have very permeable walls and provide a very large surface area for the high rate of filtration of materials.

- 48.
- Water, glucose, ions (salts), amino acids, urea, creatinine, uric acid, metabolites of medications, hormones and other breakdown products from the liver and some vitamins.
 - Blood cells and plasma proteins.
 - (i) The glomerular capillaries are very long providing a large surface area.
(ii) The membranes through which the substances pass are very thin and porous.
(iii) Blood pressure forcing filtrate into Bowman's capsule.

- 49.
- Selective reabsorption refers to the movement of substances by both active and passive processes from the filtrate (in the nephron) back into the blood.
 - Water, glucose, ions (sodium, potassium, chloride, bicarbonate) amino acids and a little urea.
 - Proximal convoluted tubule – reabsorbs glucose, amino acids, urea, ions (sodium, potassium, chloride, bicarbonate), water. Loop of Henle – water, sodium, potassium and chloride ions. Distal convoluted tubule – sodium, chloride, bicarbonate ions, glucose and water. Collecting duct – sodium ion under the influence of aldosterone, chloride ion and urea and water under the influence of antidiuretic hormone.

- 50.
- Tubular secretion refers to the movement of substances from the blood into the filtrate in the nephron, can be by active transport or passive diffusion.
 - Ions (such as hydrogen, potassium, and ammonium), creatinine, uric acid and some drugs such as penicillin.
 - Distal convoluted tubules.
 - Secretion removes unwanted substances from the blood, and helps to control blood pH.

51. Aldosterone – adrenal cortex; antidiuretic hormone (ADH) – posterior lobe pituitary.



- 53.
- Dialysis is a process of separating large particles from small particles by a differentially-permeable (semi-permeable) membrane.
 - In an artificial kidney machine, a tube made of a semi-permeable membrane, is connected to an artery on the patient (usually the radial artery in the arm). This tube is bathed in a special solution that is constantly replaced. The solution contains a carefully balanced mixture of substances such as glucose, amino acids and ions. This maintains a concentration gradient between the solution and the blood which causes waste materials to leave the blood. The blood minus the waste materials then flows back into the body via a vein. This form of dialysis is known as haemodialysis. More commonly used by patients at home is Continuous Abdominal Peritoneal Dialysis (CAPD). This involves a tube being connected into the abdomen, into the peritoneal space and the urea that has collected there, being flushed out of the abdominal cavity.
 - As the kidney is from another person, the body into which the kidney has been transplanted recognizes it as foreign. Then the immune system reacts as if it was pathogenic and tries to reject the transplanted kidney. (Infections are also possible at the site of dialysis either haemodialysis in the arm or CAPD in the abdomen). Patients with transplants have to take immunosuppressant drugs to prevent rejection of the kidney and this can then reduce their immune response to other

antigens making them more susceptible to other diseases. A combination of drugs is used to reduce the chances of rejection.

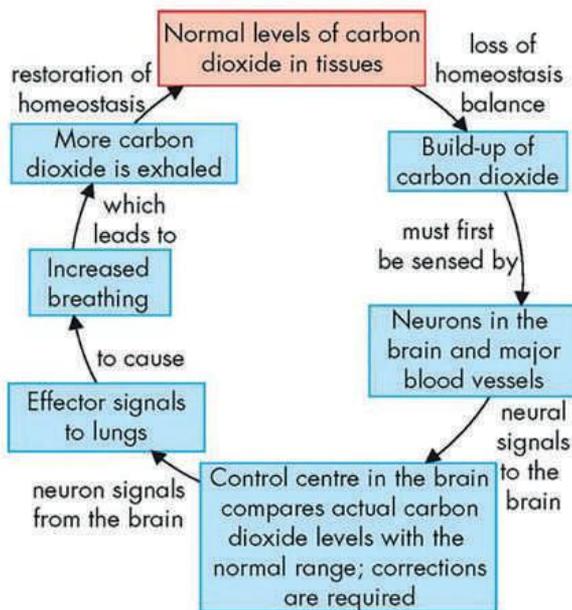
54. Over time, high sugar levels in the blood can cause the glomerulus capillaries to become narrow and clogged. Without enough blood passing through these, the kidneys become damaged and albumin (a type of protein) passes through these filters and ends up in the urine where it should not be.

Controlling Gas Concentrations

55. food + oxygen → carbon dioxide + water with heat released during the reaction
 $C_6H_{12}O_6(s) + 6 O_2(g) \rightarrow 6 CO_2(g) + 6 H_2O(l) + \text{heat}$
56. Alveoli in the lungs.
57. Concentration difference between one side and the other; the size of the area that gas molecules can diffuse through; the rate at which the diffused gas are removed.
58. pH – acid levels
- 59.

Receptor	Where found	Function
Aortic body	Aortic arch	Chemoreceptor – monitors the concentration of carbon dioxide and oxygen in the blood.
Carotid body	Carotid artery	Chemoreceptor – monitors the concentration of carbon dioxide and oxygen in the blood.
Respiratory centre	Medulla oblongata	Chemoreceptors for pH

60.



61. Hyperventilation reduces breathing rates. It reduces the level of carbon dioxide in the blood so takes longer for the levels to build up to be detected by the respiratory centre and other chemoreceptors that control breathing rate.

62.

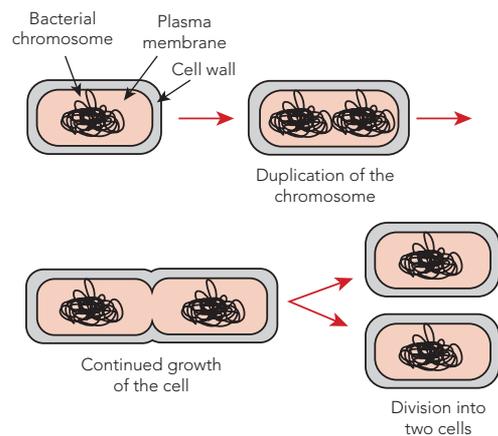
- (a) The number of alveoli decrease and their walls collapse producing fewer and bigger air sacs.
- (b) As there are less and larger alveoli, the total surface area through which gases could exchange is a lot smaller. As blood is moving more slowly through the lungs due to the collapse of lung tissue, less gas can be exchanged. With fibrosis, the elasticity of the lungs is affected and they do not expand as much as they used to, which also decreases gas flow into and out of the lungs.
- (c) Stop smoking, avoid air pollution.

5: RESPONSE TO INFECTION

Review Questions

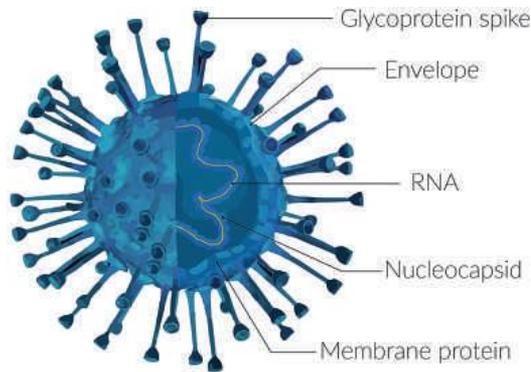
- Infectious diseases can be transmitted from one person another e.g. Covid 19, measles, AIDS; Non-infectious diseases are not transmissible eg. Haemophilia, cancer, hives.
- No. Only those that contain specific genes that mediate interactions with the host, eliciting particular responses from the host cells. Only a very small percentage of microorganisms are pathogenic.
- Pathogens include fungi (tinea), protozoa (malaria), and worms (elephantiasis).
- Cocci, bacilli, spirochaetes
- The colour (of the capsule), how they stain in different dyes, the conditions they need for growth.
- Moisture, food, and warmth, with or without oxygen and specific nutrients e.g. milk proteins.
- (a) Binary fission

(b)



- (c) About 5.0 hours, less than 9 hours, less than 10.5 hours.
8. Chlamydia, cholera, gonorrhoea, meningitis (bacterial), pneumonia, tetanus, tooth decay, tuberculosis, typhoid, syphilis, whooping cough

9.



- Can be cultured on artificial media and so are easily studied.
- Only reproduce in moist conditions by binary or simple fission. Some species of bacteria can form an endospore in adverse conditions. Endospores can survive extreme heat, a lack of moisture, exposure to radiation and many toxic chemicals.
- Protein coats differ in content and extensions (surface spikes).

10. No, as they do not carry out any of the processes of living things, i.e. do not move, respire, respond, grow, reproduce, excrete or feed and don't have the basic structure of cells that make up living things.

11. 1. Virus enters the cell releasing RNA;
2. Virus RNA invades the cell nucleus and takes over control of protein production;
3. Viral RNA uses the host cell to produce new RNA and assemble more virus particles;
4. New viral particles are released, sometime destroying the host cell in the process.

12. Specific host cells are ones that a virus must occupy and use to replicate. The molecular basis for this specificity is due to particular viral receptors on the host cell surface. A specific viral receptor is required for the virus to attach and enter the cell.

13. A bacteriophage is a virus that infects and replicates within bacteria, usually destroying the host bacterial cell.

14. Covid 19, smallpox, the common cold and different types of flu, measles, mumps, rubella, chicken pox, and shingles, hepatitis, herpes and cold sores, polio.

15.

Bacteria	Viruses
<ul style="list-style-type: none"> • Found in a variety of habitats. • Can be seen with a light microscope. • Most are harmless to us, as they are decomposers. • Some produce chemicals called toxins which are poisonous to other organisms. • Single celled spherical (cocci), rod shaped (bacilli) and spiral shaped (spirochaetes). Found singly, in chains or colonies. • Have rigid cell wall except the spirochaetes which have a flexible cell wall. • No distinct nucleus. • Can be killed by antibiotics. 	<ul style="list-style-type: none"> • Can be seen with an electron microscope. • Vary in shape and composition. • Have a protein coat surrounding a core of nucleic acid (DNA or RNA). • Can only multiply inside other living cells. They cause the infected cell to manufacture new virus particles. • Are not harmed by antibiotics. • Can only be cultured (grown) in living cells (often hen's eggs) so difficult to study. • Vary, simple in shape and composition.

16. Usually enter our bodies through the mouth, eyes, nose, or urogenital openings, or through wounds or bites that breach the skin barrier.

17. Contact (direct or indirect), aerosol (airborne), oral (ingestion), transfer of body fluids and vector borne.

18. Skin – waterproof, mechanical barrier due to keratinized epidermis; resident microbiota serve as an important first-line defence against invading pathogens. Through their occupation of cellular binding sites and competition for available nutrients, the resident microbiota prevent the critical early steps of pathogen attachment and proliferation required for the establishment of an infection; sebum secreted from the sebaceous glands has innate antibacterial activity.

Ear wax – the wax and tiny hairs in these passages trap dust and other foreign particles; contains antimicrobial chemicals.

Mouth – saliva contains antibodies and lysozyme (enzymes that breakdown cells including bacterial cells).

Nasal hairs – act as a physical barrier to infection. Cells in the nose produce mucus which traps pathogens before they can enter the lungs. When the nose is blown, the mucus, and any pathogens that are trapped within it, is removed or the mucus is swallowed.

Vaginal fluids – the acidic content of the fluids inhibit the growth of micro-organisms. Stomach acid – are such a low pH very infectious agents ingested in food or water can survive.

Tears – Foreign bodies that enter the eye are washed out by tears. Tears also contain lysozymes, which has an antibacterial action, and works to prevent invasion and infection by microbes.

Urine – contains inhibitory and sometimes bactericidal for the bacteria that cause urinary tract infection. This inhibition of bacterial growth along with regular flushing during urination serves as a very effective antibacterial defence mechanism.

Respiratory cilia – propel a liquid layer of mucus that covers the airways. The mucus layer traps pathogens and other particles,

preventing them from reaching the lungs. Cilia beat more than 1,000 times a minute, moving the mucus that lines the trachea upwards and particles that are trapped on the mucus layer are coughed out or moved to the mouth and swallowed.

Mucous membranes – surface cells that release fluids (in the form of mucus, tears, saliva, etc.) to wash away pathogens. These fluids contain lysozyme, which can destroy cell walls and cause cell lysis. Mucous membranes may be ciliated to aid in the removal of pathogens trapped in the mucus.

19. Keeping up personal hygiene on a regular basis to remove surface pathogens, treating and covering skin breaks, using insect repellents to discourage biting insects using skin moisturisers to help keep skin in good condition.
20.
 - (a) This means keeping our bodies clean, taking care not to infect others with diseases we may have and taking precautions not to contract (catch) infections.
 - (b) Washing hands after going to the toilet, after handling dirty or hazardous materials, before eating, cooking or handling food, after being near someone who has a cough or cold, after handling pets, wear masks if in vicinity of infected person.
 - (c) Changing tampons and sanitary napkins four to five times per day and wash hands before and after changing. Avoid soaps which may irritate the vaginal skin as this may make infections such as thrush more likely. Urination after sexual intercourse can flush out bacteria in the bladder and urethra which can cause cystitis.
 - (d) Men who are uncircumcised should roll back the foreskin and clean underneath with mild soap and plenty of water.
21.
 - (a) The body's natural protection consists of three lines of defence. The first line consists of external barriers (skin, nasal hairs, cilia, stomach acidity, tears, saliva, sweat, ear wax, urine, vaginal acidity, mucus and mucosa). The second line includes large white blood cells (macrophages), neutrophils, inflammation and temperature rise (resulting in increased production of T lymphocytes and makes reactions faster so the body may repair itself quicker). The third line is the immunity to specific pathogens provided by the lymphocytes (B and T cells). Both the second and third lines of defence are mainly internal. Assisted protection is anything a person can do artificially to add to this natural protection. This includes the use of antiseptic creams, antibiotics, antivirals, good hygiene, and taking precautions to minimise the spread of communicable disease.
- (b) External assisted protection generally involves the application of barriers and creams (e.g. condoms, gloves and masks) to external surfaces, i.e. skin and mucosa. Internal assisted protection involves the use of vaccines and ingested antibiotics, which enter the body's internal environment and supplement the second and third lines of its natural defence
22. Mucus, tears, saliva, vaginal fluids, urine, sebum
23.
 - (a) Stomach, vagina, skin
 - (b) The low pH means that these areas are acidic. The acidity kills most microorganisms by rupturing cell wall or affecting metabolism.
24.
 - (a) The digestive system (salivary glands, gastric pits in the stomach, intestinal glands) and the respiratory system (nasal cavity, trachea, bronchi, bronchioles).
 - (b) Mucus which lines the digestive tract protects it from physical damage (e.g. abrasion) and chemical damage (e.g. acids, digestive enzymes) by providing a physical barrier. Therefore, microorganisms are generally prevented from moving from the lining into the internal environment (i.e. into blood, intercellular and intracellular fluids). Traps pathogens and then is moved through the digestive system for digestion or removal. Mucus on the lining of the respiratory system traps pathogens (bacterial and fungal spores on dust particles) and is swept up to the top of the trachea and into the opening of the oesophagus by cilia and swallowed. The microorganisms are then destroyed by the acids and enzymes in the stomach.
25. It separates the digestive cavity from the blood and internal organs. To reach the internal environment, microorganisms must first pass through this barrier. The contents of the digestive tract are usually considered outside of the internal body because they have not crossed any membranes.
26. Individuals should: cover nose and mouth when sneezing; wash hands regularly; not share towels, drinking cups and toothbrushes; clean table surfaces, kitchen benches regularly; stay at home if infected; remain at least one metre away from others if infected (social distancing); stay home while infectious; wear a mask in public areas.
27. Communicable disease – any disease that can be spread from one person to another; contagious – can be easily passed from one person to another by direct or indirect contact (via breathing, clothing, etc); non-communicable – cannot be passed from one person to another.

28. An endemic disease is always present in an area, e.g. malaria in some tropical places such as Central Africa, Indonesia, Thailand. An epidemic occurs when there is a sudden outbreak of disease in an area and it affects a lot of people in a short time, e.g. influenza in winter. A pandemic is a world-wide epidemic, e.g. Covid 19.

29. Vectors

30. From: <https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases>

Vector	Disease caused	Type of pathogen	
Mosquito	Aedes	Chikungunya Dengue Lymphatic filariasis Yellow Fever Zika	Virus Virus Parasite Virus Virus
	Anopheles	Malaria	Parasite
	Culex	Japanese encephalitis	Virus
		Lymphatic filariasis	Parasite
		West Nile fever	Virus
Aquatic snails	Schistosomiasis (bilharziasis)	Parasite	
Blackflies	Onchocerciasis (river blindness)	Parasite	
Fleas	Plague (transmitted from rats to humans)	Bacteria	

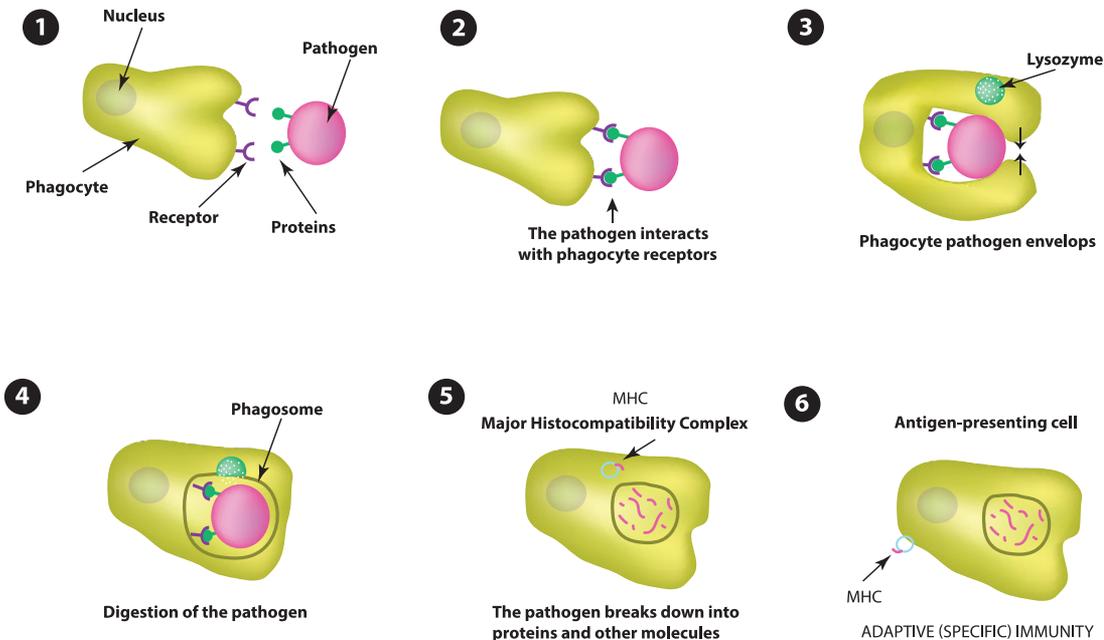
Lice	Typhus	Bacteria
Sandflies	Leishmaniasis	Parasite
Ticks	Crimean-Congo hemorrhagic fever	Virus
	Lyme disease	Bacteria
	Rickettsia diseases (eg: spotted fever and Q fever)	Bacteria
	Tick-borne encephalitis	Virus
Triatome bugs	Chagas disease (American trypanosomiasis)	Parasite
Tsetse flies	Sleeping sickness (African trypanosomiasis)	Parasite

31. By controlling the presence of the vectors eg. breaking the life cycle; killing the vectors eg. spraying of insecticides; wearing protective clothing; using insect repellents.

32. Usually enter our bodies through the mouth, eyes, nose, or urogenital openings, or through wounds or bites that breach the skin barrier.

33. Macrophages – recognise pathogens by cell surface receptors that differ between the pathogen and the body cells. They engulf cells recognised as non-self.

34. Phagocytosis is the ingestion of bacteria and dead cell material or particles by cells. It is the major function of macrophages.



35.

(a) The lymphatic system is a series of vein-like vessels that generally follow the circulatory system. These lymph vessels contain fluid called lymph which is derived from interstitial fluid. Along the vessels are swellings called lymph nodes which contain

a lot of macrophages and lymphocytes. The lymphatic system also includes some organs that contain lymphatic tissue and bone marrow.

(b) The lymphatic system helps to protect the body against the spread of disease by removing bacteria from lymph. The lymphocytes

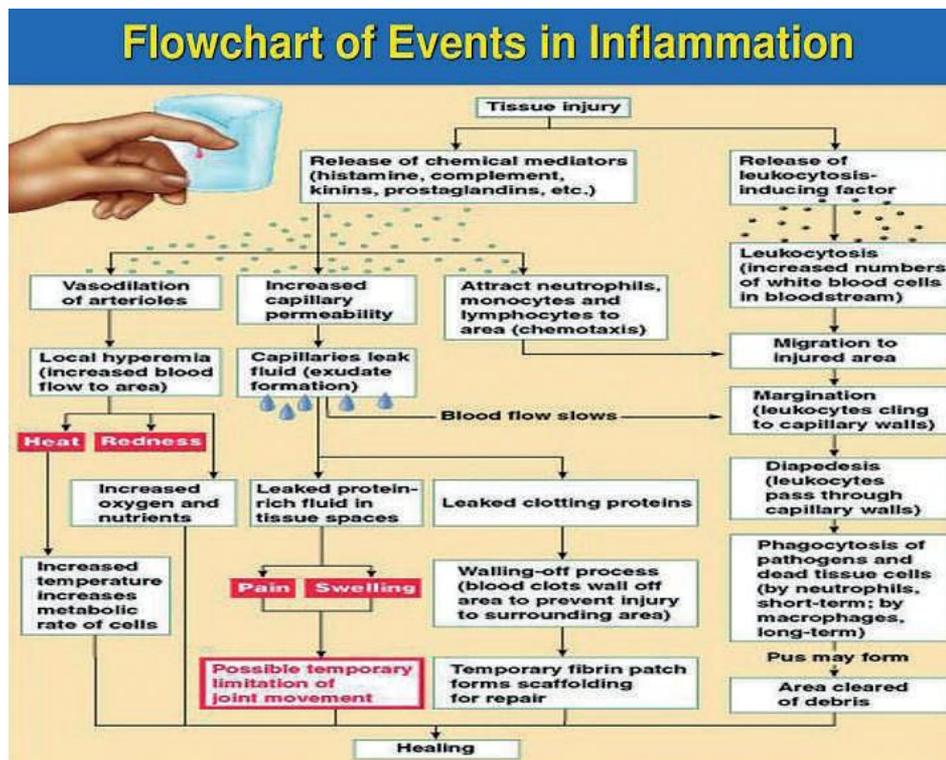
(a type of white blood cell found in lymphatic tissue) carry out immune responses which are specific defence mechanisms.

36. Contraction of skeletal muscles squeezes lymph through the vessels. Valves present in the vessels ensure that lymph moves in one direction only.
37. Tonsils, adenoids, spleen, thymus gland, small intestine and bone marrow.
38. As lymph enters the lymph nodes, fibres inside the lymph node act as a filter and

trap bacteria. These are then destroyed by phagocytes and lymphocytes present in the lymph node.

39. (a) Inflammation is triggered by damage to tissues of the body caused by a microbe or a wound. Damaged tissue releases chemicals that start the inflammation reaction chain.
- (b) It produces redness, heat, swelling, and pain.

39. (c)



40. Pus is a mass of dead phagocytes, dead tissue cells and bacterial cells and body fluid formed at the site of infection.
41. Fever is a body temperature higher than normal. The hypothalamus, is triggered by substances called pyrogens, which flow from sites infection or inflammation via the bloodstream. Some pyrogens are produced by damaged body tissue; many pathogens also produce pyrogens. When the hypothalamus detects them, it resets the body temperature to a higher level and initiates the body; response to generate and retain more heat, thus producing a fever.
42. With the body temperature being reset to a higher temperature, the body's response is similar to hypothermia. The person feels cold. Shivering, vasoconstriction of peripheral blood vessels, higher metabolic rate will occur to generate or retain heat within the body to attain the higher set temperature. Behavioural activities will be to huddle under covers near a heat source. When the fever 'breaks' the body temperature is reset at a lower temperature so that the person now

feels hot. The responses will be sweating, vasodilation of peripheral blood vessels and reduced metabolic rate. Behavioural activities will be to remove covers and go to a cooler location, reducing body temperature.

43. Internal body temperatures in excess of 40.5°C, for instance, expose proteins and body fats to direct temperature stressors which can threaten the structure and function of proteins especially enzymes that have narrow tolerance limits. Cellular stress, infarctions, necrosis, seizures and delirium are among the potential consequences of prolonged, severe fevers.
44. (a) Antibiotics are chemicals/drugs that kill or inactivate bacteria that cause infections.
- (b) Which bacteria caused the infection, possible side effects, potential allergy, cost, etc.
- (c) They either prevent the reproduction of bacteria, or they inactivate the bacteria, by stopping the mechanism responsible for building their cell walls. Inhibit DNA/RNA or protein synthesis, alter cellular metabolism.

- (d) Because if you stop when you feel better, there may still be some active bacteria in your body. Some bacteria may have a higher tolerance to the antibiotic than other bacteria and will not be killed by it. It is these 'resistant' bacteria that reproduce, passing on this resistance to the next generation. This then has ramifications for you or other people if these drug-resistant bacteria are released into the community, e.g. *Staphylococcus aureus*, also known as 'golden staph'.
- (e) Antibiotics only work on bacteria not viruses. The flu is caused by a viral infection.
- (f) Some bacteria have become resistant to prescribed antibiotics. Resistant bacteria do not respond to the antibiotics and continue to cause infection.

45.

- (a) Drugs that have been designed to inactivate or suppress the viral actions in the body.
- (b) Antibiotics are produced from fungi or plants, designed generally to kill or inactivate bacteria, can only be used for bacterial infections. Antiviral drugs are designed to either prevent the virus from entering its host cell or to prevent the host cell from making replicates of the virus.
- (c) Some antiviral drugs use molecules that will bind to the cell receptors and inactivate it, preventing the virus from attaching to cell membranes. Other drugs use receptor-like molecules to bind to the virus and inactivate it before it meets the cell. Another drug targets the uncoating step during viral infection so RNA can't be injected into the host cell.
- (d) Both pass across the external barriers (generally across the lining of the digestive tract or injected) and move into the blood. They are then carried internally via the circulatory system to their target pathogens.

46. Self – are those cells and tissues that are part of the body, non-self are cells or tissues, or particles from somebody or something else. Recognised by unique and distinct surface cell molecules.

47. The body's response to a specific antigen.

48.

T Lymphocytes	B Lymphocytes
Form in bone marrow. Long-lived.	Form in bone marrow. Short-lived.
Move to thymus during foetal development and just after birth.	Mature in bone marrow (hence B-cells).
Mature in thymus (hence T-cells).	Responsible for antibody (humoral) mediated immunity.
Responsible for cell mediated immunity.	Effective against bacterial and acute viral infections.
Most effective against viruses, fungi, transplanted cells, cancer cells and some bacteria.	

49.

- (a) In a cell mediated response, lymphocytes called T cells are involved. There are two main sorts of T cells – cytotoxic 'Killer' T's and helper T cells. When a phagocyte engulfs a pathogen or non-self cell, a fragment of the cell that has been engulfed attaches to a special protein called major histocompatibility complex (MHC). This is then displayed on the cell membrane and presented to T cells in a lymph node. This activates the T cells which enlarge and form a clone of cells that all recognise the same antigen. MHC is genetically determined and is unique to each individual. There are two sorts of MHC, Class I and II. If the antigen is coupled to MHC Class I, killer T cells are activated. They travel through the body directly destroying cells that have the same antigen, or by attracting macrophages, or suppressor T's which help to prevent autoimmune responses. If the antigen is coupled to MHC Class II, helper T cells are activated. They then activate killer T and B cells to produce antibodies. Some clone cells remain as long-lived memory T cells in the lymphatic tissue that will recognize the pathogen if it ever invades again. Their presence initiates a faster response to the antigen next time it invades. T cells are most effective against viruses, fungi, transplanted (foreign) cells, cancer cells and some bacteria.
- (b) In an antibody mediated (humoral) response, B cells produce and release antibodies into the blood where they bind to and destroy antigens. B cells have antibodies on the surface of their cells. When they combine with a particular antigen, they are then 'recognised' by a helper T cell. This activates the B cell and it divides to form a clone. The cells in the clone become either plasma cells or memory cells. Plasma cells manufacture and release large quantities of antibodies specific to the antigen. These antibodies circulate in the blood and lymph and bind to the antigens to form antibody-antigen complexes. This inactivates and destroys the antigen. Memory cells stay in the body as a record of what antibodies have been made. If the body should be invaded by the same antigen, these memory cells recognise it and the immune system will respond faster to it. B cells stay in the lymphoid tissues, but when they are exposed to an antigen, a surface receptor on the cell recognises the antigen. The B cells are activated and they enlarge and divide to produce a clone, forming plasma and memory cells and the antigen is destroyed.

50. Plasma cell – the B lymphocyte cell which produces antibodies; memory cell – a long-

lived immune cell that has the ability to recognize an antigen that it previously encountered and can consequently produce a faster and stronger immune response if the same antigen.

51.

(a) Primary immune response describes the initial reaction when a pathogen invades the body (ie the formation of the MHC and activation of the T-cells to clone to sufficient levels to have an effect on the antigen levels). Consequently, a person can be affected by it and fall sick before the immune response inactivates the pathogen/antigen.

(b) The primary response produces memory cells which will recognise the pathogen and produce large quantities of antibodies and killer T cells to counteract it quickly. As the response is so fast, symptoms of the infection may not have time to develop.

52. Receptors on lymphocytes are specific to a particular antigen. The shape of the receptors mirrors the shape of the antigen on the surface of the pathogen.

53. Cytotoxic T-cells – recognise normal body cells that have become infected with a pathogen and releases cytotoxic molecules that kill the infected cell, stopping spread of the pathogen; Helper T-cells – recognize pathogen peptides that have been displayed by antigen presenting cells. When helper T cells recognize a peptide on an antigen presenting cell, they become activated and begin to produce molecules called cytokines that signal to other immune cells; Regulatory T-cells – play a protective role by shutting off the immune response when it is no longer needed, preventing excessive damage to tissues in the body.

54.

	Natural immunity	Artificial immunity
Passive immunity	Antibodies are passed from mother to child through placenta or breast milk. As antibodies are short-lived this only protects the child until its own immune system has developed and produced its own antibodies and the relevant memory cells.	Antibodies injected directly, e.g. rabies and tetanus.
Active immunity	Antibodies develop from having had the disease or exposed to the attenuated antigen. Life long immunity due to memory cells.	Antibodies develop as a result of vaccinating with an antigen that stimulates their production.

55. A substance that stimulates the immune system to produce antibodies to a particular antigen without an individual having to be infected by antigen.

56. Weakened strains (attenuated) of bacteria or viruses, neutralised toxins, (toxoids) or genetically engineered mRNA.

57. Intramuscular injection, subcutaneous injection, intradermal injection, oral administration, intranasal spray, only some can be delivered intravenously.

58.

(a) Availability of welfare benefits may be linked to child immunisation. Below is the childhood immunisation schedule for WA.

Age	Diseases covered
Birth to less than 7 days	<ul style="list-style-type: none"> Hepatitis B (1 injection)
6 weeks	<ul style="list-style-type: none"> Diphtheria, tetanus, whooping cough, hepatitis B, polio, Haemophilus influenzae type b (1 injection) Pneumococcal (1 injection) Rotavirus (drops in mouth)
Aboriginal children	<ul style="list-style-type: none"> Meningococcal ACWY (1 injection)
Aboriginal children and/or children with a medical risk condition	<ul style="list-style-type: none"> Meningococcal B (1 injection)
4 months Including immunisations for Aboriginal children and children with a medical risk condition	<ul style="list-style-type: none"> Same as 6 weeks
6 months	<ul style="list-style-type: none"> Diphtheria, tetanus, whooping cough, hepatitis B, polio, Haemophilus influenzae type b (1 injection)
Aboriginal children and/or children with a medical risk condition	<ul style="list-style-type: none"> Pneumococcal (1 injection)
Children with a medical risk condition	<ul style="list-style-type: none"> Meningococcal B (1 injection)
12 months	<ul style="list-style-type: none"> Measles, mumps, rubella (MMR) (1 injection) Pneumococcal (1 injection) Meningococcal ACWY (1 injection)
Aboriginal children and/or children with a medical risk condition	<ul style="list-style-type: none"> Meningococcal B (1 injection)
Children with a medical risk condition	<ul style="list-style-type: none"> Hepatitis B (1 injection)
18 months	<ul style="list-style-type: none"> Diphtheria, tetanus, whooping cough (1 injection) Haemophilus influenzae type b (1 injection) Measles, mumps, rubella, varicella (1 injection) – only for children who have already received a measles, mumps, rubella (MMR) vaccine previously
Aboriginal children	<ul style="list-style-type: none"> Hepatitis A (1 injection)
<2 years Aboriginal children	<ul style="list-style-type: none"> Meningococcal B (catch-up injection)
4 years	<ul style="list-style-type: none"> Diphtheria, tetanus, whooping cough, polio (1 injection)

Aboriginal children	<ul style="list-style-type: none"> • Hepatitis A (1 injection) • Pneumococcal (1 injection)
Children with a medical risk condition	<ul style="list-style-type: none"> • Pneumococcal (additional injections required)

(b) Adolescents and adults can receive influenza and Covid-19 vaccinations

Adolescent vaccination		
12–13 years (school programs)	Human papillomavirus (HPV)f	Gardasil®9
	Diphtheria, tetanus, pertussis (whooping cough)	Boostrix®
14–16 years (school programs)	Meningococcal ACWY	Nimenrix®
Adult vaccination		
70 years and over	Pneumococcal	Prevenar 13®
70–79 years	Shingles (herpes zoster)	Zostavax®

(c) Dengue fever, HIV/AIDS, malaria.

(d) *Streptococcus pneumoniae* is a bacterium which may cause ear infections, pneumonia and meningitis.

Hib (*Haemophilus influenzae* type B) is a bacterium which may cause infection of the meninges (membranes which enclose the brain and spinal cord), the upper respiratory tract and other parts of the body.

Meningococcal C is a strain of bacterium (*Neisseria meningitidis*) which causes a disease which develops rapidly and may cause brain damage and death. The bacterium can infect the meninges or can be carried to major organs, joints and connective tissue. It causes serious damage to these body parts. Symptoms include high fever, headaches, sleepiness, joint and muscle pain, stiff neck, light sensitivity and rash.

59. Herd Immunity occurs when a large portion of a community becomes immune to or has been vaccinated against a disease, making the spread of disease from person to person unlikely. As a result, the whole community becomes protected – not just those who are immune or vaccinated.

60. Objections to vaccinations are based on side effects (real or perceived), religious beliefs though most mainstream religions do not condemn vaccines; think that the risks outweigh the benefits; think that pharmaceutical companies can't be trusted; unfounded belief that vaccines can cause mental disorders; opposition to vaccines comes directly from a mistrust of science, or mistrust of the government. All these points need to be investigated and discussed in a scientific manner to determine their validity.

61. Step 1: Identification and isolation of the desired DNA Sequence.

Step 2: Insertion of the isolated DNA sequence into a vector.

Step 3: Selection of transformed recombinant cells containing the desired DNA sequence.

Step 4: Multiplication/cloning of recombinant cells to increase numbers.

Step 5: Expression of the gene introduced into the host – ie the vaccine.

62. Some vaccines are produced using eggs. Those with an allergy to eggs can't have this vaccine.

UNIT 4

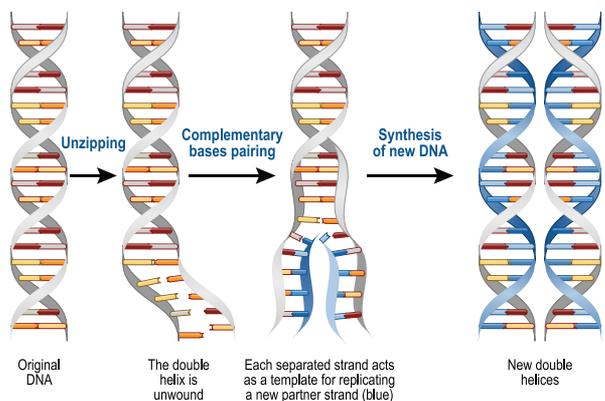
6: MUTATIONS

Review Questions

- DNA
- Nucleus and mitochondria
- Cross shape – two strands linked at the centromere.
 - Circular single strand of DNA.
- Plasmids
- Nucleotide
 - 4
 - Adenine, guanine, thymine, cytosine
 - Deoxyribose sugar and phosphate groups
 - Hydrogen bonds
 - Covalent bonds
 - C-G and A-T
 - C-G have three hydrogen bonds between them and A-T have 2 hydrogen bonds linking them together;
- Unzipping – enzyme helicase aids in unwinding the double helix.

Complementary base pairing form 5' to 3' ends; DNA polymerase wraps around the strand and attaches new nucleotides onto the original strand by complementary base pairing.

Two DNA double helices are formed each with one original strand and one newly made strand.



- A mutation is a change in a DNA sequence.
 - Mutations can occur during DNA replication.

- (c) Point mutation – are changes in a single nucleotide in the DNA sequence eg. sickle celled anaemia; Chromosomal mutations change chromosome structure or number eg. trisomy 21 Down’s syndrome.

7.

- (a) A germ line mutation is an error that occurs during meiosis. It may result in a change to a gamete. A somatic mutation is an error which occurs during mitosis. It therefore affects normal body cells other than the gametes.
 (b) Because the germ line mutation affects a gamete there is a possibility that it could be passed on to an offspring and become an inherited change affecting future generations. A somatic mutation will not be inherited as it occurs in only body cells. If it does occur early in an embryo’s development, it may result in many subsequent cells growing that are different. This may cause a significant change to the developing individual. Sometimes somatic mutations may develop as a cancer. However, most somatic mutations are believed to have no serious effect as they are hidden by normal genes, or just cause the death of an individual cell.

8. Factors that cause mutations are called mutagens. They include: physical agents: heat and radiation – X-rays, UV, cosmic radiations; Chemical agents: base analogs – chemical with very similar structures to the nucleotide bases that they are incorporated into the DNA but don’t have the same function, alkylating agents eg vinyl chloride that induce base pairing errors, intercalating agents – insert between bases and disrupt DNA structure, metal ions – usually heavy metals can directly damage DNA, Biological agents: bacteria – cause DNA damage or breakage and viruses – insert DNA into cell genomes.

9.

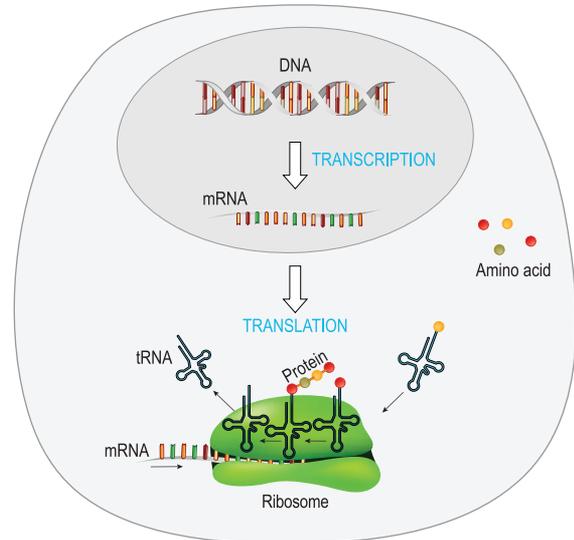
- (a) Chromosomal
 (b) Each chromosome consists of two copies (called chromatids) connected by a structure called a centromere. The chromosomes are arranged in pairs. The autosomes (autosomal chromosomes) all look similar (i.e. 22 pairs that look much the same) and the sex chromosomes are put together separately at the bottom of the karyotype.
 (c) The one on top has two X chromosomes and the one on the bottom has an X and a Y chromosome.
 (d) The one at the top is from a female; the one at the bottom is from a male.
 (e) A child with Trisomy 21 (Down’s Syndrome) would have three copies of chromosome number 21.
 (f) One can acquire an extra chromosome from non-disjunction in meiosis, in which the

chromosomes do not separate and one gamete ends up containing an extra chromosome.

10.

- (a) Female
 (b) 45 chromosomes
 (c) Male
 (d) 47 chromosomes

11.



12. No, because several different triplet codes are linked to the same amino acid.

		Second nucleotide					
		U	C	A	G		
U	UUU	Phe	UCU	UAU	Tyr	UGU	Cys
	UUC		UCC	UAC		UGC	
	UUA	Leu	UCA	UAA	STOP	UGA	STOP
	UUG		UCG	UAG	STOP	UGG	Trp
C	CUU		CCU	CAU	His	CGU	
	CUC	Leu	CCC	CAC		CGC	Arg
	CUA		CCA	CAA	Gln	CGA	
	CUG		CCG	CAG		CGG	
A	AUU	Ile	ACU	AAU	Asn	AGU	Ser
	AUC		ACC	AAC		AGC	
	AUA		ACA	AAA		AGA	Arg
	AUG	Met	ACG	AAG	Lys	AGG	
G	GUU		GCU	GAU	Asp	GGU	
	GUC	Val	GCC	GAC		GGC	Gly
	GUA		GCA	GAA		GGA	
	GUG		GCG	GAG	Glu	GGG	

13.

- (a) The GAG codes for a particular amino acid in the protein haemoglobin, GTG codes for a different amino acid. Therefore, the change results in haemoglobin which has one amino acid in its chain which is different to the normal. This gives the haemoglobin produced different properties. It changes its shape and oxygen carrying capacity.
 (b) Being heterozygous, Hb^NHbⁿ (N-normal; n-sickle-cell), is usually described as having the sickle cell trait. This genotype confers a protection from the pathogen that causes malaria because the parasite cannot invade a sickle-shaped red blood cell (like it does a normal shaped RBC). Therefore individuals

with the sickle cell trait are more likely to survive and reproduce than individuals with the normal homozygous genotype, $Hb^N Hb^N$, in those areas of the world where malaria is endemic. Individuals who inherit the homozygous sickle cell genotype, $Hb^s Hb^s$, are described as having sickle cell disease or sickle cell anaemia, a condition that may lead to death in childhood due to the abnormal rate of red blood cell destruction. The disease reduces life expectancy significantly and therefore does not confer an advantage in any part of the world.

- 14.
- If the mutation provides the offspring with some feature which gives it an advantage in competition with its rivals, it is an advantageous mutation. The offspring with the mutated gene is more likely to survive, especially in adverse conditions and pass on its mutated gene to its offspring which then has the same advantage.
 - An adaptation.
 - A number of mutations have probably occurred in the human genome which resulted in our ability to walk bipedally. These include changes to our feet, legs, pelvis and vertebra.
- 15.
- Only if the offspring have inherited two recessive deleterious alleles, one from each parent.
 - In interbreeding between close relatives.
- 16.
- (i) Homozygous dominant or heterozygous.
(ii) Homozygous dominant or heterozygous.
(iii) Homozygous recessive.
 - The people with the allele had some advantage over others and so they survived and reproduced to pass this allele onto the next generation.
 - Mother could be TT or Tt ; assume father is TT (t – Tay-Sachs allele, T – normal allele). If mother is TT , then the probability of an affected child is 0 as neither parent has the allele to pass on.
If the mother is Tt ...

		Father	
Mother		T	T
T		TT	TT
t		Tt	Tt

the probability of an affected child is 0 as father does not have the allele to pass on; condition requires homozygous recessive to be expressed.

- (d) Late onset – homozygous recessive (tt):
Partner Tt

		Father	
Mother		T	t
t		Tt	Tt
t		Tt	tt

The possible genotypes of the offspring are heterozygous and homozygous recessive.

- (e) A simple blood test can identify Tay-Sachs carriers. Blood samples can be analysed by enzyme assay that measures the level of Hex-A in a person's blood. Carriers have less Hex-A in their body fluid and cells than non-carriers.

7: GENE POOLS

Review Questions

- The collection of different alleles for a trait in an interbreeding population – the percentage of a given genotype or allele within a population.
- A population refers to the phenotype whereas the gene pool refers to the genotypes of individuals.
- Natural selection, random genetic drift, mutation, Founder effect, immigration and emigration. Cultural isolation of a group within a breeding population.
- Variation refers to the phenotypic or genotypic differences between members of the same population of a species.
 - The amount of sunlight that skin is exposed to can affect the degree of melanin development. Variation (IQ, weight, height) in identical twins separated at birth and raised in different family circumstances and nutrition.
 - (i) Mutation; (ii) Crossing over; (iii) Random (independent) assortment of chromosomes in meiosis; (iv) Chance combination of gametes in sexual reproduction (random fertilisation).
- Gene flow refers to the movement of genes from one population to another as a result of interbreeding between members of the two different populations. This introduces new variations into the population increasing the range of variations within that group.
 - Migration (and interbreeding) of European, African and Asian people to Australia bringing alleles for sickle-cell anaemia, thalassemia and Tay-Sachs into the population.

6.

Event	Increase or decrease gene frequency
Mutation	Increase
Natural selection	Decrease
Migration or gene flow	Increase
Random genetic drift	Decrease or increase
Isolation	Decrease

7. *Random genetic drift describes the random change in genetic frequencies that occurs in the gene pool of small populations from generation to generation. It suggests that variation in gene frequencies of populations can occur by chance rather than by natural selection. In other words, evolutionary change occurs by chance only. It is important in small or isolated populations. In a small population not all the alleles of a species may be present. Chance events like the accidental death of an individual that carries the only example of a particular allele can result in the disappearance of that allele. Similarly, it is also possible for an allele to increase in frequency simply by chance, i.e. random genetic drift means that what happens is unpredictable. As a result, a small population gene pool frequencies will differ from other similar populations.*
8. *Small populations are more susceptible to the forces of genetic drift due to the larger impact of chance events. If one individual of a population of 10 individuals happens to die at a young age before leaving any offspring to the next generation, all of its genes (1/10 of the population's gene pool) will be suddenly lost. In a population of 100, that individual represents only 1 percent of the overall gene pool; therefore, genetic drift has much less impact on the larger population's gene pool.*
9. *When members of a population become separated from others of the same population, they may possess only a small selection of alleles from the gene pool of their species. Genetic drift that results from this is called the Founder effect, e.g. the Dunkers who migrated from Germany to America. Interbreeding within this group has produced allele frequencies quite different to the German population as well as to the American population amongst whom they live. They have a high frequency of genes for Ellis-van Creveld Syndrome – dwarfism and polydactyly (more than 5 digits on hands or feet) The same applies to the various Pacific sub-populations – Melanesians, Polynesians, and NZ Maori.*
10. (a) *Reproductive isolation is a process in which members of a population get separated from*

other members of the same population so that there is little or no interbreeding. In people it may be due to geographical features or cultural reason.

- (b) *Gene flow is reduced.*
- (c) *Cultural features: economic status, religion, education, occupation. Geographical features: oceans, mountain ranges, deserts.*
11. (a) *This allele is maintained in this population because of cultural isolation. Members of this population are encouraged to intermarry with people in the same population.*
- (b) *They could be told that it is due to a recessive autosomal allele and as parents that obviously do not have the disease; they could be carriers for the condition. They can be tested for their genotype and if both parents are carriers, i.e. heterozygous for the gene, there is a 25% chance of having a baby with Tay- Sachs disease. It is then their choice as to whether they have a child.*
12. *'Fittest' in this context is defined as reproductive success, ie the ones that can survive long enough to pass their genes onto the next generation. The alpha male of a population is more likely to breed with more females than other males so his genes will be prevalent in the next generation.*
13. *Natural selection is process that happens naturally with no specific outcome required whereas with artificial selection humans determine the desired characteristic and select the individuals to breed. Natural selection: people with lighter skins produce more vitamin D in high latitude area. Artificial selection – breeds of dogs and horses for particular purposes or human eugenics.*
14. *Any factor in the environment that impacts the survival of and reproduction by individuals. Food, water, shelter, accessibility of mates, disease, conflict, weather.*
15. *Gene flow can be compromised or reduced by geographical features (lakes, mountains, oceans, rivers), lifestyles (nomadic or settled) beliefs, conflict.*
16. *Genotype is the genetic basis for a trait; phenotype is the physical expression of the genotype. Aa, AA – normal pigment, aa – albino.*
17. *Different genotypes can produced the same phenotypes – homozygous dominant and heterozygous look the same so there will be no difference on the selection pressure on these individuals.*
18. *Selective advantage of phenotypes – some phenotypes in a population are better adapted than others in the population. These phenotypes are more likely to survive and reproduce. A human example of this would be darker skin in equatorial regions of the world.*

Having darker skin provides protection from UV radiation. It results in less skin cancer among people who have darker skin living in tropical and sub-tropical regions of the world. The phenotype is therefore better suited or adapted for living in these areas. Differential survival could also include the differences due to environmental conditions that are more favourable for survival such as good water and food supply.

19. These alleles are usually recessive and may survive because when inherited as the heterozygous condition they confer some advantage on the individual eg. Sickle cell anaemia and malaria. OR They exist as the heterozygous combination that is not detrimental to the individual's chances of survival and being rare it would be uncommon to get a homozygous offspring.
20. Mechanisms of natural selection:
 - (a) Inherited variation – each individual has a slightly different genome from all other members of the population due to the inheritance of recessive or dominant alleles from its parents through random assortment and random fertilization.
 - (b) Struggle for existence – all individuals compete for the resources they require from the environment. Those that out-compete others to have all their requirements met will survive to reproduce. Not all offspring survive.
 - (c) Isolation – different populations of the same species live in different locations reducing or stopping the gene flow between the two groups.
 - (d) Differential selection – the different locations are slightly different such as environmental conditions, food supply or type, amount of shelter that impact on the survival of different members of the populations. Over time the two groups will have survivors of slightly different phenotypes/genotypes. Eg. Darwin's finches on the Galapagos Islands.
21. Gene pools change over time due to natural selection.
22. Speciation occurs when the two different populations of the same species become so different that when they are no longer isolated, they do not interbreed, classifying them as different species.
23. Speciation is driven by natural selection. The change in species over time is evolution.
24.
 - (a) Changes to internal environment include increased addition of processed foods to our diet, surgery to treat disease, the use of tumour specific drugs, antibiotics, vaccines and other drugs, etc.
Changes to the external environment include deforestation, pollution of water, air and land, development of cities, acidification of sea water, etc.

- (b) Alleles that used to result in early death and would be in low proportions in the population now continue to survive in greater proportions in the population, e.g. some cancers, allergies, disease susceptibility.
- (c) Implications include – overpopulation, unequal distribution of health resources and wealth, running out of resources, increased conflict between peoples, climate change, new technological developments, more reliance on alternative energy sources.

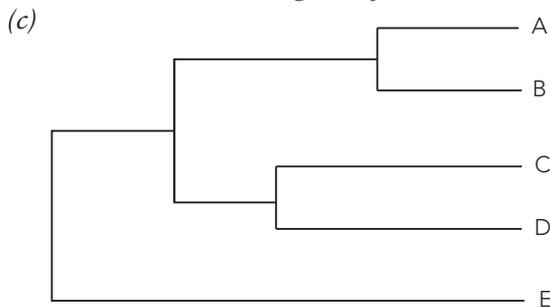
8: EVIDENCE FOR EVOLUTION

Review Questions

1. DNA and RNA. These are the genetic chemicals that control the phenotypes of organisms, of life. Any changes in these will mean changes in the organism.
2. Polymerase Chain Reaction. It is used to amplify the amount of DNA producing enough to be analysed using other biotechnological techniques such as DNA profiling or sequencing.
3.
 - (a) Restriction enzymes cut the DNA at specific sites according to the nucleotide sequence. They would be found prior to the cycle starting. They are used to cut selected sections for amplification by PCR.
 - (b) Hot springs micro-organisms can survive in a wide range of temperatures without their enzymes denaturing. Taq polymerase remains enzymatically active after the high temperature step of denaturation of the DNA so no new enzymes need to be added to the process for each cycle. Prior to the use of Taq polymerase, new doses of enzymes had to be added for each cycle because human enzymes are denatured at such high temperatures. Kary Mullis won the Nobel Prize in Chemistry in 1993 for developing the use of Taq polymerase in PCR.
 - (c) Increased amounts of selected DNA sequences.
 - (d) The greater the number of nucleotides in the primer, the fewer places it will bind with the DNA because the sequences don't occur as often as shorter sequences. Having longer primers can mean greater specificity in locating the required DNA sequence for amplification. They cut the DNA at particular places called recognition sites. Different enzymes cut different recognition sites. Even though DNA may come from different sources, if it is cut at the same recognition site, the pieces can be joined up.

4.
 - (a) *Electrical force*
 - (b) *DNA fragments are negatively charged so will move towards the positive electrode.*
 - (c) *The gel is a matrix of fibres. Smaller fragments of DNA can pass through the spaces in the matrix faster than large fragments so that the smaller fragments are found closer to the positive terminal at the end of the time the electrical current is on. The longer the current runs, the wider the spread of fragments.*
 - (d) *Voltage of the electrical current – the higher the voltage the faster the movement of the fragments; concentration of the gel – at higher concentrations the matrix of fibres is more dense and harder to move through making the separation slower; the size of the DNA fragments being separated – smaller fragments move faster through the gel; the ionic concentration of the buffer solution – influences the current through the system; time the current is running – the longer the time the greater the separation.*
 - (e) *A–E represent different samples of DNA taken from different sources.*
 - (f) *The blue rectangles represent the location of different sized fragments after the current has been turned off.*
 - (g) *Once the current is turned off, the fragments tend to diffuse away from the area making the clear rectangles very fuzzy blobs. This makes it hard to be precise in determining the distance moved by the fragments.*
5.
 - (a) *At the base of the tube.*
 - (b) *Towards the positive (upper) end of the capillary tube.*
 - (c) *The peaks represent the concentration of the different DNA fragments that pass the optical detector sensor.*
 - (d) *The capillary electrophoresis is much more precise than the flat bed gel. The flat bed gel produces bands of various widths that may cover two peaks shown in the capillary gel eg. 14,15 could be together as one band on the flat bed gel. Being able to record the separation of fragments as numbers rather images makes the process of comparison of samples much more precise, and much easier to digitally store information.*
6. *DNA sequencing is a process used to establish the order of bases along a piece of DNA.*
7. *DNA sequencing is used to determine the sequence of nucleotides in the human genome and the genome of other species. DNA profiling just uses a small sample of DNA showing variations at similar loci between two individuals.*
8.
 - (a) *DNA is always synthesized in the 5'-to-3' direction, meaning that nucleotides are added only to the 3' end of the growing strand due to the orientation of the phosphate group and the attachments sites for the next nucleotide in the sequence.*
 - (b) *When conducting the Human Genome Project, scientists developed a number of sequencing techniques that emphasized speed without too much loss of accuracy. Initially, these techniques expanded upon the so-called Sanger process that was first developed in the 1970s which relied on a high level of human activity and input at various stages. Gradually, the processes were automated and an increasing the number of samples could be sequenced more accurately at one time. Machines that used an automated version of Sanger method were essential to completion of various stages of the Human Genome Project. Recently, researchers have increasingly begun to rely on newer and even faster methods, and machines that use smaller and smaller samples.*
 - (c) *Determining the genetic information that is carried in the DNA, which may affect its function in the body. It can then, in turn, help to detect genetic changes that may be associated with causing certain health condition. DNA sequencing is currently used for cancer patients to help identify the type of cancer that is present, which directs the treatment decisions for the patient. Similar methods are currently in development for other health conditions that are likely to have a genetic element, such as cardiovascular disease and diabetes and species comparisons.*
9.
 - (a) *To determine the differences between the sequences.*
 - (b) *Differences between sequences means mutations have occurred.*
 - (c) *Genomic DNA is found in the cell nucleus and is a combination of maternal and paternal DNA. Mitochondrial DNA is found in the mitochondria and is only from the maternal parent. At fertilization, only the head of the sperm enters the ovum and it carries no other cellular contents than the nucleus. All other cellular contents are found in the ovum which becomes the zygote so are therefore contain the mother's mitochondrial DNA only.*

- 10.
- (a) *Phylogenetic tree or cladogram*
- (b) *Phylogenetic tree can be built using physical information like body shape, bone structure, or behaviour, but most are currently built from molecular information, like genetic sequences. Any DNA, RNA, or protein sequences can be used to draw a phylogenetic tree. But DNA sequences are the most widely used. DNA contains more information that can help produce more accurate trees. For example, some changes in DNA sequences do not lead to changes in proteins.*



- (d) *The diagram represents the evolutionary relationships between organisms.*
11. *Molecular biology has clarified the nature of genes and the nature of genetic variations. DNA is common to all organisms; the same four nitrogenous bases make up the DNA in all living things. If the base sequences are compared between two organisms it will give an indication of their relationship. The more similar they are, the closer the two organisms are related. Comparative analysis of DNA and proteins continues to provide a detailed view of patterns of variation, common ancestry, and relationships.*

- 12.
- (a) *DNA molecules from different species can be compared by a process called DNA hybridisation. In this process, heat or enzymes are used to separate the strands of DNA molecules from different species. When strands from one species are mixed with strands from a different species, they join together to form a 'hybrid'. Not all of the bases on one strand will match with the bases on the other strand. However, the more that the two strands do match, the more closely related are the species.*
- (b) *When the technique was used to compare primates, it was found that chimpanzees are most closely related to humans (>97% similar).*

13. *Protein structure depends on the genetic code for manufacture. Changes in the genetic code could mean changes in the proteins present. Proteins indirectly indicate genetic sequences, the differences are due to the genetic coding of the amino acid sequences in proteins.*

- 14.
- (a) *The remnant, impression, or trace of an organism of a past geologic age that has been preserved in Earth's crust.*
- (b) *Bones, teeth, shells, footprints, leaf imprints, coprolites (fossil faeces). Whole (or parts of) bodies in tar pits, peat bogs, permafrost/ice are rare occurrences, e.g. mammoths, Iceman.*

- 15.
- (i) *The item has to be covered or buried quickly, e.g. immersed in sediment at the bottom of the sea or a lake, covered by volcanic ash, falling into a bog etc to protect the tissues from scavengers and mechanical disturbance.*
- (ii) *No oxygen (anaerobic). This prevents decay bacteria destroying soft tissues.*
- (iii) *Alkaline soils preserve bone best since acid soils tend to dissolve bone and shell. (NB wet, airless acid soils such as peat can preserve soft tissues).*

- 16.
- (a) *Relative dating is simply finding out if a fossil, artefact or sedimentary layer (strata) is older or younger than other fossils, artefacts or sedimentary layers. It puts fossils/strata in order of age without knowing the actual age in years.*

- (b) (i) *Stratigraphy or superposition; (ii) index fossils.*
- (c) (i) *Stratigraphy – can only determine the sequential order in which a series of events occurred, not when they occur; fossils may not be from the time of the strata in which they are found – could be cave dwellers or have been buried; geological movements may have inverted the order of the strata; erosion may have taken the fossils from their original location to another where they become embedded in another layer. (ii) Index fossils – must be easily recognizable and easy to identify and look unique; have to be geographically widespread, or found over large areas so that they can be used to match layers separated by huge distances; must have lived for only a short time, so that it appears in only one layer of sedimentary rocks.*

17. *Radioisotopes are atoms that contain an unstable combination of neutrons and protons, or excess energy in their nucleus and release radiation when they breakdown to form more stable atoms. Radioisotopes used are carbon-14, uranium-238 or 235, potassium-40.*

18. *The half-life is the time taken for half of the quantity of radio-isotope to break down or decay to stable isotopes, e.g. carbon-14's half-life is 5730 years; potassium-40's half-life is 1.3 billion years; uranium-238 decay to lead is about 4.5 billion years; uranium-234 to thorium-230 is about 80 000 years.*

19. Absolute dating provides an age in years with confidence limits based on the techniques used. The calculation of age needs the half-life and the measurement of radiation from the sample.
20. Carbon-14 is continuously produced in the upper atmosphere by the action of cosmic rays on nitrogen. Some of the carbon that plants take in as carbon dioxide is carbon-14 and it is passed along the food chain just like carbon-12. When an organism dies it does not take in any more carbon and the carbon-14 starts to decay. The time taken for half of the mass of carbon-14 present to decay is 5,730 years (i.e. the half-life is 5,730 years). The amount of carbon-14 remaining is measured by the amount of radiation being given off the sample. Because this is so short in geological times, carbon-14 is only useful to date relatively recent remains up to 50,000 to 70,000 years old.
21. Potassium – argon dating is used to date the time a volcanic rock was molten. A very small proportion of natural potassium is the isotope potassium-40 which decays to argon-40 (a gas). This gets trapped in the rock as the rock cools. The ratio of potassium-40 to argon-40 gives the age of the remains. It is used to date the age of the volcanic rock rather than a fossil. The half-life of potassium-40 is 1.3 billion years and it takes 200,000 years for argon to accumulate in sufficient quantities so that it can be measured. It is useful for hominid fossils found in East Africa, many of which have been found under volcanic ash.
22. Tree-ring dating involves counting and measuring the rings in a cross-section of a tree trunk. Each ring represents one year's growth. These are compared with tree-ring sequences of known age. Variations in climatic conditions are reflected in the thickness of the tree-ring. Tree-rings can be used to date material up to 9,000 years old.
23. For most fossils – pigmentation, body covering, details of soft tissues, physiology. (Exceptions are fossils like the iceman, mammoth which were found complete as they were frozen intact in ice.)
24. The fossil record is incomplete (fossilisation is a rare event), it is open to a variety of interpretation, fossils may be incomplete or distorted by fossilisation, many fossils may still be buried, many organisms or their parts do not fossilise easily.

9: HOMINID EVOLUTIONARY TRENDS

Review Questions

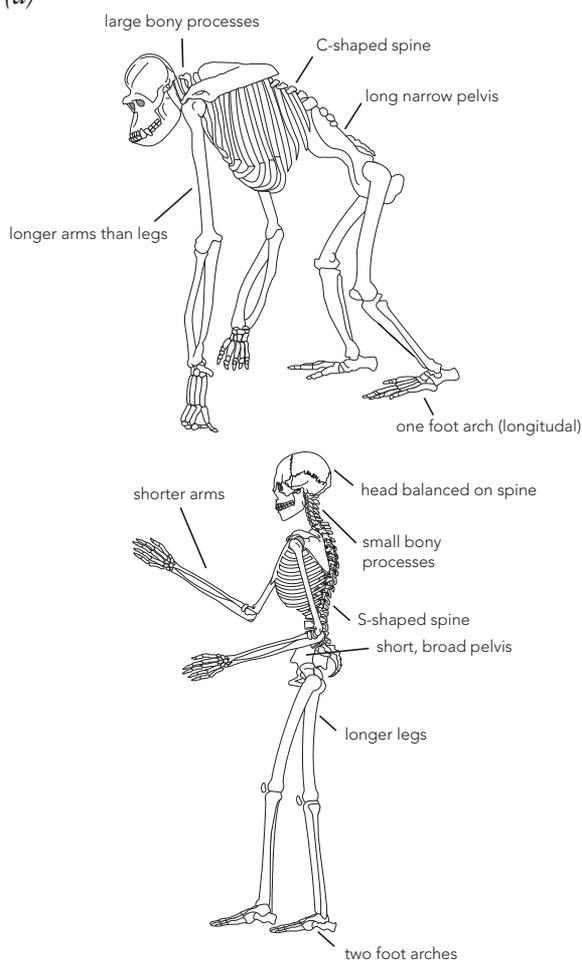
1. That the sequence of nitrogenous bases in a segment of DNA (usually mitochondrial DNA) can be compared from one hominid to another. The amount of similarity can be used to show how closely, or distantly, they are related to one another.
2. Primates (including humans) are different to all other animals because they are the only mammals that have the following combination of features: relatively large, complex brains, forward-facing eyes with overlapping fields of view that allow depth perception, eye sockets with a ring or cup of bone surrounding and supporting the eyes, grasping hands with long fingers to curl around objects, opposable thumbs and/or big toes (able to touch the other digits on the same hand or foot), flat nails (rather than claws) on some fingers and toes, sensitive pads under the tips of the fingers and toes containing special touch receptors called Meissner's Corpuscles, a well-developed collarbone (clavicle), two nipples (but sometimes more) on the chest (in females, these supply milk to the young), penis and testes that permanently hang down from the body (in males), long childhood that extends well beyond weaning. From <https://australian.museum/learn/science/human-evolution/humans-are-primates/>

3. (a)

Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Primates
Family	Hominidae

- (b) Hominids includes humans and the great apes. Hominins are those primates for which bipedalism is the normal walking habit. The group includes all modern and ancestral humans, e.g. *Homo* spp, *Australopithecus* spp.
4. Orangutans, gorillas and chimpanzees (including pygmy chimpanzees, or bonobos).
5. (a) A power grip folds the fingers around an object and holds it tight (like holding a hammer), a precision grip uses the fingertips and thumb (like picking up a pin).
- (b) *Homo*

6.
(a)



(b) Ape: C-shaped spinal curve, foramen magnum at the back of the skull, long bony processes on neck vertebrae, chest flattened side-to-side, arms longer than legs, long, narrow pelvis, one foot arch. Human: erect posture, S-shaped spinal curve, foramen magnum centred underneath the skull, short bony processes on neck vertebrae, chest flattened front to back, legs longer than arms, bowl-shaped pelvis, strengthened knee joints, two foot arches.

7. Advantages of being bipedal: (i) it frees up hands to carry food, offspring, use tools and weapons ii) the eyes are higher above the ground so predators or carcasses can be seen from further distances iii) the air is cooler above the ground so the body would be cooler. Less area of the body surface would face the Sun at midday too iv) walking on two legs is more energy efficient than movement on four legs.

8.

(a) Ape

(b) Australopithecus

(c) Homo. [The ape's jaw has parallel sides with large canines. The Australopithecine has huge molars and relatively small incisors. As you move to the right the jaw becomes more parabolic and the teeth get smaller. The human's teeth are more similarly sized.]

9. Dentition shapes the size and amount of prognathism of the jaw. The smaller the teeth and more parabolic the dental arcade, the less prognathism of the face.

10. See next page.

11. J, O, X. Others may show animals capable of brachiation, but they are not actually brachiating in the outlines.

12. They have changed from arboreal quadrupeds to ground-dwelling bipeds.

13. Australopithecines

14.

(a) Cerebral cortex

(b) Increased thinking reasoning and problem-solving abilities.

15.

(a) Pongid

(b) Australopithecus africanus

(c) Paranthropus robustus

(d) Homo sapiens

(e) Australopithecus afarensis

(f) Homo erectus

(g) Homo habilis

(h) Homo neanderthalensis

(i) Australopithecus boisei

16. Cranial capacity and shape, and jaws.

17. Scale to indicate the size of the skulls.

18.

(a) Homo erectus

(b) H. erectus has both the Broca's area and Wernicke's area in the cerebral cortex (usually on the left side) as shown by indentations on the internal surface of the skull. The Broca's area is concerned with speech production and the Wernicke's area is concerned with the interpretation of speech.

19. It supports anatomical and physiological comparisons that suggest the two species are closely related and therefore have a relatively recent common ancestor.

20.

(a) The ancestral Homo line split first into Africans and the rest. Then the European line split off followed by the Australians and Asians. As the Australian and Asian groups were the last to split off, then they are the most closely related.

(b) DNA is very difficult to extract from fossil bones. It is usually fragments and are highly degraded. Samples need to be compiled from several different individuals to get a near complete genome.

21.

(a) Artefacts are objects made by humans such as tools, weapons, jewellery and pottery.

(b) They can show how techniques used to manufacture them have changed and infer how providing shelter, food or warmth has changed.

10. Numbers may vary according to sources of information due to the specimens used.

Hominin	Cranial capacity	Time of existence (mya)	Skull features	Dentition prognathism	Opposability of digits	Pelvis structure	Limb and foot structure	Other
<i>Australopithecus afarensis</i>	430	3.9 – 2.8	low sloping forehead; prominent brow ridges; short sagittal crest in males	prognathic jaw; small canines, but larger taha. Africanus; diastema present	big toe not opposable	short and wide	long arms but shorter than legs; curved fingers and toes; feature for bipedalism	East Africa
<i>Australopithecus africanus</i>	457/480	3.2 – 2.0	slightly arched forehead; smaller brow ridges	prognathic jaw; shorter and smaller incisors and canines, large molars and premolars; no diastema	big toe not opposable	short and wide, less rounded than modern humans	long arms but shorter than legs; curved fingers and toes; features for bipedalism	Southern Africa
<i>Paranthropus robustus</i>	530	1.8 – 1.2	large sagittal crest, heavy brow ridges, low cranial vault	large molars and premolars with small incisors and canines by comparison; prognathism but less than Australopithecines	opposable thumb, limited precision grip	short and wide, no refinements for striding gait	features for bipedalism	South Africa
<i>Homo habilis</i>	650	2.3 – 1.5	rounder skull, small brow ridges, central foramen magnum	teeth arranged in a rounder arc, moderate prognathism	able to form precision grip – opposable thumb	no fossil evidence	relatively short legs and longer arms, slightly curved fingers indicating power grip	Southern Africa
<i>Homo erectus</i>	850 – 1100 average 958	1.89 million – 110,000	low sloping forehead, defined brow ridges	large, thick jaw without a chin; reduced molars	semi-opposable thumb	narrower than modern humans	similar to modern humans	Africa, Eastern Europe, SE Asia
<i>Homo neanderthalensis</i>	1500 – 1740	28 000 – 300 000	long low brain case with occipital bun, thick brow ridges, flared zygomatic arch	larger more robust prognathic jaw, lacking a chin, larger teeth	opposable thumb, not big toe	wide pelvis	thick limbs with large joints	Europe, South western to central Asia
<i>Homo sapiens</i>	1350	300 000 – present	short base and high cranial case	short jaw, bony chin, small teeth, parabolic arch	opposable thumb, not big toe	broad shallow pelvis	long legs compared to arms, straight fingers	

- 22.
- (a) *Hominin – Homo habilis Culture – Oldowan*
 - (b) *Hominin – Homo erectus Culture – Acheulian*
 - (c) *Hominin – Homo neanderthalensis Culture – Mousterian*
 - (d) *Hominin – Homo sapiens (Cro Magnon) Culture – Aurignacian*
 - (e) *Hominin – Homo sapiens (Cro Magnon) Culture – Solutrean*
 - (f) *Hominin – Homo sapiens (Cro Magnon) Culture – Magdalenian*
- 23.
- (a) *Increased complexity with greater amount of working of the stones and use of other materials in producing specialised tools.*
 - (b) *Complexity of the tools indicates a higher thinking ability of the people making them.*
 - (c) *Mode 1: H. habilis; Mode 2: H. erectus; Mode 3: H. neanderthalensis; Mode 4 and 5 H. sapiens*
 - (d) *specialisation increases – tools are made for specific tasks; tools are smaller and can be easily carried.*
 - (e) *Increased due to specialisation of each tool.*
- 24.
- (a) *Tools enabled nuts to be cracked, roots and tubers to be dug up, bones cracked for marrow and animals killed for meat. This increased the variety of the diet.*
 - (b) *Meat is high energy food and once that became a regular part of the diet, perhaps hominins were able to spend less time foraging for food. This would free them up for other activities such as the refinement and development of tools. With meat in their diet (and the use of fire), they could also migrate and live in colder climates. It may also have enhanced social behaviour and the development of speech as cooperation and communication between members of a group would be needed to bring down very large animals. This would have led to use of bones and skins for tools, clothes and shelters.*
- 25.
- (a) *Culture is any behaviour or information – knowledge, beliefs, customs, attitudes – held by a population that is acquired by learning.*
- These are passed on from one generation to another by communication and tradition.*
- (b) *Examples of cultural evolution include a change in lifestyle from hunter/gatherer to farmer to urban inhabitant, the development of a written language, religion, the development of art, painting, ceramics, textiles, photography and changes in tools from stone choppers and scrapers to metal implements.*
 - (c) *Biological evolution refers to the passing of genetic characteristics from one generation to another. What information is passed on is random and does not change in the life of the individual. As the information is only passed from parent to offspring, it is a very slow process. Cultural evolution can be a fast process; information can be passed onto a large number of individuals at any one time, it can be changed within a lifetime and have a purpose (to anticipate a need or satisfy a demand).*
- 26.
- (a) *A kitchen midden is an accumulation of objects that indicate human activity, e.g. empty sea shells, bones, stone tools and weapons (i.e. a prehistoric rubbish tip).*
 - (b) *They can show seasonal changes in diet, the types of tools that were used to process food by a certain group, and cultural development.*
- 27.
- (a) *Homo erectus*
 - (b) *Remnants of fire-blackened stones forming hearths, charcoal and charred bones found in association with their tools or skeletal remains.*
 - (c) *It would enable food to be cooked, killed potentially harmful microbes or worms in meat, provide light at night, provide warmth, harden wood for tools, kept away predators, etc.*
- 28.
- (a) *Homo neanderthalensis*
 - (b) *Evidence of burial rituals including body decorations and tools with body. They also made symbolic or ornamental objects.*



ANSWERS TO TRIAL TESTS

TT 1 – SCIENCE INQUIRY SKILLS

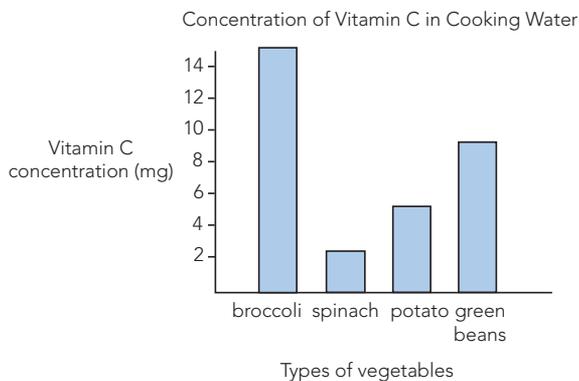
Section 1: Multiple choice (10 marks)

1. a
2. d
3. b
4. a
5. d
6. c
7. a
8. d
9. b
10. c

Section 2: Short answer (50 marks)

1.
 - (a) Cooking vegetables reduces the amount of vitamin C in them (2)
 - (b) The size of vegetable pieces (1), how long they were cooked for (1), the quantity of water used, the container they were heated in (1), the temperature that was used to cook them (1), whether the water was boiling before they were added or whether it was cold and brought to the boil (1), Any 3
 - (c) Repeat the experiment (1), but do not heat the water (1)

(d)



- (1) column graph
 - (1) for axes labelled correctly
 - (1) for correct scales on each axis
 - (1) for the heading on the graph
 - (1) for plotting the data correctly
 - (1) for a key or some other way to distinguish between each vegetable
 - (e) That cooking some vegetables does cause them to lose vitamin C.
2.
 - (a) In a double-blind test, neither the test subjects nor the testers (1) know who is in the control group and who is in the experimental group (1). Subjects are randomly allocated to each group (1) Due to the anonymity of a subject's treatment, the 'placebo effect' is exposed and

can be taken into account when the results are analysed (1)

- (b) The idea is to reduce the possibility of bias being introduced into the results by the subjects (1), who, by knowing the details of the treatment, could respond to psychosomatic inputs, or by the unintentional influence of the tester through suggestive comments or undue interest in the subjects' welfare (1)
3.
 - (a) same activity done (1); same conditions (1); same time of day (1); no practice allowed (1) same number of trials (1) (any 3)
 - (b) At least 3 but more is preferable (1) 3 will provide some sense of accuracy if all are within the same range (1) should be least one from each year in the age range if it is a true representation of the spread of ages the range (1)
 - (c) Error bars are graphical representations of the variability of data (1) and used on graphs to indicate the error or uncertainty in a reported measurement (1). They give a general idea of how precise a measurement is (1), or conversely, how far from the reported value the true (error free) value might be (1). Any 2
 - (d) The physical skills of 4 year olds are much less than 13 year olds (1) The ability of 4 year olds to understand and carry out instructions is less than 13 year olds (1) these differences will impact the results produced and skew comparisons and means (1)
 - (e) The method was inconsistent with others (1) producing results that are not comparable (1) skewing the results of the age group (1) giving false comparisons (1)
 4.
 - (a) The Salmonella came from one of the three possible food outlets – the restaurant, the take away outlet or the camp kitchen. (1)
 - (b) By asking all the people suffering Salmonella symptoms the source of their meals (1) and by asking where non-sufferers ate their meals. (1)
 - (c) Check other people not connected to the camp who ate at the different locations and who became ill. (1) If there was access to laboratory facilities, food samples and swabs of bench tops, from each location could be done to confirm the source. (1)
 - (d) Isolate the infected students. (1) Enforce hygiene measures eg. washing hands (1). Use separate eating and toilet facilities

to those uninfected (1). Send the infected students home. (1) Any 2

5.
 - (a) It is more common in groups F, G, H, I and J than in groups A to D (1) with J having significantly higher and A having significantly lower rates of diabetes (1)
 - (b) Lifestyle – sedentary, diet, (1) or maybe some ethnic groups are more prone to it (a genetic factor). (1)
 - (c) No, because this only represents a small sample of people in a specific age range (1) at one narrow location (1)
 - (d) Separate data and report separately on males and females with diabetes (1)
 - (e) This is the age group that is at risk of this disease. (1)
 - (f) Increase public awareness of its causes (1), education at school level (1) and promote ways to combat the problem via the mass media – TV, radio, newspaper (1)

Section 3: Extended answer (20 marks)

- (a) Hypothesis: elderly people who practise Tai Chi fall less often than people who do not practise Tai Chi (2)
Each dot point = one mark unless otherwise stated. (14 marks)
 - Select a large group of elderly people, i.e. 60 years of age and older.
 - Divide into two groups.
 - Use both males and females – randomly allocated to each group.
 - Have at least 100 people (the more the better) in each group.
 - They should be in the same age range and general health.
 - Participants should have similar lifestyles.
 - Participants have no previous experience of Tai Chi.
 - Record the numbers of falls and/or fractures each individual has experienced so far in their lifetime.
 - Train one group in the techniques of Tai Chi (they are the experimental group).
 - The other group is then the control group and go about their lives as usual.
 - Encourage the test group to practise the techniques every day for a year.
 - At the end of the year survey both groups again for the number of falls and/or fractures suffered over the year.
 - Compare these results using graphs and appropriate statistical analyses (e.g. mean, standard deviation, significant difference).[2]
 - If the experimental group has experienced less falls and or fractures than the control group, the hypothesis is supported.
 - If there is no difference in the number of falls or fractures between the experimental and control group, the hypothesis is refuted.

- Repeat the experiment.
- (b) Ethical considerations: (any 4)
 - selection of people for each group – self-selection; drop-out options
 - participant consent to collect data about health
 - working to national standards of best practice associated with this type of research
 - use of expert Tai chi instructors
 - amount of time required by participants

TT 2 – THE ENDOCRINE SYSTEM

Section 1: Multiple choice (10 marks)

1. d
2. a
3. d
4. b
5. c
6. c
7. c
8. d
9. b
10. d

Section 2: Short answer (50 marks)

1.

Hormone	Secreted by
Glucagon	alpha cells of the Islets of Langerhans in the pancreas (1)
Aldosterone	adrenal cortex (1)
Adrenalin	adrenal medulla (1)
Calcitonin	thyroid gland (1)

2.

- (a) to get an initial reading with which to compare readings after the injection (1)
- (b) inverse relationship (1): as thyroxine increases TSH decreases. (1)
- (c) hypothalamus (thyroid releasing factor) (1) anterior pituitary (TSH) (1) and thyroid gland (thyroxine) (1)
- (d) thyroxine increases the body's metabolism causing the release of heat to maintain body temperature (1), increases appetite (1), increase heart rate and promotes vasodilation (1)
- (e) They have increased sensitivity to cold (1), because their metabolic rate is low (1) due to lack of thyroxine (1)
- (f) lack of iodine in the diet (1), damage to the thyroid (cancer, radiation therapy, surgery) (1)
- (g) thyroxine increases metabolism increasing the use of glucose and storage fats (1) but also causes rapid and irregular heart rate (1) and nervousness and anxiety which are not good for general health (1). It relies on the person not increasing food intake when the supplement causes an increase in appetite. (1) Ethical problems: the amount of information given about the side effects (1); using the supplement by people who may have other health issues eg. heart (1); stating dosages

that may not be appropriate to the person's conditions and stature (1). (Any 2 for claims; any 2 for ethics)

- 3.
- A – hypothalamus (1), D – posterior pituitary (1), F – anterior pituitary (1)
 - The axons of nerve cells link the hypothalamus to the posterior pituitary through the infundibulum. (1) Hormones produced in the cell bodies of these neurons travel down the axons into storage sites in the axon terminals of the posterior pituitary. (1)
 - oxytocin (1) antidiuretic hormone (1)
 - Hormones are made or stored in D and F. To travel to their target cells/organs, they need to diffuse into the blood circulation. (1) The capillary networks provide a large surface area to volume ratio to allow the fast movement of hormones into the blood. (1)
 - These cells manufacture hormones that are protein-based (1). Ribosomes are the site of protein assembly (1), the endoplasmic reticulum is where the final protein structure is done (1) and the Golgi bodies package the proteins/hormones for secretion from the cell. (1)
 - Overproduction of prolactin from a pituitary tumour (prolactinoma) can cause a decrease in normal levels of FSH (1) there will be no follicle development (1) – no possibility of ovulation of an ovum (1).

- 4.
- protein (water-soluble) (1)
 - in X – A represent a hormone receptor (1); protein-based hormones are no lipid soluble so can't diffuse across the lipid-based cell membrane (1) these hormones need to bind to a receptor resulting in activation of a signalling pathway (1). in Y – the hormone diffuses across the membrane because it is lipid soluble to enter the cell (1)
 - G protein is the first messenger (1), activates the signalling system for the cell to react to the hormone. (1)
 - Hormones attach to receptors within the cell (cytoplasm or nucleus) (1) and increase the transcription of specific genes (1) increasing the production of proteins as a response to the hormone (1),
 - Calcitonin attaches to hormone receptor on the surface of the cell membrane. (1) The G-proteins are activated (1) which stimulates cellular activity (1) such as changing cell membrane permeability to calcium and phosphate (1) to increase or decrease the amounts of these in the blood. (1)

Section 3: Extended answer (20 marks)

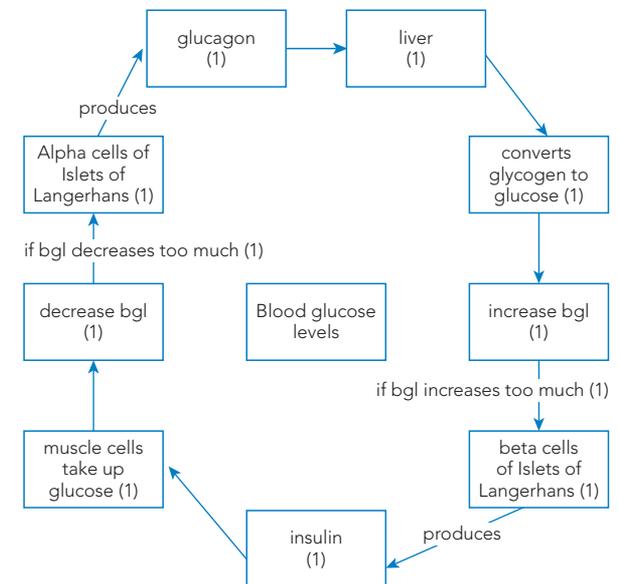
(a) (8 marks)

Must have examples (2) plus any other 6.

Feature	Endocrine glands	Exocrine glands
secretions	hormones	range of different materials including mucus, milk, saliva, digestive juices, acid
response time	slow	fast
how secretions are released	directly into the blood stream	via a duct onto a surface (internal or external)
area of effect	target cells/organs are at a distance from the gland	directly to the area of use
examples	thyroid, gonads, adrenal gland, pancreas	pancreas, liver, salivary glands, mucous glands, sweat glands

(b) (12 marks)

- The pancreas produces insulin and glucagon to control blood glucose levels (bgl). (1)
- At the end of the running event, the person's blood glucose levels will be low (1)
- The use of glucose by the runner is still high so needs a constant supply (1)
- The release of glucose from storage needs to compensate for the use of glucose by the active muscles (1)



TT 3 – THE NERVOUS SYSTEM

Section 1: Multiple choice (10 marks)

- c
- b
- d
- d
- a
- a
- d
- b
- c
- a

Section 2: Short answer (50 marks)

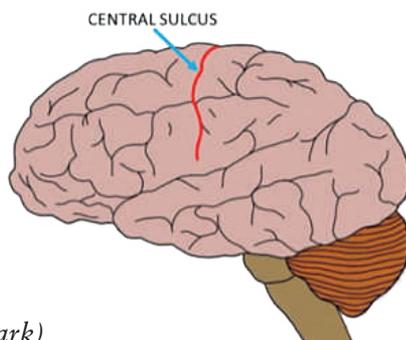
1. (2 marks) – need to have both pieces of information for the mark to be given

Two systems to compare	Main functional difference
Central nervous system compared to the peripheral nervous system	CNS – the processing centre of the body interpreting and responding to information from the PNS PNS – sends nerve impulses to and from the CNS to the rest of the body (1)
Afferent division vs Efferent division of the peripheral nervous system	Afferent – impulses coming in via the sensory nerves; Efferent – impulses leaving the CNS through motor nerves (1)

2. (a) (6 marks)

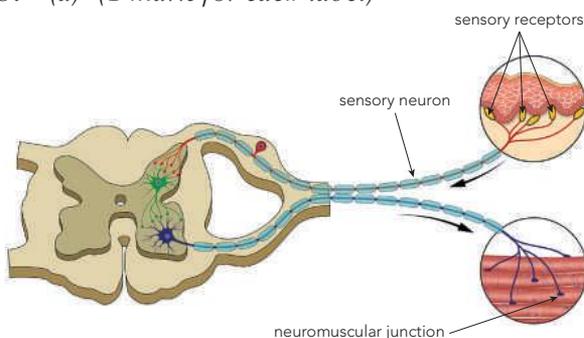
Part	Name	Function
A	corpus callosum (1)	connect the hemispheres of the cerebrum (1)
B	cerebellum (1)	coordination, precision and timing of movements, as well as in motor learning (1)
D	medulla oblongata (1)	regulating basic functions of the autonomic nervous system, including respiration, cardiac function, and reflexes. (1)

- (b) (i)



(1 mark)

- (ii) The primary motor area is to the front (anterior) of the central sulcus (1); the sensory area is to the rear (posterior) of the central sulcus. (1)
- (c) The primary and association areas of vision (1) the impact would have caused impulses to be generated in these neurons and be perceived as light or 'stars' (1)
3. (a) (1 mark for each label)



- (b) Dan would have impaired movement (partial paralysis) of the muscles controlled by the damaged motor neuron (1); would also have reduced sensation (numbness) from the area covered by the damaged sensory neuron (1)

- (c) the synapse between the interneuron and the motor neuron (1); sensory impulses still went to the brain so the synapse between the sensory neuron and the interneuron still functioned (1), but impulses didn't pass along the motor neuron to cause any actions (1)

- (d) The sensory impulse from the burn travelled to the spinal cord via the sensory nerve (red neuron), then transferred directly to the motor neuron (purple neuron) via the interneuron (green neuron) (1) where the impulse travelled to the muscle to produce a response (1) before the impulse was sent to the brain via connections with the interneuron (1).

4.

- (a) A – neurotransmitter molecule; B – synaptic vesicles carrying neurotransmitter; C – receptors
- (b) The electrical impulse travelling down the neuron causes Ca ions to enter and trigger the vesicles to migrate towards the synapse (1)
- (c) The membrane of the adjoining neuron is depolarised (1) initiating the nerve impulse in the adjoining nerve (1)
- (d) A (neurotransmitter) is acted on by enzymes (eg. cholinesterase) to break it down (1) or actively reabsorbed (1)

(e)

Animal	Effect	Symptoms in victim
Cyanobacteria (algal blooms)	Stimulation of acetylcholine receptors	uncontrolled muscle twitching (1)
Funnel web spider	Blocks calcium channels	paralysis (1)

5.

- (a) A – dura mater (1); B – Arachnoid layer (1); C – pia mater (1)
- (b) Pia mater – delicate fibrous tissue (1) which contains blood vessels (1) attached closely to the surface of the brain and spinal cord and acts as a barrier (1) and aids in the production of cerebrospinal fluid. (1) (any 3)
- (c) meningitis (1)

6.

- (a) X – sympathetic nervous system (1)
Y – parasympathetic nervous system (1)
- (b) Sympathetic nervous system (1)
- (c) Undoes the work of the sympathetic nervous system after a stressful situation (1); reduces heart rate and blood pressure, constricts bronchi which combined reduce the supply of oxygen the cells because the metabolic rate has decreased (1). Other organs return to normal function eg. digestive system which has reduced blood flow during stress (1) Increases glucose uptake and conversion of glucose to glycogen in the liver because it is not needed to response to stress (1) (Any 3)

7. 4 marks – one for each space answered correctly.

Type of receptor	Example	Stimulus
Chemoreceptor	taste buds on the tongue olfactory cells in the nose	presence of different chemicals
Mechanoreceptor	free nerve endings Pacinian corpuscles	pressure and touch on the skin
Thermoreceptor	Krause and Ruffini structures in the skin	temperature changes
Photoreceptor	retina of eye	light

Section 3: Extended answer (20 marks)

(a) 10 marks

At time 0: resting potential Na/K ion pump actively maintains the concentration differences of Na and K across the membrane at about 70mV. (1)

At A: this is the threshold potential (1) at which the stimulus opens the Na ion channels allowing Na ions across the membrane into the cell which causes the electrical potential to become positive. (1) The Na ion channels close at the peak (1). Below the threshold level at A, no action potential will be generated (1).

B: At the peak, the K ion channels are stimulated to open when the potential difference has reached about 35+ mV (1)

C: This allows the K ions to flow out (1) causing the electrical potential to drop and become negative. (1) D: The K ion channels close at about -80mV (1) causing hyperpolarisation. (1)

E: The Na/K ion pump returns (1) the Na and K ions to their resting potential locations. (1)

(b) 10 marks

The myelin sheaths act as insulation (1) so the Na/K ions don't move across the membranes under them. (1) Therefore, not action potentials are produced under the myelin sheaths (1). Depolarisation of myelinated axons jump from one Node of Ranvier to the next (1) as there are the gaps that have the ion channels through which Na and K ions can move (1) producing an action potential. (1) In unmyelinated nerves all points along the membrane will become depolarised (1) in a self-propagating wave (1). As only the Nodes of Ranvier are depolarised in myelinated nerves, the impulse travels faster (1) than the unmyelinated nerve where all points are depolarised in order. (1)

TT 4 – HOMEOSTASIS

Section 1: Multiple choice (10 marks)

- b
- b
- a
- a
- b
- c
- a
- d
- a
- d

Section 2: Short answer (50 marks)

1.

(a) glycogenolysis (1), glucagon (1); glycogenesis (1), insulin (1)

(b) skeletal muscles (1)

(c) glycogen is insoluble and not osmotically active (1) so will not change the osmotic pressure in cells (1) whereas glucose does (1)

(d) (i) inversely proportional – as one increases, the other decreases (1)

(ii) high blood glucose increases rate of activity of glucose synthetase which stores glucose as glycogen (1); decreases rate of activity of glycogen phosphorylase which releases glucoses from storage (1)

(e) (i) Normal: 7.5 mmol/L (1); Diabetic: 4.5 mmol/L (1) (must have units)

(ii) increased blood glucose detected (1); insulin is produced (1) causing uptake of glucose by cells (1) which keeps blood glucose levels quite low (1)

(iii) 1.0 hours (1) (must have units)

(iv) insulin (1)-uptake of glucose by cells (1); increase conversion of glucose to glycogen (1)

(f) from the breakdown of fats (1) or proteins (1)

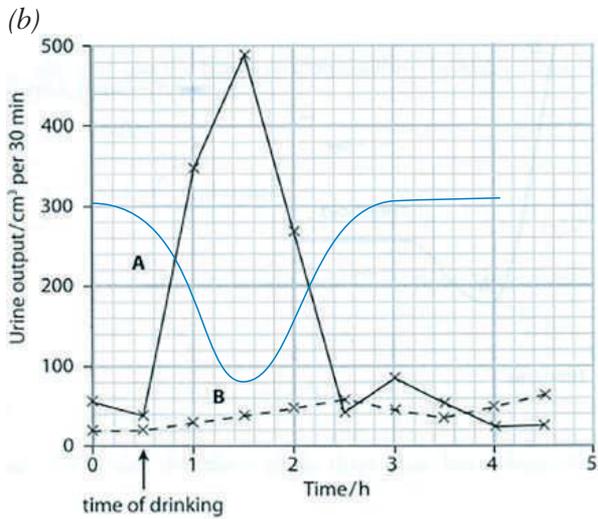
(g) use of glucose in cellular respiration (1); storage of glucose as glycogen (1)

2.

Organ	Involvement in excretion
Liver	production of urea from nitrogenous wastes (1)
Lungs	removal of carbon dioxide (1)
Skin	removal of water and some wastes/salts (1)

3.

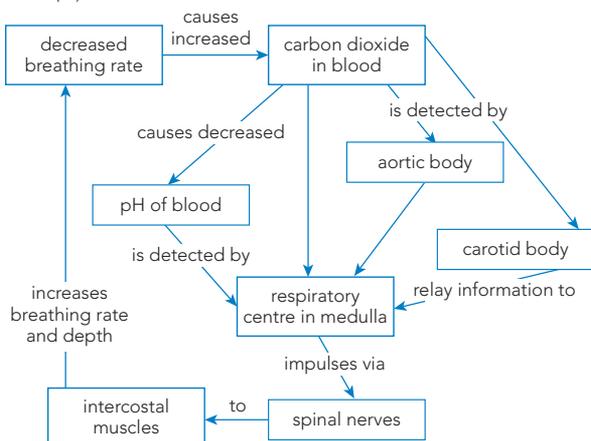
(a) 350 mL after 30 mins (1); 490 mL between 30 and 60 mins (1) total 840 mL (1)



1 mark for dip aligned with peak; 1 mark for return to normal levels

- (c) After the time of the second urine collection (1); ADH causes the uptake of water from the filtrate in the kidney (1); after the second collection urine volumes decreased (1) indicating that ADH is working (1)
- (d) The drink was the same osmotic potential as blood so the body can only detect a change in volume of blood (blood pressure) (1) not the concentrations of salts/water that will stimulate the ADH/aldosterone response (1) The body responds to changes in blood pressure more slowly (1) and removes excess water and salts alternatively at low levels as a result (1)
- (e) Proteins – are too large (1) to be filtered from the blood across the capillary membranes into the Bowman's capsule (1); glucose is filtered into the filtrate (1) but is actively reabsorbed (1) at the proximal convoluted tubule (1)
- (f) Only some urea is reabsorbed by diffusion the nephron (1); about 90% water is reabsorbed before the collecting duct (1) so the concentration of urea increases due to less water in the filtrate (1); at the collecting duct more water can be reabsorbed, increasing the concentration of urea even further. (1) urea is not actively reabsorbed or secreted (1)

4. (a)



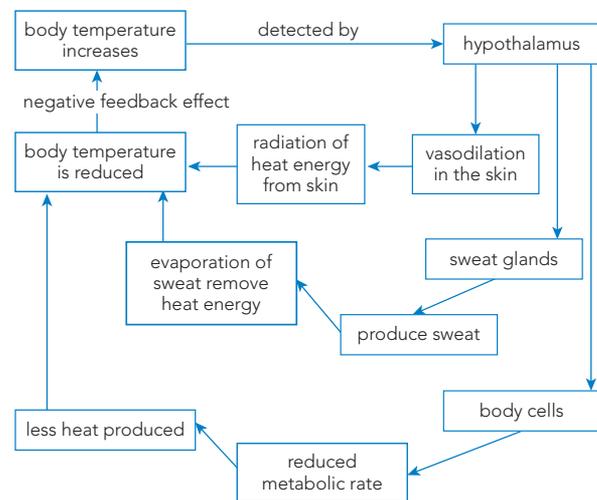
- (b) heart rate increases with exercise (1); more blood is pumped to the lungs (1) where carbon dioxide can be moved at a greater rate (1) and more oxygen can be taken up (1) and pumped to the active muscles (1)
- (c) carbon dioxide reacts with water in the blood to produce hydrogen ions (1) pH a measure of the amount of hydrogen ions in solution (1)

Section 3: Extended answer (20 marks)

(a) Heat gain by the body (10 marks)

	Heat Gain	Changes
Conduction (1)	when the body touches a warmer surface heat energy will flow into the body from that surface (1)	can increase the temperature of the external surface to increase heat energy flow; can increase the amount of body surface in contact with the warmer object (1)
Convection (1)	when the air/water flowing passed the body is warmer than the body surface heat energy will flow into the body (1)	increase the temperature difference between the flowing current and the body; increase the flow rate; increase the body surface exposure (1)
Radiation (1)	heat energy is transferred from hot objects to cooler ones by infrared radiation (1)	move closer to the radiant source; increase the temperature of the radiant source; increase body exposure to the source (1)

(b) Thermoregulation on a hot day (11 marks)



TT 5 – RESPONSE TO INFECTION

Section 1: Multiple choice (10 marks)

- c
- d
- b
- c
- d
- c
- b
- b
- a
- d

Section 2: Short answer (50 marks)

1.

- (a) state of health, previous exposure to antigen, range of ages, gender balance, lifestyles (any 3)
- (b) rate of infections in vaccinated group when exposed to antigen (1)
- (c) side effects, shelf-life and conditions of storage, dosage and frequency of administration, (any 2)
- (d) (i) plasmid (1), comes from a bacterium (1)
 (ii) they are cut with the same restriction enzyme to cut at the same sequence of each and will form complementary ends
 (iii) to produce sticky ends (1) of complementary base sequences (1) that will hold together while ligase joins the nucleotide pairs (1)
 (iv) the recombinant DNA is inserted into a cell (1) human or bacterial (1) where it will produce the protein coded for on the inserted DNA (1)

2.

(a)

Site	Defence mechanism
Mouth	enzymes in saliva breakdown cell walls of bacteria (1)
Stomach	stomach acid kills bacteria and parasites (1)
Trachea	cilia lining the trachea move mucus and trapped particles towards the pharynx (1)
Eyes	lysozymes in tears, mechanical action of blinking washing away pathogens (1)

(b)

Role in the inflammatory response	
Histamine	increases blood flow and the permeability of the capillaries to white blood cells and some proteins at the wound site (1)
Mast cells	act to trigger the immune response by releasing histamines (1)
Phagocytes	engulf pathogens, debris of damaged body cells (1)

- (c) (i) masks stop droplets that may carry pathogens from spreading from the nose and mouth while talking, sneezing or coughing (1). It may also stop pathogens being inhaled if they are present in the air. (1)
 (ii) regular hand washing removes any pathogens a person may pick up from contaminated surfaces. (1)
 (iii) not sharing drink bottle reduces the probability of contact transfer of pathogens from an infected to a non-infected person. (1)

3.

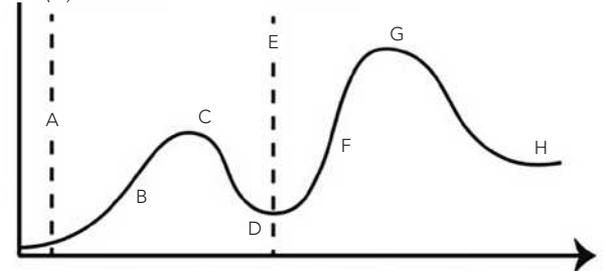
- (a) breaking down the cell walls killing the bacteria, disrupting the plasma membrane (1); blocks metabolic pathways (1) damages the structures of the cell (1); disrupt protein and DNA synthesis causing reproduction

and repair of cellular structures to be compromised or not to happen (1) (any 2)

- (b) antibiotics target the specific differences between human cells and bacteria (1 – must have this) eg. the cell wall of bacteria, (1) the different proteins in the ribosomes (1), the structure of the DNA (1) or interacts with receptors/chemicals on the plasma membrane of bacteria that are not found in humans (1). (any 2)
- (c) antibiotics target the cellular structures of bacteria that don't exist in viruses (1) so they will not have any effect on viruses (1)
- (d) to ensure that all of the pathogenic bacteria are killed or prevented from multiplying (1). When you stop treatment early, it may allow a small number of bacteria to remain in the body and these bacteria have the potential to change and develop resistance to the antibiotic and re-infect the person (1).
- (e) Any 2

Mechanisms	How it works
interfere with the virus's ability to enter the cell	can't take over cell functioning to produce more virus particles
can disrupt the uncoating of the virus (1)	stops the RNA or DNA content of the virus inserting itself into the cell's genome
disrupt the replication of DNA/RNA	stops the cell from making the viral DNA/RNA content
prevent protein production	the virus's protein coat is not produced virus particles are not formed
stops the release of the viral particles	no virus particles enter the internal environment to infect other cells

4. (a)



A – vaccination; B – pathogen is recognised by macrophages and activate B cells to produce plasma cells to produce antibodies; C – antibodies have overcome the antigen; D – long-lived memory cells with antibodies are produced; E – exposure to antigen; F – faster response by B cells in producing plasma cells to produce more antibodies; G – antibodies have overcome antigen; H – greater residual amount of antibodies after second exposure to antigen. (1 for each letter explained)

- (b) The AstraZeneca may have a low residual amounts of antibodies and few memory cells after the first exposure, so needs another the increase this to effective levels (1). The

Johnson & Johnson vaccine may produce a greater antibody response with the first exposure (1).

- (c) *macrophages (1)*
 (d) *memory cells (1)*
 (e)

Vaccine type	Method of production
Attenuated or inactivated virus vaccine	kill the virus in a specific way so that it maintains the structure of that dead virus but is not infectious (1)
mRNA vaccine (1)	Synthesize, using biotechnological methods, the RNA sequence that encodes the spike protein of the virus. This is mixed with lipid droplets producing the vaccine. No cells or viruses are involved in the making of this type of vaccine.
Viral-vectored vaccine	take a harmless virus, and add the spike protein DNA to it so that it can infect cells, but can't reproduce and go on to infect other cells. (1)

- (f) *Social – family history with vaccines; perceived risks and ‘fake’ new spread through social media; concerns of side effects and efficacy of vaccines*
Cultural – beliefs about the use of vaccines; lifestyles and the role of individual’s choice in health care options. (any 3)

Section 3: Extended answer (20 marks)

- (a) *Passive and active immunity comparison (10 marks)*

Feature	Passive Immunity	Active Immunity
how it is acquired	antibodies are received from an external source (1)	produced by the body's immune system in response to an antigen (1)
how long it lasts	short lasting (1)	long lasting (1)
how long to take effect	immediate (1)	from 4 days to 4 weeks (1)
reaction to second exposure to antigen	none (1)	secondary response is faster and greater (1)
involvement of the lymphocytes	none (1)	T-cells and B-cells phagocytes and macrophages (1)

- (b) *Disease transmission methods Any 5 – 1 mark for name/description; one mark for example*

Method	Description	Example
Airborne	an infectious agent enters the air when an infected person sneezes, coughs, laughs—or even just breathes—and it can remain in the air for an extended period of time	Influenza, Covid - 19
Vector-borne (zoonotic)	mosquitoes and ticks may carry pathogens that can multiply within their bodies and be delivered to new hosts, usually by biting	Malaria, bubonic plague, Lyme disease, dengue fever,

	direct – people touch or exchange body fluids	HIV, glandular fever, measles, TB, influenza, Covid-19
Contact	indirect – coughing or sneezing producing droplets containing the pathogen	measles, TB, influenza, Covid-19
Food	when food is contaminated with a pathogen during preparation or transport	Cholera, typhoid, salmonella poisoning, Listeria
Water	contaminated with pathogen-laden faeces or urine; sharing drinks containers contaminated with saliva	Cholera, hepatitis, diarrhoea

TT 6 – MUTATIONS

Section 1: Multiple choice (10 marks)

- a
- c
- a
- b
- a
- b
- c
- d
- d
- b

Section 2: Short answer (50 marks)

- (a) *STOP codons all start with a U have A and G combination (1)*

(b) *Met – AUG; Cys – UGU or UGC; Glu – GAA or GAG*
possible combinations:
 AUG UGU GAA (1)
 AUG UGC GAA (1)
 AUG UGU GAG (1)
 AUG UGC GAG (1)

(c) *DNA AGT → RNA UCA – codes for Ser amino acid (1) DNA ACT → RNA UGA – is a STOP codon (1) The change will stop the amino acid chain at this mutation point (1) which will change the protein produced by this sequence. (1)*
- (a) *Autosomal (1)*

(b) *Sex-linked means the males will have the affected phenotype if they have the allele (1). An unaffected male has produced an affected daughter. She had to get an affected allele from each parent, therefore the allele could not have been on the X chromosome donated by the father. (1) Therefore is autosomal.*

(c) *Recessive – unaffected parents (1-2; 4-5; 14-15) have all produced affected offspring. (1) a recessive phenotype requires two recessive alleles (1). Heterozygous parents each have a recessive allele which can combine in fertilization to produce a homozygous recessive (1).*

(d) *4 generations (1)*

- (e) Carrier mothers – 4 – had an affected son #11 (1); 9 – had an affected son to an unaffected father #16 (1); 12 – had an affected daughter with an affected partner #19 (1);
- (f) Parent: 18 $X^N Y$ (unaffected father) (1); 19 $X^N X^n$ (heterozygous/carrier mother) (1); N – normal/unaffected; n – affected (1). This is the only combination that will produce an affected son from a sex-linked inherited condition (1).
- (g) $X^b Y$, (1) $X^B X^b$ (1)
- (h) Prob of X^b from mother = 0.5 (1)
 Prob of Y from father = 0.5 (1)
 Prob of $X^b Y$ = $0.5 \times 0.5 = 0.25$ or 25% or 1 in 4 (2)
- 3.
- (a) Dry ear wax is recessive to sticky ear wax (1) sticky parents produce dry offspring to both have dominant phenotype but heterozygous genotype (1)
- (b) To get the expected ratios, the genotypes of individuals need to be known (1). The sticky individuals could be homozygous EE or heterozygous Ee (1). Only the dry individuals' genotypes are known: ee (1).
- 4.
- (a) chromosomes are not arranged in homologous pairs therefore not meiosis (1); no crossing over seen (1)
- (b) gametes containing X chromosomes and gametes containing Y chromosomes (1) as this karyotype is from a male with XY chromosomes (1)
- (c) chromosome X (1) the genes are further apart than those on Chromosome 1 so have a greater chance of crossing over occurring in that distance (1)
- 5.
- (a) autosomal recessive (1) – two unaffected parents produce an affected (1) daughter so is not sex-linked (1)
- (b) sex-linked recessive (1) – unaffected parents (1) have an affected son (1) mother carries affected allele (1)
- (c) autosomal recessive (1) – an affected father and unaffected mother (1) produce an unaffected (1) son (1) OR sex-linked recessive – an affected father and unaffected mother (1) produce an unaffected (1) son (1)
- (d) autosomal recessive – two unaffected parents produce affected (1) children (1)
- all children produced missed the chance inheritance
 - until recently foetuses with the homozygous recessive trait may not have survived to birth
 - naturally aborted foetuses were not tested for genetic conditions
- (b) Inbreeding (3 marks)
- greater percentage of carriers likely in small inbreeding population
 - greater chance of two carriers producing offspring
 - greater chance of homozygous recessives being produced
2. Genetic counselling (any 10)
- Researching (and drawing) a family pedigree, genetic counsellors may be able to determine the probability of a couple having a child with a particular genetic disease.
 - E.g. if the couple are determined by the pedigree to be heterozygous for a particular disease, the likelihood of any child having the disease would be 0.25.
 - Beta thalassaemia and sickle-cell anaemia are diseases which can be identified in this way.
 - If the probability of having a child with a serious genetic disease is unacceptably high, the couple may choose to adopt or use assisted reproduction technology (e.g. IVF, GIFT, etc.), combined with donor gametes/s if necessary.
 - Genetic testing can show chromosomal abnormalities or the presence of abnormal proteins (which are indicators of affected alleles
 - These tests can be carried out on both the parents and foetus (prenatal).
 - DNA profiling of parents to see if they carry the affected alleles
 - Genetic screening of embryos to identify those NOT carrying the alleles
 - Prenatal testing may involve amniocentesis, umbilical blood sampling or chorionic biopsy to examine the karyotype of the developing child.
 - Karyotypes can be used to test for a number of conditions, including Down's syndrome.
 - Karyotypes can be used to determine the sex of the foetus and therefore in the case of sex-linked diseases, help to determine the probabilities of inheritance.

Section 3: Extended answer (20 marks)

- 1.
- (a) Deleterious alleles presence not known (any 7)
- allele is recessive
 - may only occur in a few family members
 - carriers need to produce offspring
 - chances of gametes carrying affected allele being involved in fertilization is $\frac{1}{2}$ for carrier parent

TT 7 – GENE POOLS

Section 1: Multiple choice (10 marks)

- | | |
|------|-------|
| 1. a | 6. d |
| 2. b | 7. d |
| 3. c | 8. b |
| 4. b | 9. c |
| 5. a | 10. b |

Section 2: Short answer (50 marks)

1.

- (a) 1. the size of the population being small will lead to more close inbreeding of people carrying the allele. (1) 2. Isolation of the population reducing migration to dilute the population of carriers (1) 3. Social/cultural traditions of groups that does not allow mating outside the group. (1)
- (b) A small group of migrants from France had members carrying the T-S allele (1). These people had more chance of interbreeding with others in the population who also carried the allele (1). More offspring carried the allele increasing the proportion in the population (1)
- (c) Genetic profiling of embryos can identify those carrying the T-S allele. Selection of those without T-S to implant in Assisted Reproductive technologies (1); Genetic profiling of parents to advise on probabilities of producing a child with T-S (1)
- (d) (i) The mutation to produce the T-S allele occurred in the production of gametes in the mother or father (1). This gamete was fertilised to produce an offspring with the recessive allele (1). This person survived to reproduce children carrying the T-S allele (1). (ii) T-S spread when people with T-S alleles were able to travel – migration out of eastern Europe (1).
- (e) The T-S allele carried as a heterozygous gave the person a survival advantage (1) allowing them the live to reproduce and pass the allele onto their offspring (1)

2.

- (a) Heterozygous people have a survival advantage (1) and can pass the allele onto their offspring (1)
- (b) Increase the incidence of Thalassaemia in the new country (1) because people carrying the allele will be among the migrants (1)
- (c) The heterozygous genotype would not give a survival advantage (1). It has an overall survival disadvantage so more people would die earlier and leave fewer offspring. Therefore reducing the number of thalassaemia alleles in the population (1).
- (d) The younger people has a similar probability of having the athalassemis alleles as the older generations. (1) The younger migrants have a high probability of having children and so passing the alleles to the next generation, increasing the number of people carrying the alleles. (1) The older migrants would not reproduce therefore would not add to the proportion of the population with the thalassaemia alleles. (1)

3.

- (a) Mutation (1); random mating (1); recombination during meiosis and fertilisation (1); gene migration (1)

- (b) Ability to survive in low oxygen atmosphere (1)

- (c) Indeterminant (1) Evidence: the family tree histories (1) of those with and without the characteristic (1); observations of offspring of known individuals with/out the characteristic (1) OR genetic screening (1) or genome sequencing (1) of people with and without the characteristic (1) linked to studies of offspring and family trees (1)

- (d) The allele does not confer any advantage for survival (1) at low altitudes so is not a selection factor in survival (1) Those without the allele can survive and reproduce at the same rate as those with the allele (1)

4.

- (a) Struggle for existence – competition between individuals for the requirements of survival eg, food, mates, shelter (1) Those that win the struggle can reproduce and pass their genes onto their offspring (1)

- (b) Differential selection – selection pressures act differently (1) on individuals with different phenotypes (1)

5.

- (a) Change from coastal city where malaria is common to mountains where malaria is rare (1) Having the sickle cell allele gives no advantage or is a disadvantage in the mountains (1) the individuals with the sickle cell allele are more likely to die and not pass their genes to any offspring (1) thereby reducing the proportion of sickle cell alleles in the next generation (1)

- (b) Non-related family – unlikely to carry the sickle cell allele (1) Large number of offspring would increase the proportion of individuals without the allele (1) so would reduce the frequency of the sickle cell allele in the population (1)

- (c) Could have been controlled by a dominant allele (1) making the phenotype more common (1); the families carrying the allele may have had large families compared to other families in the population (1); the genetic condition may have increased the survival rate of carriers compares to those without the allele (1);

- (d) Smaller populations have less genetic diversity (1); have a greater chance of individuals carrying the specific trait to interbreed (1); the death of one person makes a big percentage difference in the population (1)

Section 3: Extended answer (20 marks)

1. Loss of diversity in an island population over time (any 10)

- low level of diversity initially (1)
- some island families had more offspring (1) so become a greater proportion of the subsequent generations (1) after 1890s (1)

- some island families left after 1890' (1) removing their genes from the gene pool (1)
 - not all people who died 1830-1890 were buried on the island – died at sea, cremated, taken to mainland for medical treatment (1) so not included in the consensus for those dates (1)
 - extended family members from main island families migrated to the island between 1890 and 1990 (1) increasing their proportion of the population (1)
 - social and cultural practices impacted on who could wed and have children (1) reducing the chances of some families to contribute to the gene pool and increasing others. (1)
2. Activities: (any 10 covering all 3 areas)
- fighting deforestation and habitat destruction
 - allows for greater interaction between groups of orangutans in the wild (1)
 - these activities overcome the problems of small isolated populations that are prone to inbreeding and genetic drift (1)
 - increases the survival of animals in particular areas (1) maintaining diversity of the gene pool (1)
 - training of ex-pets and orphans
 - show how to survive in the wild (1)
 - increased survival leads to increased chances of producing offspring (1)
 - pets have come from a wide range of capture locations so increase the size of the gene pool (1)
 - captive breeding
 - exchanging individuals with other zoos to reduce the impact of inbreeding in small populations (1)
 - zoo-bred individuals add to the natural population gene pool (1)
 - increase the number of young that survive (1)
- proteins causing the phenotype (1) because some amino acids are coded for with several different triplet codes (1)
- (d) change from C to G in T (1); T also has the same change as in S (1) which does not appear in R (1) The T is a changed version of S (1)
- (e) ethical implications: once people know they carrier the allele for an inherited condition they can choose a. to ignore it and have children and take the chances of having an affected child; b. decide to tell their partner about the risks and test the partner for the presence of the allele; choose IVF techniques of reproduction to have embryos tested and selected for implantation; c. decide not to have children. OR a. decide to act on the formation or not (1); b. decide about letting others know about it because it may indicate others with the allele (1); c. decide whether to use biotechnological techniques in addressing the issues that arise (1)
- (f) Comparing proteins does not give the fine level of detail the DNA sequencing does (1) because amino acids can be coded for by different codon triplets (1)
- 2.
- (a) Argon gas (1)
- (b) $12.5\% = 1/8\text{th}$ (1) which requires 3 half-lives to reach (1) $3 \times 1.3 = 3.9$ billion years (1)
- (c) Limitations of K-40 dating: determining the amount of argon in a sample when the amounts are so small (1) errors caused by escape of argon from the sample (1) excess argon may have entered the sample from external sources (1); the decay constants for K-40 are accurately known (1); that the K-40 in the sample doesn't break down into any other isotope (1); (any 4)
- (d) 27000 is 4.712 half lives (hl) (1) 4 hl is $1/16 = 6.25\%$ (1) 5 hl is $1/32 = 3.125\%$ (1) 0.712 of the difference between half life 4 and 5 = $0.712 \times 3.125 = 2.225$ (1) estimate 6.25 = $2.225 = 4.025\%$ (1)
- (e) Samples this old have very small amounts of carbon-14 (1) and are prone to measurement errors (1)
- 3.
- (a) index fossils are fossils have a short geological time range (1), wide geographic distribution (1).
- (b) are a relative dating technique (1) can age object above or below strata of index fossils (1) to indicate younger or older (1)
- (c) sedimentary rocks (1)
- (d) the remains of dead organisms need to be preserved from scavengers or decay to become fossils (1). Marine – remains sink and are quickly covered by silt (1) Terrestrial – remains are not covered before decay and scavengers dispose of them (1)
- (e) earth movements – earthquakes, landslides reveal fossils; (1) erosion through sediment

TT 8 – EVIDENCE FOR EVOLUTION

Section 1: Multiple choice (10 marks)

- | | |
|------|-------|
| 1. c | 6. b |
| 2. c | 7. c |
| 3. b | 8. d |
| 4. a | 9. c |
| 5. a | 10. c |

Section 2: Short answer (50 marks)

- 1.
- (a) DNA sequencing (1) or electrophoresis automatic sequencing (1)
- (b) R: ACCTCCCCG CAGTGGGGAC
S: ACCTCCCC T CAGTGGGGAC (1)
- (c) (i) S phenotype (1) have the T in the sequence not G. (1)
(ii) the change in the sequence made no change in the amino acid sequence (1) of the

layers by wind or water remove the top layers revealing fossils from lower layers (1); folding and faulting of the earth's surface can expose layers by folding, inversion and causing rifts and canyons with new layer revealed. (1)

4.
 - (a) mitochondria (1)
 - (b) at fertilization, only the head of the sperm (nucleus) enters the ovum (1) all other cellular contents are in the ovum (1).
 - (c) it can provide direct evidence for population origins and migration processes (1); shows the relatedness of populations (1); mtDNA has a higher mutation rate than nuclear (1) DNA so is useful for the comparison of groups to produce phylogenetic trees (1).
5.
 - (a) Tertiary (1)
 - (b) Cainozoic (1)
6.
 - (a) no purpose (1)
 - (b) reduced in size (1)
 - (c) similar; different (1)
 - (d) related; different (1)

Section 3: Extended answer (20 marks)

1. importance of fossil record

Fossils are the preserved remains or indications of something that was once living. [2]

Objects that can be fossilised include: bones, teeth, shells, coprolites (fossil faeces), impressions of foot prints, jellyfish and leaves, whole organisms such as insects in amber (a pine tree resin they become stuck in which becomes fossilised), worm burrows, stone implements, or humans in ice or peat bogs. [4 examples = 2]

They are mainly found in sedimentary rocks [1] such as mudstone, sandstone and limestone. For fossils to form there needs to be some mechanism that ensures they are rapidly buried [1] when they die. This could occur in either volcanic ash or sediments laid down in shallow seas or lakes. Rapid burial means less chance of the remains being disturbed by scavengers, wave action or damaged by oxidation (which would cause decay). [2] Sand storms and flash floods could also bury an organism quickly. Alkaline conditions are generally more favourable [1] than acidic conditions which can react and dissolve calcium carbonate shells. Once buried, the sediments could become sedimentary rock. The impression of a footprint could harden into a rock (mold) or be filled in with another material that hardens to become a rock (cast). Minerals in the original organism can be replaced by calcite or silica (petrified).

The fossil record can provide information about: the sorts of organisms that once lived, how existing organisms have changed over time (e.g. the fossil record of the horse is well supported with evidence so changes to the horse that occurred over time, can be observed), how environments have changed over time, how diverse past communities were, what has become extinct, new organisms that appeared in the record and the rate of evolutionary change. The most primitive forms of an organism are in the oldest strata. Techniques like carbon dating can be used to age some fossils. The fossil record can also now be compared to and supported by the genetic evidence. [any 6 = 6 marks]

2. incomplete fossil record.

The conditions needed to produce fossils are rare so often pieces of the record are missing. Poor conditions for fossilisation occurred, scavengers eat or scatter the remains, fossils of particular organisms not yet found, the sedimentary rocks in which fossils are found are undergoing geological forces which destroy the fossils or the organisms themselves were not suitable for fossilisation (i.e. soft bodied). [any four = 4]

TT 9 – EVOLUTIONARY TRENDS IN HOMINIDS

Section 1: Multiple choice (10 marks)

- | | |
|------|-------|
| 1. b | 6. d |
| 2. d | 7. a |
| 3. c | 8. d |
| 4. c | 9. b |
| 5. b | 10. c |

Section 2: Short answer (50 marks)

1.
 - (a) Hominid – the group consisting of all modern and extinct Great Apes (1) (that is, modern humans, chimpanzees, gorillas and orangutans plus all their immediate ancestors) (1); Hominin – the group consisting of modern humans, extinct human species and all our immediate ancestors (1) (including members of the genera Homo, Australopithecus, Paranthropus and Ardipithecus)(1)
 - (b) Fossils could be from individuals of different ages – child skulls would not be fully grown so would have a smaller cranial capacity (1); males generally have a larger cranial capacity than females (1) larger individuals have large cranial capacities (1)
 - (c) Fragmentary nature of fossils (1) – rarely is the whole skeleton of one individual complete or it is only fragments of teeth or

skulls that have been found and the whole shape is inferred from similar finds (1); state of the fossils when found – some are very degraded by environmental conditions eg erosion so the original surface is no longer intact and overall shape could be changed (1).

(d) Different researchers prioritise different features when classifying hominin fossils (1). Some may have access to fossils from a variety different sources which may provide variations and missing parts of the fossil skeleton (1). The agreed characteristics of different hominin groups change over time due to international collaboration. (1)

2.

(a) Cultural evolution refers to the changes that have occurred in ways of life, language, manufacture of tools and weapons, customs and rituals (1) over time in a population (1).

(b) Fire was used for hunting (1), cooking food (1), providing warmth (1), keeping away predators (1), providing a focal point for the group perhaps enhancing socialisation and language development (1) any 3

3.

(a) overall size of the head (1) and presence of a chin/amount of prognathism (1) from skull measurements (1)

(b) muscle size (1) is inferred from muscle attachments sites on the bones of the skull and jaw (1)

(c) colour of hair, eyes, skin; distribution of body hair; size of the ears and lips (soft tissue features) (1) Inferred from similar organism present today or imagination of model-maker. (1)

4.

(a)

	Chimpanzee	Australopithecine	Human
Shape of Dental Arcade	U-shaped	U-shaped (1)	Parabolic (1)
Cranial Capacity (cc)	320-480	530 (1)	1350 (1)

(b) big toe lies flat alongside the other toes – non-opposable (1); longitudinal arch – toe to heel (1); transverse arch – side to side across the tarsals (1)

(c) 1 mark for each line max 2d)

Feature	Australopithecines	Modern humans
pelvis	narrow (side to side), long (top to bottom)	broad (side to side), short (top to bottom)
knee	similar sized hinge sections	outer hinge section larger and stronger than inner section
carrying angle	femurs don't converge inwards	femurs converge inwards
arm:leg ratio	arms longer than legs	legs longer than arms

(d) increased cranial capacity caused by an increase in size of cerebral cortex (1) which is the area for thinking, memory and problem-solving abilities (cognitive abilities) (1)

(e) only two imprints in each set of tracks (1); positioning of the big toe relative to the rest – not opposable (1)

5.

(a)

Tool Kit	Cultural Period	Hominin group associated with the tool kit	Complexity and manufacture of the tools
A	Acheulian (1)	Homo erectus (1)	Large cutting tools; shaped cores; multi-purpose; flakes used as scrapers (1)
C	Mousterian culture	H. neanderthalensis (1)	fully worked cores to produce flakes; variety of sizes and shapes for different uses eg. knives and hand axes (1)
D	Oldowan (1)	Australopithecines Homo habilis (1)	larger, crude working of cores with some parts of the cores remain unworked to produce simple tools of little variation

(b) B – made of stone with very fine flaking (1) generalised use for cutting, scraping etc (1); E – made of bone and sculptured using another tool (1) specific uses eg. needles, spear heads (1)

Section 3: Extended answer (20 marks)

1. Use of tools (any 5)

- basic tools were essential for butchering large animals, because human teeth and fingers are totally inadequate for cutting through thick skins and slicing off pieces of meat. (1)
- more specific tools could come through experimentation and chance through the working of stones and other materials (1)
- tool-making was a learned skill (1) – so needed to have groups where tool-makers taught others (1) or social interactions with other groups to pass on knowledge of tool making (1)
- hunting techniques made more successful (1) increasing the food supplies so more people could live together in the group (1)
- had to know the locations of tool-making stones eg flint and needed to go there on a regular basis to make new tools (1) or to live close to these locations in a less nomadic more settled way (1)

2.

(a) and (b)

(a) 5 examples = 5 marks	(b) 5 examples = 10 marks
(i) Position of the foramen magnum.	Centred under skull so skull balances on top of the vertebral column.
(ii) S-shaped curves in vertebral column.	Places head and body over the centre of gravity.
(iii) Shape of pelvis (short and bowl shaped).	Supports organs and provides attachment of big muscles in locomotion.
(iv) Carrying angle of the femur.	Upper body is positioned over the centre of gravity.
(v) Knee joint.	Is strengthened at the bottom of the femur to stop the sideways deflection of the muscles during walking.

GLOSSARY

Absolute Dating: Methods that enable us to put an actual age on an object.

Accuracy: The extent to which a measurement result represents the quantity it purports to measure; an accurate measurement result includes an estimate of the true value and an estimate of the uncertainty.

Acetylcholine: A neurotransmitter found in the synapses between neurons and skeletal muscles.

Acheulian tools: Tool culture associated with *Homo erectus*, characterised by hand axes.

Action potential: A wave of negative charge that self-propagates along the membrane of a neuron or muscle fibre. In a nerve it is called a nerve impulse.

Active immunity: Long term, acquired immunity due to antibodies that are either produced naturally because of exposure to a disease, or artificially after vaccination with an antigen.

Active site: The part of an enzyme structure that binds with the substrate.

Active transport: When energy is required to move substances against a concentration gradient across a cell membrane.

Adaptation: A characteristic that an organism has that helps it to survive in its environment. Adaptations may be physical (structural), physiological (functional) or behavioural.

Adenoids: Lymphatic tissue found in the pharynx.

Adenosine diphosphate (ADP): The molecule that forms when ATP breaks down to release energy. ADP molecules can then recombine with phosphate groups to form more ATP.

Adenosine triphosphate (ATP): The molecule found in all cells that stores energy for use in their activities.

Adipose tissue: A connective tissue in which triglycerides (fats) are stored. Each cell contains a large droplet of fat and the organelles are pushed to the edge of the cell.

Adrenal gland: Endocrine gland found on top of the kidneys. Has two sections: an outer cortex which secretes hormones such as cortisol and aldosterone and an inner medulla which secretes adrenalin (epinephrine) and noradrenalin (norepinephrine).

Aerobic respiration: Cellular respiration that uses oxygen.

Afferent (sensory) neuron: A neuron that carries information from a sense organ such as the eye, to the brain.

Agglutination: Refers to the clumping together of cells in an antigen – antibody reaction.

Agriculture: The practice of cultivating land to provide food for a community.

AIDS: Acquired Immuno Deficiency Syndrome. A disease caused by a virus called Human Immunodeficiency Virus (HIV) that attacks the immune system. It inactivates the T cells.

Aim: The purpose of the investigation or “what you are trying to do”.

Allele: An alternative form of a gene that could occupy the same place (locus) on a chromosome.

Alzheimer’s disease: A degenerative disease of the brain in which the nerve cells no longer function correctly. It is the most common form of dementia and affects memory, thinking skills and behaviour.

Amino acid: The building blocks of protein composed of hydrogen, oxygen, carbon and nitrogen atoms. Amino acid molecules are held together by peptide bonds.

Anabolism: Chemical reactions in which substances are built up, e.g. protein synthesis.

Anaerobic respiration: Cellular respiration that does not use oxygen.

Analgesic drugs: Drugs that are used to treat pain, e.g. aspirin, paracetamol.

Analyse: The process where the data, problem, etc, is critically reviewed in order to come to a conclusion.

Anatomy: The study of the structure of an organism and of the relationships of the parts to one another.

Animal ethics: Consideration of respectful, fair and just treatment of animals. The use of animals in science involves consideration of replacement (substitution of insentient materials for conscious living animals), reduction (using only the minimum number of animals to satisfy research statistical requirements) and refinement (decrease the incidence or severity of ‘inhumane’ procedures applied

to those animals that still have to be used).

Anorexia nervosa: An eating disorder that mainly affects adolescent girls who are fearful of gaining weight. It may be initiated by low self-esteem and low body image. This results in excessive dieting and exercise to keep thin. Unfortunately, it can also result in death.

Antagonistic: An action that directly opposes the effect of another process, e.g. the action of some hormones – insulin decreases blood sugar level and glucagon increases the level. It is also used to describe the opposite action of some muscles, e.g. biceps and triceps.

Anthropoid: Classification level that refers to all primates other than Prosimians.

Anthropology: The study of human societies, culture and evolution.

Antibiotic: A drug that will kill or damage bacteria.

Antibody mediated immune response: Also called humeral immunity. Immunity in which B lymphocytes develop into plasma cells that produce, and release antibodies, which destroy antigens.

Antibody: A protein (immunoglobulin) produced by lymphocytes in response to the presence of an antigen. It is released into the blood stream.

Antigen – antibody complex: Formed when an antibody binds to a specific antigen. It results in the antigen being destroyed.

Antigen: A foreign substance, often a protein, which is not produced by the body. Its presence stimulates the production of antibodies.

Antiseptic: A chemical that will kill pathogens, but will not harm our cells so it is safe to use on the body.

Antiviral: Drugs used to treat viral infections.

Aorta: The major artery leaving the heart taking blood from the left ventricle and distributing it to the body.

Aortic body: A chemoreceptor found in the aorta that monitors the concentration of carbon dioxide and oxygen in the blood.

Arachnoid mater: The middle membrane of the meninges; the membranes that cover the brain.

Arboreal: Animals that live in trees.

Artefacts: Objects made by humans such as tools and weapons.

Association neuron: Also known as interneuron or connector neuron. Found in the central nervous system.

Attenuated: A microorganism used in vaccines, that has had its ability to cause disease reduced.

Aurignacian: Tool culture characteristic of early *Homo sapiens* (Cro Magnon) typified by blade tools with parallel sides and including knives, scrapers.

Auto-immune disease: A disease in which the body's immune system mounts an immunological response against its own tissues. Examples include rheumatoid arthritis, lupus and multiple sclerosis.

Autonomic nervous system: Part of the nervous system that is 'automatic' as it controls the activity of cardiac muscle, smooth muscle and glands. It is divided into the sympathetic and parasympathetic nervous systems.

Autosome: A chromosome that is not a sex chromosome.

Axon: The part of a neuron that the nerve impulse travels along. It carries the nerve impulse in one direction only.

B lymphocyte (B cell): A lymphocyte that is produced in bone marrow. It develops into a plasma cell which produces antibodies.

Bacilli: Bacteria that have a rod like appearance under a microscope.

Bacteria (singular bacterium): Single celled microorganisms whose genetic material is not contained within a nucleus. Most are decomposers but some are pathogenic.

Bacteriophage: Viruses that attack bacteria.

Bioethics: Deciding the rules of conduct that should apply when dealing with biological issues such as the uses of biotechnology.

Bionic limbs: Legs or arms that are electronically powered.

Biotechnology: The application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for human purposes, e.g. wine, beer, yoghurt, drugs, vaccines, biodegrading bacteria.

Bipedal: Two-legged.

Bladder: The internal storage organ for the retention of kidney output (urine) until it is released during urination.

Blade tools: Tools that have parallel sides, typical of early *Homo sapiens*.

Blastocyst: The hollow ball of cells that forms by mitosis from the zygote.

Blood sugar level: The concentration of glucose in the blood.

Bone marrow: Soft, fatty tissue found inside bones, in which blood cells are made.

Bowman's capsule: The cup shaped structure that encloses or wraps around a glomerulus in the kidney.

Brachiation: is a form of arboreal locomotion in which primates swing from tree limb to tree limb using only their arms.

Brain: A mass of nervous tissue that forms the major section of the central nervous system and is found in the cranial cavity (head).

Broca's motor speech area: The part of the cerebrum that controls the muscles of the mouth and tongue so that sounds and speech are produced.

Brow ridge: The ridge of horizontal bone found over the eye sockets on early fossil skulls and apes. The brow ridge is much reduced in modern man.

Bulimia: An eating disorder that comprises binge eating followed by self-induced vomiting. It may also involve the use of laxatives, enemas, diuretics and excessive exercise to reduce body weight.

Burin: A parallel-sided, chisel like stone tool used to manufacture other tools. It is associated with the Upper Paleolithic and Magdalenian culture of Cro Magnon in particular. They were used to cut bone, antler and wood into pieces that could then be turned into fish hooks, harpoons, needles and jewellery.

Canines: The pointed teeth found on either side of the incisors. They are very evident in carnivores and reduced in man to roughly the same size as the other teeth. They are represented by the 1 in the dental formula for primates.

Capillary: The smallest blood vessel forming microscopic connections between arterioles and venules. The thin walls of the capillaries enable the exchange of materials between the blood and tissue cells.

Cardiac output: The amount of blood leaving the heart every minute.

Carotid body: A chemoreceptor found in the carotid artery that monitors the concentration of oxygen and carbon dioxide in the blood.

Carrier: Could be someone who harbours a disease without suffering from it and can spread it to other people. It can also refer to a recessive gene carried by an individual.

Carrying angle: Also called valgus angle. It forms between inside knee and a vertical line into the pelvis.

Cast: Formed by material filling a mould and producing a copy of the fossil that made the mould.

Catabolism: Refers to chemical reactions in which substances are broken down, e.g. cellular respiration.

Cell: The smallest unit of life that is capable of carrying out all of the functions necessary for survival. It is the basic structural unit of the body.

Cell mediated immune response: Immunity in which T lymphocytes attach to antigens and destroy them.

Cell replacement therapy: Refers to transplanting healthy cells into organs to replace dead cells that no longer function. It may be a future treatment for conditions such as Parkinson's disease, Type 1 diabetes and cardiovascular diseases.

Cellular respiration: The chemical reaction in the cell that releases energy from

glucose. The reaction produces carbon dioxide, water and heat as wastes to be removed from the cell. May be aerobic or anaerobic, depending on whether or not oxygen is used in the process.

Centre of gravity: A line from the body along which gravity acts.

Centriole: An organelle found in animal cells that forms the spindle in cell division.

Cerebellum: Part of the brain that controls posture and balance and coordinates skilled movements.

Cerebral cortex: Another name for the cerebrum. Receives all sensory information and enables perception of various sensations, stores memories, enables abstract thought (planning and creativity), generates speech and sends out motor impulses.

Cerebrospinal fluid: A fluid produced by the capillaries in the ventricles (spaces) in the brain. It is found between the arachnoid and pia mater in the subarachnoid space. It acts as a shock absorber for the brain and spinal cord and allows exchange of nutrients and waste products between the blood and nervous system.

Cerebrum: Also called cerebral cortex.

Chemoreceptor: Receptors composed of nerve tissue, which are sensitive to the presence of chemicals in the blood, e.g. some that are sensitive to the concentration of oxygen and carbon dioxide are located in the carotid and aortic arteries.

Chromosome: A strand of DNA that carries the genetic information of an organism.

Comparative genomics: the study and comparison of the genome sequences of different species. It enables

identification of genes that are conserved or common among species, as well as genes that give each organism its unique characteristics.

Coordination: The activity of the nervous and endocrine systems that ensures the body functions as a whole unit.

Cocci: Bacteria that have a round appearance under a microscope.

Collagen fibre: A protein found in connective tissue that is relatively inelastic. It is found in the skin, tendons, bone and cartilage.

Collecting duct: The tube in the kidney into which the waste fluids that comprise urine drain from the nephron.

Compare: Identify similarities and differences between things.

Concentration gradient: Refers to a change in concentration from one area to another.

Concentration: Refers to the amount of a substance in a solution.

Conclusion: A final statement that says whether or not the hypothesis was supported or disproved.

Conduction: The transfer of heat to another object by contact. Heat will move from the warmer object to the cooler object.

Conductor: A substance that heat, (or electricity) can pass through.

Connector neuron: Also called an inter neuron or association neuron; found in the central nervous system.

Contagious: Passing on a disease by contact. Can also be called communicable disease.

Continental drift: The movement of continents over the surface of the Earth.

Contraction: Shortening, usually used in reference to muscle action, i.e. the muscle fibres get shorter. This puts tension on bones and produces movement.

Convection: The process in which air next to the body is heated, moves away and is replaced by cool air. This in turn is heated and moves away.

Convolutions: Refers to the folds that can be seen on the surface of the brain.

Corpus callosum: A bundle of nerve fibres that connect both halves (hemispheres) of the brain.

Corpus luteum: The structure that forms from a Graafian follicle in the ovary after ovulation. It secretes progesterone.

Cranial capacity: The volume (in cubic centimetres) of the cavity of a skull that is occupied by the brain.

Cranial nerves: Twelve pairs of nerves that arise in the brain and supply the head, neck and some internal body organs.

Creatinine: A nitrogenous by-product of muscle contraction that is excreted by the kidney.

Cultural evolution: Change in information that a population has – its beliefs, knowledge, customs, skills, etc.

Culture: Any behaviour or information – knowledge, beliefs, customs, attitudes – held by a population that is acquired by learning. These are passed on from one generation to another by communication and tradition.

Cusps: The points on the top of teeth.

Cystic fibrosis: A recessive, genetic disorder in which abnormal quantities of mucus are produced and build up in the lungs. This leads to infection and difficulties with

breathing. Current treatment includes physiotherapy and prevention of respiratory infections.

Cytoplasm: The contents of a cell excluding the nucleus.

Data: The plural of datum. It could be a single measurement or the result of averaging several repeated measurements. Data may be quantitative or qualitative and be from primary or secondary sources.

Deamination: Removal of nitrogen from an amino acid. This process occurs in the liver.

Define: To give or state the meaning of a word, phrase or term.

Dementia: Is a general term that refers to a range of conditions involving the brain and its function. Dementia is due to the progressive death of brain cells so that a person's memory is impaired and they have difficulty performing everyday activities such as planning, organising, problem solving and exercising judgement.

Demonstrate: Show how something works, or what it looks like, or identify and explain differences between things.

Dendrites: An extension of a nerve cell that carries the impulse towards the nerve cell body.

Dental arch: The curve of the jawbone evident in a plan view.

Dental formula: A method of describing the distribution of the teeth in a jaw by using the number of the types of teeth. In pongids (and man) this is 2:1:2:3 for one half of the upper or lower jaw and refers to 2 incisors, 1 canine, 2 premolars and 3 molars.

Dentition: Arrangement of teeth.

Dependant variable: Also called 'responding variable' as it is the one that responds to the changes to the independent variable that have been deliberately made.

Depressants: Drugs that slow down the activity of the central nervous system, for example, alcohol, barbiturates, tranquillisers, heroin and aspirin.

Describe: To tell about something, what it is, what it does or how it works.

Diabetes insipidus: A rare disease that can be caused by a lack of antidiuretic hormone. It produces frequent and large volumes of urine which if untreated, can cause dehydration.

Diabetes mellitus: A disease caused by the lack of the hormone insulin. It occurs in two forms: Type 1 and Type 2. Type 1 appears in childhood and Type 2 appears in adults.

Diagnosis: The process of identifying an illness from its symptoms.

Dialysis: A process of separating large particles from small particles by a semipermeable membrane.

Diaphragm: The muscle that forms the division between the thoracic cavity and the abdominal cavity. Necessary for breathing as it contributes to the increase or decrease in lung volume.

Diarrhoea: Very watery faeces that are eliminated frequently.

Diastema: The gap between the incisors and canine teeth evident in the dental structure of apes. This is not found in Hominins.

Differentiation: The process in which cells become more specialised as they develop or mature.

Diffusion: Movement of a substance from an area containing a high concentration of that substance to an area containing a low concentration of that substance.

Dilation: Means to get bigger or wider. Usually refers to the pupil of the eye or blood vessels.

Dilute: A solution that contains very little of a particular substance.

Diploid number: ($2n$) is the normal number of chromosomes found in the nucleus of a body cell. It consists of two homologous sets of chromosomes.

Discuss: Identify issues and provide points for and against.

Disease: A disorder of structure or function in a human being.

Distinguish: Recognise or note/indicate as being distinct or different from; note differences between.

Diuretic: A substance that increases the amount of urine produced and therefore the amount of water lost from the body.

Diurnal: Active during the day.

DNA (deoxyribonucleic acid): A double stranded nucleic acid found in the nucleus, capable of self-replication, that stores and transfers genetic information from one generation to the next.

DNA hybridisation: A process used to compare DNA strands from different species, in which the DNA strands are heated which causes them to unwind. When single strands from different species are mixed together, they join together. The extent of the matching between the bases on the different strands can be used as an indication of how closely related the species are. The

more the two strands match, the more closely related the species.

DNA ligase: An enzyme which joins the ends of DNA strands together.

DNA polymerase: An enzyme that attaches nucleotides to a DNA strand during DNA replication.

DNA profiling: When the sequence of bases of two or more DNA samples are compared to see if they are related.

DNA recombination: When genes from different organisms are artificially combined together.

DNA sequencing: Determining the order of bases on a strand of DNA.

DNA technology: the study and the manipulation of DNA using polymerase chain reaction, recombinant DNA technologies, DNA profiling, sequencing and hybridisation.

Dominant: A gene or allele that masks the effect of another gene or allele called the recessive. The dominant gene is the one that determines the phenotype in a heterozygote.

Dorsal root ganglion: A mass of nerve cell bodies found together outside the central nervous system on the dorsal side of the body.

Drug: A chemical deliberately introduced into the body that affects the way it functions.

Drug abuse: The overuse of a drug to the detriment of a person's physical and mental health, their social behaviour, or even to the detriment of society, e.g. the use of alcohol and other substances.

Drug misuse: The inappropriate use of a drug, e.g. taking penicillin for a headache.

Duct: A tube or channel down which substances like sweat or bile can pass, from where they have been produced to where they will be used.

Dura mater: The tough outer membrane of the meninges covering the brain, just under the bones of the cranium.

Dynamic: Not still, constantly moving.

Dysfunction: Does not work.

Ectotherm: An organism whose body temperature is determined by that of the environment, e.g. a fish or frog.

Effector: A structure which carries out a response that counteracts the effect of the stimulus.

Efferent (motor) neuron: A neuron that carries information from the brain to a muscle or gland.

Elastic fibre: A protein found in connective tissue that is elastic. It is found in the skin and ligaments.

Electrolyte: A substance, when dissolved, forms ions in solution and hence conducts electricity.

Embryology: The study of the development of the embryo.

Emphysema: A disease of the lungs due to smoking (tobacco or cannabis) that results in a reduction in the surface area of the alveoli.

Endemic: From that area. For example, kangaroos are endemic to Australia, or diseases such as malaria are endemic to some tropical places.

Endocrine gland: A ductless gland whose products (called hormones), are released directly into the blood e.g. thyroid gland. As they are in the blood, hormones can potentially reach every cell

in the body – but not all cells respond to every one.

Endoparasite: A parasite that lives inside the body, e.g. tapeworm or liver fluke.

Endotherm: An organism that generates its own heat inside the body from metabolic reactions, e.g. mammals and birds.

Enzyme: A biological catalyst that speeds up the rate of a chemical reaction without itself being destroyed.

Epicanthic fold: Is a fold of skin between the eyebrow and eyelid that hangs down and obscures the upper eyelid. It is also called a Mongolian eye fold and is common in Asian people from very cold areas. It may be an adaptation to cold conditions.

Epidemic: A sudden outbreak of disease. A rapid increase in the number of people with a disease.

Epigenetics: Refers to changes in the phenotype of an organism which are due to something other than the sequence of bases on DNA.

Euthanasia: A voluntary, peaceful death; the timing of which is decided by the person who wants it.

Evaporation: The process in which water is changed into a vapour due to the absorption of heat.

Evidence: In science, evidence is data that is considered reliable and valid and which can be used to support a particular idea, conclusion or decision. Evidence gives weight or value to data by considering its credibility, acceptance, bias, status, appropriateness and reasonableness.

Evolution: (according to Darwin) referred to gradual changes in organisms over a long period of time. This implies that organisms

have become increasingly complex over time and that all organisms have shared common ancestry at some time in the past. More recently, evolution is defined as a change in gene frequency in a population.

Excretion: Removal of cellular wastes such as water and carbon dioxide.

Exocrine gland: A gland that secretes its product directly into a duct which release it to where it is used, e.g. a salivary gland.

Exon: The section of DNA on a chromosome that codes for an amino acid sequence and hence a protein.

Explain: Give detailed information on a process or how something happens.

Extracellular fluid: The fluid found outside a cell, includes the tissue fluid (or interstitial fluid) found between cells, and plasma.

F1: The first (filial) generation. It refers to the offspring produced in a particular genetic cross.

F2: The second filial generation.

Fair Test: A controlled experiment in which all variables are kept the same except the one you are testing – the independent variable.

Feedback system: Modifies the original stimulus in order to achieve a steady state.

Fertilisation: Union of the ovum and sperm to produce a fertilised egg or zygote.

Fertility rate: The numbers of live births divided by the number of women between the ages of 15 and 44 years of age, usually expressed as number of births per 1000 women.

Field work: Observational research undertaken in the normal environment of the subject of the study.

Filament: A slender, threadlike structure.

Fissure: Refers to the indentations on the surface of the brain.

Flagellum (plural flagella): A long thin projection from a cell used to move the cell along, such as the tail on a sperm cell.

Flake tools: Stone tools made by cracking portions of appropriate stone from a larger piece. The pieces have a point and/or a sharp edge.

Foramen magnum: The hole in the base of the brain through which the spinal cord passes.

Fossil: The preserved remains of something that once lived.

Founder effect: When a new population arises from only a few individuals who may only possess a sample of genes from the original population.

Function: How something works, what it does.

Fungi (singular fungus): A group of non-photosynthetic organisms which are either parasitic or saprophytic. They reproduce by spores and some are responsible for diseases such as *Timea* and ringworm. Other fungi (yeasts) are used in brewing and bread making.

Gamete: A sex cell, either an ovum or sperm.

Ganglia (singular ganglion): A group of nerve cell bodies that are found outside the central nervous system.

Gene expression: Refers to the effects of a gene as displayed by the phenotype of an organism. It relates to the proteins that were determined by the sequence of bases on the DNA, and what their roles are.

Gene flow: The movement of genes from one population to another. It comes about by immigration and emigration.

Gene frequency (allele frequency): The proportion of members of a population with a particular gene.

Gene pool: The total variety of genes and alleles present in a sexually reproducing population that are available to be passed onto the next generation.

Gene therapy: Replacing faulty or inactive genes with correctly functioning ones.

Gene: An area or section of DNA on a chromosome that determines a feature.

Genetic code: A table that enables mRNA to be interpreted and the amino acids coded for, or determined.

Genetic engineering: Refers to the deliberate manipulation of DNA.

Genetic markers: Features determined by a single pair of genes that are not affected by age or environmental conditions, i.e. either you have it or you don't, there is no continuous variability, e.g. blood groups, haemophilia.

Genetic probe: A length of DNA of known sequence that has a base sequence that is complementary to part of a target gene or piece of DNA.

Genome: The complete set of genes or genetic material present in a cell or organism.

Genotype: The genetic makeup of an individual, e.g. Bb or bb.

Genotypic ratio: The proportion of offspring that can have each of the possible genotypes in a cross.

Genre: The categories into which texts are grouped. It may distinguish them on the basis of their subject matter,

form and structure (e.g. scientific reports, field guides, explanations, procedures, biographies, media articles, persuasive texts, narratives).

Geological dating: Techniques used to age a fossil.

Germ line cell: Those cells that develop into sperm or eggs.

Gestation: Length of time of pregnancy.

Gland: An organ that secretes substances that are used in the body.

Glomerular filtrate: The material that is filtered from the blood across the capillaries of the glomerulus and into the Bowman's capsule.

Glomerulus: The knot of capillaries in the kidneys through which blood is filtered.

Gluconeogenesis: The synthesis of glucose from lipids and amino acids that occurs in the liver.

Glucose: A simple sugar used in cellular respiration.

Gluteal muscles: Large muscles that form the 'backside', important for walking and support.

Glycogenesis: The formation of glycogen from glucose.

Glycogenolysis: The breakdown of glycogen into glucose that occurs in the liver.

Golgi body (apparatus): A cell organelle composed of flattened sacs which are involved in packaging and secreting proteins and lipids.

Gonad: Organs that produce sex cells – the ovaries or testes.

Graafian follicle: The structure inside the ovary that contains the maturing ovum. It releases oestrogen.

Grey matter: Nerve cell bodies found on the outside of the brain and on the inside of the

spinal cord where it forms an 'H' shape.

Half-life: The time taken for half the mass of a radioisotope to break down or decay into a stable isotope.

Hallucinogens: Drugs that distort our perception of the world by producing hallucinations (making a person see, hear or feel things that are not real), e.g. LSD, mescaline and psilocybin.

Haploid number (*n*): The number of chromosomes found in the gametes. It is half the chromosome number found in somatic body cells.

Heart rate: The number of times the heart beats per minute.

Herbivorous: Mainly eats plant material.

Heterozygous: Has two different genes for a particular feature, e.g. Bb.

Histamine: A substance released from damaged cells that causes vasodilation and smooth muscle contraction and increases the permeability of capillaries. This can produce redness and swelling.

HIV (Human immunodeficiency virus): A viral disease of humans. It is caused by a retrovirus that allows the transcription of the virus's genome onto the host cell's DNA. HIV infects the T lymphocytes and destroys them.

Homeostasis: The maintenance of a constant internal environment.

Homeothermic: An organism that maintains a constant internal temperature no matter what the external temperature, e.g. mammals and birds.

Hominidae (hominids): The great apes, their ancestors and humans.

Hominini (hominin): The group that includes modern humans and all their fossil bipedal ancestors.

Homologous chromosomes: Pairs of identical chromosomes that pair up in meiosis.

Homozygous: When two alleles are the same for a particular feature, e.g. BB, bb.

Hormone: Chemical produced from an endocrine gland which affects the functioning of the body in some way.

Human Genome Project: An international scientific collaboration whose aim was to determine the sequence of genes in the human genome, i.e. what genes are found on each chromosome.

Humeral-mediated immune response: See cell-mediated immune response.

Hunter/gatherer: Refers to the living style of nomadic people in which they obtain their food from hunting or collecting on a daily basis.

Hydrophilic: Attracted to water.

Hydrophobic: Repelled by water.

Hygiene: Activities that promote the preservation of good health.

Hyper: Above, excessive, exceeding.

Hypo: Under, less than, below.

Hypothalamus: Part of the brain that links the nervous and endocrine systems, regulates the pituitary gland, controls body temperature, thirst and food intake, controls and integrates the autonomic nervous system.

Hypothesis: A tentative explanation for an observed phenomenon, expressed as a precise and unambiguous statement that can be

supported or refuted by experiment.

Identify: Recognise what a structure is, or parts of a system, or to what group a specimen belongs.

Immune response: A specific response by the body to the invasion of antigens which involves the activation of particular leucocytes to produce antibodies, or they combine with the antigen to bring about its destruction.

Immunisation: The artificial introduction of weakened antigens or pathogens into somebody so they can develop the appropriate antibodies without suffering from a disease.

Immunity: The resistance to infection by invading pathogens.

Immunoglobulins: Antibodies.

Investigation: A scientific process of answering a question, exploring an idea or solving a problem, that requires activities such as planning a course of action, collecting data, interpreting data, reaching a conclusion and communicating these activities. Investigations can include observation, research, field work, laboratory experimentation and manipulation of simulations.

In vitro: Outside the body.

In vivo: In the body.

Incisors: Biting teeth found at the front of the mouth.

Incubation: The time from when the infection invades the body until the symptoms of the disease appear.

Independent variable: The variable in an experiment that is manipulated or changed in order to determine the effect that this may have on the dependant variable.

Index fossils: Fossils that only appear at a specific time in the geological record and can be used to correlate strata from different areas.

Infection: The effect on the functioning of the body by the invasion and multiplication of pathogens in the body.

Inference: A suggestion as to why something happened.

Insulator: A material that does not let heat (or electricity) through.

Interneuron: Also called a connector or association neuron, found in the central nervous system.

Intercellular fluid: Fluid found outside cells, also called tissue fluid or interstitial fluid.

Intercostal muscles: The muscles found between the ribs, which move them.

Interstitial fluid: Also called tissue fluid or intercellular fluid, found outside cells.

Intracellular fluid: The fluid found inside cells.

Intron: The section of a chromosome that does not code for characteristics, the section that is edited out of mRNA before translation occurs. The sequence of bases in some areas within introns are used in DNA profiling.

Involuntary: An action that does not require thought, not under conscious control. Usually refers to the action of the autonomic nervous system.

Ischial callosities: Thick pads of skin found on the backside of some monkeys.

Islets of Langerhans: Special cells in the pancreas that produce hormones.

Isotopes: Atoms of some elements that have different numbers of neutrons.

Karyotype: A picture that shows the total number and general appearance of chromosomes from the nucleus of a cell at metaphase.

Kidney: The organ that regulates the water content of the body, ions and nitrogenous wastes from the blood.

Killer T cells: A special lymphocyte that is involved in cell mediated immunity.

Kitchen midden: An accumulation of objects that indicate human activity, e.g. empty sea shells, bones, stone tools and weapons (i.e. a prehistoric rubbish tip).

Lactic acid: A by-product of anaerobic respiration in animals.

Laurel-leaf blade: The shape of some tools typical of the Solutrean period, made by early *Homo sapiens*.

Law: A statement describing invariable relationships between phenomena in specified conditions, frequently expressed mathematically.

Leucocytes: White blood cells.

Limitations: Boundaries within which you are testing. For example, were the variables sufficiently controlled, was the sample size big enough, was the accuracy of the measurement appropriate, were other health aspects taken into consideration when determining the cause of a disease?

Lipogenesis: The production of fat from glucose or amino acids.

Lipolysis: Refers to the breakdown of lipids into fatty acids and glycerol. These products are then available for cellular respiration.

List: Put your ideas, information in point form, briefly.

Liver: The largest organ in the body that metabolises carbohydrates, lipids and proteins, stores lipids and glycogen, detoxifies drugs, carries out deamination of amino acids, helps to maintain the blood sugar level, stores fat soluble vitamins and breaks down red blood cells.

Locus: The position on a chromosome that is occupied by a particular gene.

Loop of Henle: Part of the nephron, where water and sodium are reabsorbed.

Lymph nodes: Areas on lymph vessels, in which there are large numbers of lymphocytes that act as a filter for microorganisms in lymph.

Lymph vessels: Tubes that carry lymph back to the circulatory system.

Lymph: Fluid found in the lymphatic system.

Lymphatic system: Consists of lymph node (glands) and fine tubes that drain excess tissue fluid back into the blood. It also has a role in protecting the body against invading pathogens. The lymph glands store lymphocytes which fight disease.

Lymphocytes: Types of white blood cells (leucocytes) that are produced in the bone marrow. They are involved in the immune response e.g. T cells and B cells.

Lysosomes: An organelle that contains digestive enzymes.

Lysozyme: An enzyme found in tears and saliva that destroys bacteria.

Macrophage: A large leucocyte that engulfs bacteria and removes dead cells and other debris. They are also attracted to antigen – antibody complexes and remove them.

Macroscopic: refers to the size of an object and means it can be seen with the naked eye.

Magdalenian: A tool culture of *Homo sapiens* that includes many items made of bone and antler such as harpoons, fish hooks and needles.

Measurement: The physical attribute of something being investigated: size, time, weight, etc.

Measurement error: the difference between the measurement result and a currently accepted or standard value of a quantity.

Mechanoreceptor: A receptor that responds to pressure, touch, sound, position or equilibrium.

Media texts: Spoken, print, graphic or electronic communications with a public audience. Media texts can be found in newspapers, magazines and on television, film, radio, computer software and the internet.

Medulla: Part of the brain that controls breathing and heart rate via respiratory and cardiac centres, also controls swallowing, vomiting, coughing, sneezing, hiccupping and relays motor and sensory impulses between the cerebral cortex and spinal cord. Some cranial nerves also arise here.

Melanin: The dark brown pigment found in our skin, hair and eyes.

Memory cells: Lymphocytes in the immune system that have the ability to recognise a specific antigen to which the body has been previously exposed.

Meninges: A set of membranes that cover the surface of the brain underneath the bones of the skull.

Menopause: The time when a woman's ovaries no longer

produce oestrogen or release eggs, and she no longer has periods. It signals the end of her ability to have children.

Menstrual cycle: Refers to the build-up and break down of the endometrium in the uterus in preparation to nurture an embryo.

Mesolithic: The time between the Palaeolithic and Neolithic, characterized by microliths – small chips or stone flakes that were set in wood to make longer cutting edges.

Metabolic rate: The rate of metabolism in the body as measured by the amount of oxygen consumed or heat produced.

Metabolism: Refers collectively to all the chemical reactions that occur in the body. There are two types of metabolic reaction – anabolism in which molecules are built, e.g. protein synthesis; and catabolism in which molecules are broken down, e.g. respiration.

Method: A list of instructions as to how to do the investigation.

Microorganism: An organism that can only be seen with a microscope because it is so small, e.g. bacteria, viruses.

Microscopic: refers to the size of an object and means it can be seen by using a microscope.

Midbrain: Part of the brain between the pons, thalamus and hypothalamus.

Mitochondria: Organelles in which cellular respiration occurs.

Mitosis: Cell division producing two genetically identical daughter cells. These cells are used in growth and repair.

Mixed nerve: One that contains both sensory and motor fibres, e.g. spinal nerves close to the spinal cord.

Mode: The various processes of communication – listening, speaking, reading/viewing and writing/creating.

Model: A representation that describes, simplifies, clarifies or provides an explanation of the workings, structure or relationships within an object, system or idea.

Molars: The teeth at the back of the mouth used for chewing and grinding.

Motor end plate: The location at which the axon of a motor neuron establishes synaptic contact with a skeletal muscle fibre.

Mould: The imprint or shape made by a buried fossil.

Mousterian: The tool culture of *Homo neanderthalensis* typified by the tools being made from flakes struck from a core. They included hand axes, blades and scrapers.

mtDNA (mitochondrial DNA): The DNA found in mitochondria.

Mucus: The slimy and sticky material produced by special cells (goblet cells) in mucous membranes.

Multicellular: Composed of many cells.

Multiple alleles: A gene with more than two alleles.

Muscle: A body tissue capable of contraction (shortening) and relaxing.

Mutation: A sudden spontaneous change in the base sequence of DNA that can result in a permanent change which can be inherited.

Myelin sheath: The fatty covering on an axon.

Natural selection: The process whereby organisms better adapted to their environment tend to survive and produce more offspring.

Negative feedback: Feedback that reverses the original stimulus.

Neolithic: Refers to a time about ten thousand years ago when farming started. It is also called the New Stone Age.

Nephron: The unit of filtration in the kidney.

Nerve impulse: The electro-chemical 'message' transmitted along a neuron.

Nerve: A bundle of axon fibres or neurons.

Neurilemma: The membrane on the outside of the myelin sheath in nerve cells.

Neuron: The structural cell of the nervous system.

Neurotransmitter: A chemical produced in one neuron in response to a nerve impulse that diffuses across a synapse causing a nerve impulse in a neuron, or effector such as a muscle.

Nocturnal: Active at night.

Nodes of Ranvier: Gaps in the myelin sheath over which nerve impulses jump (saltatory conduction).

Noradrenalin (norepinephrine): A hormone released from the adrenal medulla that speeds up heart rate. It is also a neurotransmitter in the sympathetic nervous system.

Nuchal crest: An area on the back of the skull where the neck muscles attach.

Nucleic acid: The class of chemicals to which DNA and RNA belong.

Nucleotide: A structural unit of DNA composed of a deoxyribose sugar molecule, a phosphate group and a nitrogenous base.

Nucleus: The organelle in a cell that controls all the activities of the cell.

Observation: The information obtained from using your senses (sight, taste, touch, smell and hearing).

Olduvai Gorge: A 25 kilometre long valley in East Africa where many fossil hominids have been found.

Oldowan tools: Tool culture associated with *Homo habilis*, mainly pebble tools.

Omnivorous: An animal that eats both plants and animals.

Operator gene: Controls when a structural gene works and for how long which then affects how much product they make.

Opposable digits: Means that thumbs and fingers can touch which enables a precision grip.

Optimum: The best or most suitable condition for functioning.

Organ: A structure composed of a variety of tissues, which perform a particular function.

Organelle: Any membrane-bound structure found inside the cytoplasm of a cell, e.g. nucleus, ribosome.

Osmotic pressure: The pressure created by the movement of water through a differentially-permeable (semi-permeable) membrane.

Ovarian cycle: The sequence of events in the ovary that results in the maturation of the ovum.

Ovary: The organ that produces female gametes or ova (eggs).

Ovulation: Release of mature eggs from the ovary.

Palaeolithic (Stone Age): Covers the time from about two and a half million years ago to about 8,500 BP. Divided into Lower (oldest), Middle and Upper (youngest) Paleolithic.

Pandemic: The rapid spread of an infectious disease through

a human population affecting a large region such as a country or the world.

Parasite: An organism that benefits by deriving nutrients at the expense of another organism.

Parasympathetic nervous system: Part of the autonomic nervous system that prepares the body for rest.

Parkinson's disease: A disease mainly affecting the motor cortex resulting in tremors and loss of motor control as well as emotional changes.

Passive immunity: Refers to the immunity obtained naturally by the foetus from the mother by antibodies crossing the placenta, or artificially by the injection of antibodies. Passive immunity is not long-lived.

Pathogen: A disease – causing organism such as bacteria, virus, fungus, or protozoan.

Pebble tools: Oldowan tools made by *Homo habilis*.

Pedigree: A chart used in genetics that shows relationships between individuals and the inheritance of certain characteristics. Males are shown as squares and females as circles.

Peer review: When colleagues in the same field or with the same interest or expertise, read and critique the development of an experiment or a scientific paper before it is published to ensure that the claims that are being made are true or that the data supports the interpretation given, or the experiments were valid.

Pentadactyl: Five digits.

pH: Concentration of hydrogen ions in solution.

Phagocytes: Leucocytes (white blood cells) that engulf particles such as bacteria and form a vacuole within their cytoplasm containing the

particle. Enzymes from the lysosomes then destroy the particles.

Phagocytosis: The engulfing of bacteria or viruses, or cell debris by phagocytes.

Phenotype: The observable physical appearance of an individual, e.g. red hair, or the biochemical characteristics of an individual, e.g. blood type.

Phenotypic ratio: The proportion of offspring with different appearances resulting from a cross.

Phospholipids: Molecules composed of protein and lipid.

Physiology: The study of how organisms function.

Physiotherapy: Physical therapy that helps people to move after injury or disease.

Pia mater: The thinnest membrane of the meninges attached to the surface of the brain.

Pineal gland: A tiny gland in the middle of the brain. It secretes melatonin which is involved in circadian rhythms that regulate sleep and wake patterns.

Pituitary gland: A pea-sized gland in the head that is referred to as the 'master gland'.

Placebo: Something that is often used in drug trials. Although it resembles the drug being tested, it is not the drug and is used to see if the effect is due to the drug itself rather than a positive attitude by an individual because they are taking 'something'.

Plasma cells: Cells that develop from B-lymphocytes that produce antibodies.

Plasma membrane: Another name for the cell membrane.

Pluripotent: Cells which can become almost any kind of

cell in the body. Cells which make up the inner cell mass in a blastocyst are pluripotent (stem) cells.

Pneumotaxic centre: An area in the pons that inhibits inspiration.

Polymerase Chain Reaction (PCR): A process used to amplify (increase) very small amounts of DNA. It is very useful when only tiny samples of DNA are available.

Polypeptide: A chain of amino acids.

Pons: An area on the brain stem between the medulla and midbrain.

Population: A group of interbreeding organisms of the same species living together in a particular place at a particular time.

Positive feedback: A form of feedback in which the effect enhances the stimulus such as labour in child birth.

Prediction: What you expect to happen (if the hypothesis is supported).

Premolars: The teeth between the canines and molars in the mouth, usually two per half jaw, i.e. four in the upper jaw and four in the lower jaw.

Primary data: Data collected directly by a person or a group.

Primary source: Report of data created by the person or persons directly involved in observations of one or more events, experiments, investigations or projects.

Primate: a group of mammals that have forward facing eyes, unspecialised bodies and five digits, e.g. lemurs, monkeys, apes and humans.

Primer: A small group of nucleotides that attach to one strand of DNA and initiate the production of the

complementary strand by DNA polymerase.

Principle of Superposition: States that the layer of rock, found at the bottom of a series of layers of rock, is the oldest.

Prognathic: Refers to the shape of the lower face, 'sticks out'.

Promotor gene: A type of regulator gene that switches structural genes on in the appropriate cell, controls how long they work for and how hard.

Propagation (of a nerve impulse): The movement of a nerve impulse along a neuron in one direction.

Proprioceptor: A receptor that responds to stretch or a change in position. Found in the muscles, tendons and joints.

Prosimian: The most primitive primate group. It includes lemurs, tarsiers, sifakas, indris and aye-aye.

Prosthesis: An artificial replacement for a body part, e.g. eye, breast, leg.

Protein synthesis: The process of manufacturing proteins in the body.

Protein: A complex organic molecule composed of hydrogen, oxygen, carbon and nitrogen, formed from amino acids. Proteins have a number of roles in the body including hormones, muscles, and antibodies. Generally used in growth, maintenance and repair of cells.

Radiation sickness: Illness due to exposure to large doses of radiation. Symptoms include diarrhoea, haemorrhaging, nausea, vomiting, loss of hair and leukaemia.

Radiation: The continual loss of heat from a body that is warmer than its surroundings. No physical contact between the body and its surroundings is necessary for this heat loss

to occur, e.g. when we are warmed by the Sun or a fire.

Radioisotopes: Isotopes that have unstable nuclei. The nucleus disintegrates forming other isotopes while releasing radiation at the same time. This 'decay' occurs at fixed rates and makes the isotope stable.

Random genetic drift: Describes the random change in genetic frequencies that occurs in the gene pool of small populations from generation to generation.

Receptor site: Areas on the cell membrane of a target cell which can combine with a hormone (for proteins). Some hormones (steroids) which are lipid based easily pass through a cell membrane and their receptor is on the nucleus. A receptor site can also be an area on a neuron that responds to a neurotransmitter.

Recessive: The trait that is masked by a dominant gene. It only appears in an organism homozygous for that trait.

Reflex: An automatic and immediate response to a stimulus mediated via the reflex arc. It is simple and the same response is always produced by the same stimulus.

Reflex arc: The pathway that a reflex takes. It is made up of a receptor, sensory neuron, interneuron, motor neuron and effector. An integrating centre in the brain is also linked to it.

Regulator gene: Controls the activity of structural genes. Includes promoter genes and stop genes (which turn structural genes off).

Relative dating: A method of determining if a fossil, artefact or sedimentary layer is older or younger than another fossil, artefact or sedimentary layer.

Releasing factor: A substance produced by the hypothalamus that causes the production and release of specific hormones from the pituitary gland.

Reliable data: Data that has been judged to have a high level of reliability.

Reliability: The degree to which an assessment instrument or protocol consistently and repeatedly measures an attribute, achieving similar results for the same population.

Reliable: Means that the results are consistent; they are the same each time the procedure or experiment is done.

Replication: Refers to the process in which DNA makes a copy of itself, e.g. in mitosis or meiosis.

Respiratory centre: Controls breathing rate. It is located in the medulla in the brain.

Response: The reaction to a stimulus by a cell or the whole organism.

Representation: A verbal, visual, physical or mathematical demonstration of understanding of a science concept or concepts. A concept can be represented in a range of ways and using multiple modes.

Research: To locate, gather, record, attribute and analyse information in order to develop understanding.

Research ethic: Norms of conduct that determine ethical research behaviour; research ethics are governed by principles, such as honesty, objectivity, integrity, openness and respect for intellectual property and include consideration of animal ethics.

Restriction enzymes: Are enzymes from bacteria which are used as 'chemical scissors' to cut strands of DNA into

pieces. Restriction enzymes cut DNA at specific sites called recognition sites. These are identified by a small sequence of bases which read the same forwards and backwards, e.g.: Strand 1 – AACCGGTT
Strand 2 – TTGGCCAA

Results: The information collected from the experiment.

Ribosome: An organelle found in the cytoplasm, where amino acids are joined together to form proteins.

RNA: A single stranded nucleic acid in which the base thymine is replaced by uracil. Its main function is to transfer information from DNA in the nucleus to the cytoplasm for production of proteins. Messenger RNA (mRNA) takes information from the DNA to the ribosome, transfer RNA (tRNA) brings amino acids from the cytoplasm to the ribosome and ribosomal RNA (rRNA) is found in the ribosome where the amino acids are joined together to make a protein.

RNA polymerase: An enzyme that links nucleotides together to form mRNA.

Sagittal crest: A ridge of bone found on top of the skull for the attachment of large jaw (masseter) muscle. Found on gorilla skulls and *Australopithecus boisei*.

Schwann cells: Cells that produce the myelin sheath found around axons.

Secondary data: Data collected by a person or group other than the person or group using the data.

Secondary source: Information that has been compiled from records of primary sources by a person or persons not directly involved in the primary event.

Sex chromosomes: Either the X or Y chromosome.

Shivering: The very rapid contraction and relaxation of skeletal muscles. It is initiated by the hypothalamus. These contractions are not used in moving parts of the body so the heat generated by the metabolic reactions involved contributes to the internal heat of the body.

Simulation: a representation of a process, event or system which imitates a real or idealised situation.

Skeleton: The structure of bones which supports the rest of the body.

Solutrean tools: Made by early *Homo sapiens* and characterised by their laurel leaf shaped blades.

Somatic cells: Body cells, not including gametes.

Somatotype: Refers to body shape and refers to grouping people based on their body build.

Speciation: The process of forming new species.

Species: A collection of populations sharing a common gene pool (within which regular gene flow occurs) which are reproductively isolated from other gene pools or, a group of similar individuals which can interbreed to produce fertile offspring under natural conditions.

Specific immunity (or immunity): Refers to the body's resistance to infection by pathogens that have got past the non-specific defences. Every antigen that invades the body causes a different immune response.

Specify: Clearly state the relevant points.

Sperm: The male sex cell, or gamete.

Spinal cord: The major nerve cord that runs inside the

vertebrae. It carries motor impulses from the brain to the rest of the body and sensory impulses from the rest of the body to the brain.

Spinal nerves: Thirty-one pairs of nerves that emerge along the spinal cord from ventral and dorsal roots.

Spirochaete: A type of bacterium that has a spiral shape.

Spleen: A large organ composed of lymphatic tissue, situated between the diaphragm and the stomach on the left side of the body. It removes old red blood cells, platelets and stores blood.

State: Briefly and clearly give the main points or facts.

Steady state system: A self-regulating system which constantly monitors the aspects of the internal environment and notifies the appropriate body systems so that changes can occur to return the situation to the original or optimum level.

Stem cells: Cells found in embryos which have the potential to become any of the cells and tissues that will comprise the organism. They are also found in adults and these have some ability to differentiate into other cells.

Stereoscopic vision: Two eyes used to form an overlapping field of view.

Stimulants: Drugs that speed up the production of nerve impulses and hence the activity of the body, e.g. nicotine, amphetamines, cocaine and caffeine.

Stimulus: A change in either the internal or external environment that triggers a response in the body.

Strata: Plural for 'stratum' which refers to a layer, often a layer of rock.

Stroke volume: The amount of blood pushed out of the heart with each contraction.

Structural gene: Carries the information (codes for) for the production of things that cells make, e.g. proteins or polypeptide chains. They are controlled by regulator genes.

Subarachnoid space: The space between the arachnoid mater and the pia mater that contains cerebrospinal fluid.

Suggest: Offer possible reasons or solutions.

Sympathetic nervous system: Part of the autonomic nervous system that prepares the body for action.

Synapse: The junction between two or more neurons or between a neuron and an effector.

Synaptic cleft: The gap between two neurons across which various chemicals diffuse.

System: In biology, it is a group of organs that work together to perform a particular function for the body. It can also be described as a group of interacting objects, materials or processes that form an integrated whole. Systems can be open or closed.

T lymphocyte (T cell): A lymphocyte that can kill antigens such as fungi or viruses.

Target cell (or organ): The cells or organ which are responsive to a particular hormone.

Tay-Sachs disease: A lethal autosomal, recessive genetic disease. It is due to a lack of an enzyme called hexosaminidase A (hex A) which helps to break down chemical deposits called gangliosides. If these deposits accumulate in brain cells, nerve damage results.

Tendon: A connective tissue that joins muscles onto bones. It is inelastic. Shortening of

a muscle pulls on the tendon resulting in the movement of bone.

Terrestrial: An organism that lives on land.

Testes: The male sex organ that produces sperm.

Thalamus: An area in the brain just above the midbrain through which sensory impulses pass from the spinal cord to the cerebral cortex.

Theory: A set of concepts, claims and/or laws that can be used to explain and predict a wide range of related observed or observable phenomena. Theories are typically founded on clearly identified assumptions, are testable, produce reproducible results and have explanatory power.

Therapy: Medical treatment to improve or cure a condition.

Thermoreceptor: A receptor that responds to temperature.

Thirst reflex: An increase in osmotic pressure in the extracellular fluid stimulates particular cells in the hypothalamus and you feel thirsty. This causes you to drink which decreases the osmotic pressure. The thirst centre in the hypothalamus is then no longer stimulated and you no longer feel thirsty.

Thymus: A gland in the chest in which T lymphocytes mature. It is most active at puberty.

Tissue fluid: Also called interstitial fluid or intercellular fluid. It is found outside cells.

Tissue: A group of cells that have the same structure and function.

Tonsils: Lymphatic tissue in the mucous membranes of the throat.

Totipotent: The ability of a cell to become any cell in the organism.

Toxins: Poisonous chemicals produced by organisms, e.g. bacteria, insects, snakes, fish.

Toxoids: Inactivated toxins that are used in vaccines e.g. tetanus.

Trait: A feature or characteristic of an organism.

Transcription: The process of copying information from a DNA molecule on to mRNA.

Transformation: Refers to the take-up of recombinant DNA by another organism producing a change in its phenotype.

Transgenic organism: An organism that contains a gene from another species.

Translation: The process of using the information on mRNA to assemble amino acids in specific sequences.

Transplantation: Replacing a diseased or inactive body organ with another, e.g. heart transplants.

Trauma (physical): A serious physical injury to the body, e.g. loss of limb, sustaining injury from the impact of a blunt object or being pierced by an object.

Uncertainty: Range of values for a measurement result, taking account of the likely values that could be attributed to the measurement result, given the measurement equipment, procedure and environment.

Unicellular: An organism that has only one cell.

Urea: A nitrogenous waste formed in the liver. Deamination of amino acids produces the highly toxic substance, ammonia. Carbon dioxide combines with it to form the much less poisonous substance, urea. This is a soluble salt of small molecular size which is easily transported in the blood.

Ureter: The tube that joins the kidney to the bladder.

Urethra: The tube that runs from the bladder to outside the body.

Urine: The fluid produced by the kidneys. It contains excess water and other substances such as urea, creatinine, uric acid and inorganic ions such as sodium, potassium, chloride, sulphates, phosphates, ammonium, magnesium and calcium (approximately 96% water, 2% urea and 2% salts).

Uterus: The organ in females in which the foetus develops.

Vaccination: The introduction to the body of an antigen that stimulates the body to produce antibodies against it, and therefore develop immunity against it.

Vaccine: A substance that stimulates the immune system to produce antibodies to a particular antigen without an individual having to be infected with the antigen. It is injected or introduced into the body so that the body will develop immunity to it.

Vacuole: A membrane bound structure in which excess water, mineral ions and waste products can be stored.

Valid: Means that the experiment is testing what it is supposed to test and that it is properly controlled.

Validity: The extent to which tests measure what was intended; the extent to which data, inferences and actions produced from tests and other processes are accurate.

Variable: Any change that can affect an investigation.

Variation: Refers to differences between members of the same species.

Vasoconstriction: When blood vessels (arterioles) reduce in size (diameter) and blood flow through them is reduced.

Vasodilation: When blood vessels (arterioles) expand and blood flow through them is increased.

Vector: Can refer to an organism that transfers a pathogen from one organism to another, e.g. flies, mosquitoes or fleas. It can also refer to a virus or plasmid that transfers a section of DNA from one species to another, or to an organism such as yeast, a bacterium or a virus into which DNA is inserted for cloning.

Ventral root: A mass of nerve cell bodies (motor) leaving the spinal cord on the ventral side of the body.

Vesicle: A membrane covered sac containing fluid (secretion) from a cell.

Vestigial organs: Organs that no longer have a function in the body, e.g. the appendix, tail bones (coccyx).

Virulence: The ability of a microorganism to cause disease.

Viruses: Microscopic particles composed of a protein wrapped around a core of nucleic acid. They can only live and multiply in living cells. They are not affected by antibiotics.

Voluntary: An action carried out with full conscious control by the organism.

Wernicke's area: The area in the brain responsible for interpreting sounds or speech.

White matter: Myelinated axon fibres found inside the brain, and on the outside of the spinal cord.

Xenotransplantation: The growth of organs or tissues for use in another organism, e.g. growing pig hearts for use in humans.

Zygomatic arch: The bones that make up the cheek bones.

Zygote: A fertilised egg.

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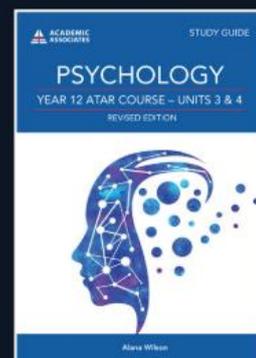
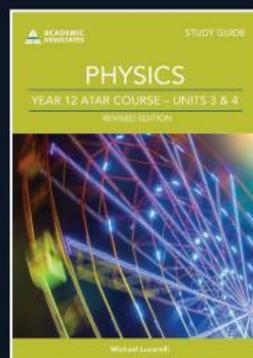
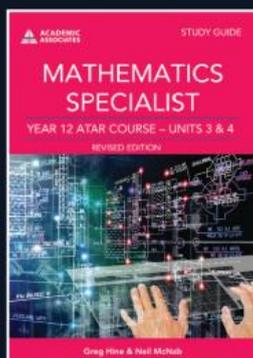
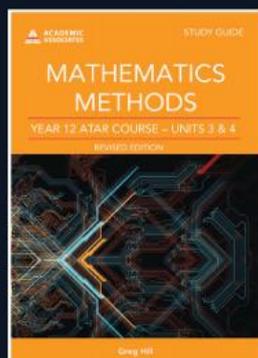
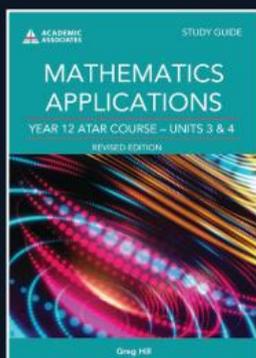
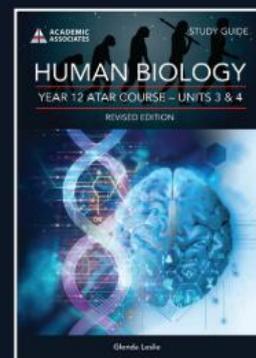
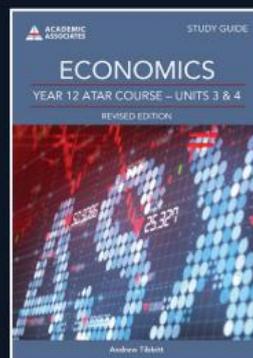
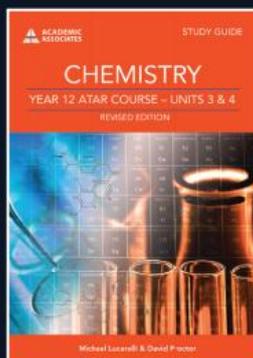
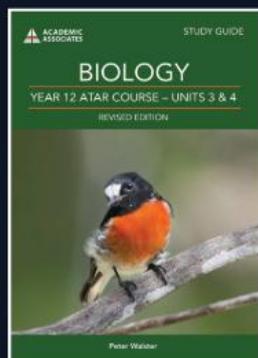
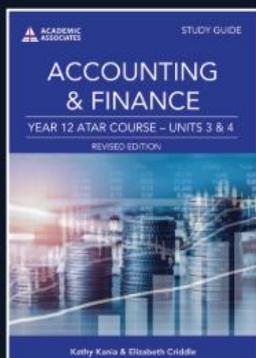
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