



**MATER DEI**  
**COLLEGE**  
FAITH WITH COURAGE

# HUMAN BIOLOGY ATAR

## Unit 3 & 4

### 2022

**Name:** \_\_\_\_\_

**Student Number:**

In figures

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In words

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### **Time allowed for this paper**

Reading time before commencing work: ten minutes

Working time for the paper: three hours

### **Materials required/recommended for this paper**

#### ***To be provided by the supervisor***

This Question/Answer Booklet

Multiple-choice Answer Sheet

#### ***To be provided by the candidate***

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: non-programmable calculators approved for use in this examination

## Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further

## Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of examination	
<b>Section One:</b> Multiple-choice	30	30	40	30	30	
<b>Section Two:</b> Short answer	7	7	90	100	50	
<b>Section Three:</b> Extended answers	<i>Unit 3</i> 38-39	2	1	50	40	20
	<i>Unit 4</i> 40-41	2	1			
<b>Total</b>					100	

## Instructions to candidates

1. The rules for the conduct of the Western Australian examinations are detailed in the *Year 12 Information Handbook 2021*. Sitting this examination implies that you agree to abide by these rules.
2. Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.
3. Answer the questions according to the following instructions.

**Section One:** Answer all questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

**Section Two:** Write your answers in this Question/Answer booklet. Wherever possible, confine your answers to the line spaces provided.

**Section Three:** Consists of four questions. You must answer two questions. Tick the box next to the question you are answering. Write your answers in this Question/Answer booklet.

4. You must be careful to confine your answers to the specific questions asked and to follow any instructions that are specific to a particular question.
5. Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

**Section One: Multiple-choice**

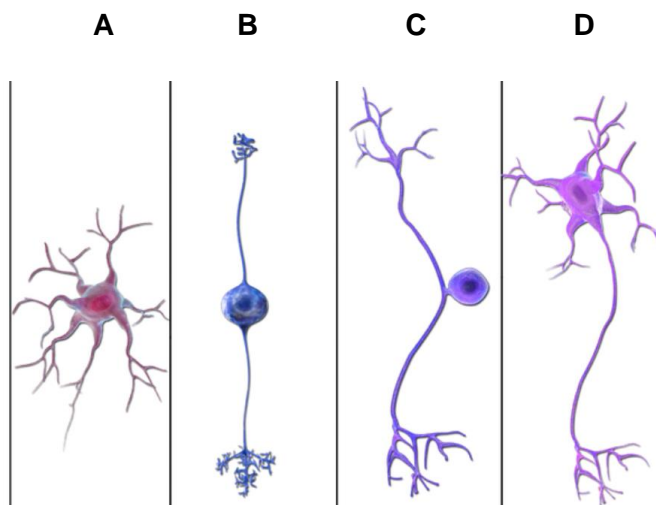
**30% (30 marks)**

This section has **30** questions. Answer all questions on the separate Multiple-Choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

**Suggested working time for this section:** 40 minutes.

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1. Hypothermia can affect people who take part in outdoor activities in winter without wearing suitable clothing. Some people think that alcohol should be given to those who have hypothermia as it makes them feel warmer. Alcohol causes vasodilation. This means that
- (a) they would lose heat faster through conduction and evaporation.
  - (b) more blood would come to the surface so they would be able to gain heat quickly.
  - (c) radiation would allow more heat to leave the body.
  - (d) their medulla oblongata would have initiated a negative feedback loop.
2. Which of the following diagrams shows a sensory neuron?



- (a) A and D only
  - (b) B only
  - (c) C only
  - (d) B and C only
3. Which of the following is **not** involved in the secondary defence against infection?
- (a) stomach acid
  - (b) mast cells
  - (c) histamine
  - (d) phagocytes

4. Scientists compared 250 bases of DNA in the same gene for two different species. They were found to have 1.2% of their bases different. Which of the following is **incorrect**?
- (a) The gene used for the comparison could be cytochrome C.
  - (b) There could be three different amino acids formed as a result of the different bases.
  - (c) The different bases may not change the amino acids produced by those codons.
  - (d) Comparing the amino acids would be more accurate than comparing their DNA.

5. Which of the following occur during meiosis and contribute to genetic variation in the offspring?

- i) crossing over
- ii) gene mutation
- iii) random assortment
- iv) random fertilisation

- (a) i), ii) and iii) only
- (b) i) and iii) only
- (c) i), ii), iii) and iv)
- (d) ii) and iv) only

6. Neuromyelitis optica is an autoimmune disease which results in the destruction of myelin. Which type of lymphocyte would cause this destruction and what would be the effect on the speed of action potential in a neuron affected by neuromyelitis optica?

	Type of lymphocyte involved	Speed of Action Potential
(a)	T cell	Increased
(b)	B cell	Decreased
(c)	T cell	Decreased
(d)	B cell	Increased

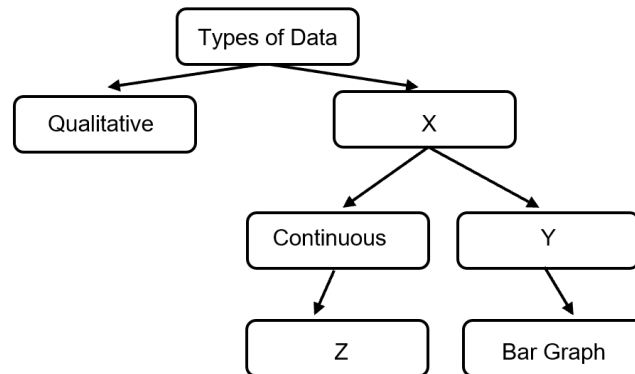
7. The table below shows the number of cases of a particular disease in four different populations. Which population showed the greatest percentage of cases?

	Population	Number of cases	Size of population
(a)	1	42	952,000
(b)	2	18	680,300
(c)	3	20	683,000
(d)	4	14	717,500

8. Scientists use both humans and other animals as subjects in their investigations. As part of their investigations, scientists should do all of the following, except one. Which one is **incorrect**?
- (a) give human subjects the right to withdraw from the investigation at any time
  - (b) seek permission from human subjects to use them in the investigation
  - (c) ensure neither human nor other animal subjects are harmed in the investigation
  - (d) use as many animals as possible
9. Which combination of features is common to all primates?
- (a) similarly sized teeth, arms longer than legs, bipedal stance
  - (b) binocular vision, hair, transverse and longitudinal arches in the feet
  - (c) parabolic jaw, tail, nails instead of claws
  - (d) forward facing eyes, large cranial capacity, opposable thumbs
10. What is the general trend shown by hominin fossils?
- (a) The more recent the fossil, the larger the molars and premolars.
  - (b) The more recent the fossil, the less bowl shaped the pelvis.
  - (c) The older the fossil, the less parabolic the shape of the jaw.
  - (d) The older the fossil, the more centrally placed the foramen magnum is.
11. When tissue is damaged, mast cells release histamine. The release of histamine results in
- (a) increased vasoconstriction and permeability of blood vessels in the damaged area.
  - (b) an increase in phagocytes in the damaged area.
  - (c) the stimulation of T cells.
  - (d) reduction in blood clotting in the damaged area.
12. Which of the following best shows how the nervous system causes an increase in pupil size?

	<b>Branch of the nervous system utilised</b>	<b>Neurotransmitter released</b>
(a)	Sympathetic	Noradrenalin
(b)	Autonomic	Noradrenalin
(c)	Parasympathetic	Acetylcholine
(d)	Somatic	Acetylcholine

Question 13 refers to the image below showing types of data and how it can be presented.



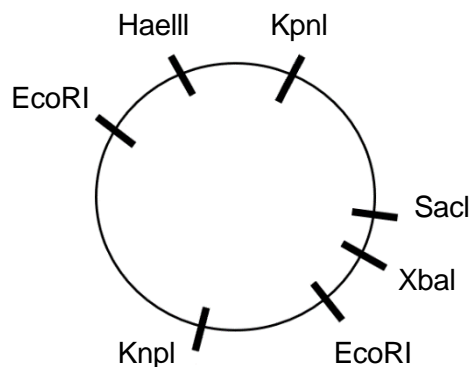
13. Which of the following is correct?
- (a) X represents categorical data.
  - (b) Z is a histogram.
  - (c) Y is discrete data.
  - (d) Qualitative data includes measurements.
14. All of the following are advantages of bipedalism, except one. Which one is **incorrect**?
- (a) improved teamwork so the group could hunt more successfully
  - (b) allowed food sources to be seen from a distance
  - (c) allowed hands free to carry tools and food
  - (d) reduced exposure to the sun
15. Cooling DNA during the PCR process
- (a) separates the double strands of DNA.
  - (b) allows the restriction enzymes to cut the DNA.
  - (c) provides an opportunity for the primer to attach to the template strand.
  - (d) stops the nitrogen bases from attaching to the template strand.
16. Who does not follow the general trend in inferred brain size in hominin evolution?
- (a) *Australopithecus afarensis*
  - (b) *Homo neanderthalensis*
  - (c) *Homo habilis*
  - (d) *Homo erectus*

Question 17 refers to the following table which shows the sequence of nitrogen bases for a portion of the haemoglobin gene for four different species.

Species	Position 5	Position 6	Position 7	Position 8	Position 9	Position 10
1	G	G	T	A	C	T
2	G	C	A	A	G	T
3	G	G	T	T	C	T
4	G	T	A	A	G	A

17. The table shows that species
- (a) 1 and 2 are most closely related.
  - (b) 2 and 4 are least closely related.
  - (c) 2 and 3 are least closely related.
  - (d) 1 and 3 are most closely related.

Question 18 refers to the image below which shows where a plasmid could be cut by a number of different restriction enzymes.



18. A plasmid was mixed with EcoRI, KpnI and XbaI restriction enzymes. Which of the following shows the correct number of restriction sites that would be cut and the number of pieces of plasmid produced?

	Number of restriction sites that would be cut	Number of pieces of plasmid produced
(a)	3	5
(b)	3	4
(c)	5	4
(d)	5	5

Question 19 refers to a section of a gene and a mutated version of the same gene.

<b>Normal section of gene</b>	G T T A G C C A A T T A C A C T G G A T A G C C
<b>Mutated section of gene</b>	G T T A G C C A A T A T C A C T G G A T A G C C

19. This is an example of
- (a) a deletion mutation.
  - (b) an insertion mutation.
  - (c) an inversion mutation.
  - (d) a point mutation.
20. There is an increasing trend for bacteria to develop resistance to antibiotics. The implication of this resistance to antibiotics is that
- (a) antibiotics will need to be replaced by antiviral drugs.
  - (b) a person's immune system will overcome the resistance in the future.
  - (c) companies will not need to produce any more antibiotics.
  - (d) different types and strengths of antibiotics will need to be used.
21. A person was lost in the bush during Perth's record heat wave this past summer. They
- (a) would gain heat by evaporation and radiation.
  - (b) would lose heat by sweating and vasoconstriction.
  - (c) could minimise their heat gain by spreading out in the shade.
  - (d) could maximise their heat loss by taking off clothes.
22. Chemoreceptors
- (a) for hydrogen ions can be found in the alpha cells of the pancreas.
  - (b) can detect oxygen, carbon dioxide and glucose.
  - (c) control the modulator in a negative feedback loop.
  - (d) and osmoreceptors are found in the hypothalamus.
23. Taq polymerase
- (a) is a type of restriction enzyme.
  - (b) is a heat stable enzyme.
  - (c) joins the primer to the template strand.
  - (d) is used in recombinant DNA technology.



24. Which row in the table correctly identifies the characteristics of the somatic and autonomic nervous systems?

	Somatic Nervous System		Autonomic Nervous System	
	<i>Number of neurons in pathway</i>	<i>Neurotransmitter used</i>	<i>Number of neurons in pathway</i>	<i>Neurotransmitter used</i>
(a)	1	Acetylcholine	2	Acetylcholine and Noradrenalin
(b)	2	Noradrenalin	1	Noradrenalin
(c)	1	Noradrenalin	2	Acetylcholine and Noradrenalin
(d)	2	Acetylcholine	1	Noradrenalin

Question 25 refers to the image of a fossil jaw below.



25. This jaw
- (a) belongs to a great ape as it has large molars and a diastema.
  - (b) is from *Australopithecus afarensis* as it has projecting canines.
  - (c) belongs to *Paranthropus robustus* as it has a U-shaped jaw.
  - (d) is from an omnivore due to its varied teeth size and shape.
26. Which of the following about thalassemia and Tay Sachs is correct?
- (a) Tay Sachs has two different forms that affect populations differently.
  - (b) The frequency of Tay Sachs in some populations occurs due to sociocultural isolation.
  - (c) Thalassemia results in a fatty build up in the brain which causes physical deterioration.
  - (d) Thalassemia offers a heterozygous advantage against tuberculosis.

27. In what order did the cultural advancements of hominins occur?
- (a) tools, religion, fire, art
  - (b) butchery sites, tools, art, religion
  - (c) fire, religion, art, butchery sites
  - (d) tools, fire, butchery sites, religion
28. Which of the following would be considered to be a bottleneck event?
- (a) A typhoon on Pingelap island reduced the population to 20 individuals.
  - (b) The Pitcairn island population of 12 was joined by the 9 mutineers from the Bounty.
  - (c) Dutch people moved from Holland to South Africa to live.
  - (d) The Silk Road opened up, linking China to Europe.
29. Fossils
- (a) require quick burial and an acidic condition to be formed.
  - (b) must have soft parts and a long period of stability in order to be made.
  - (c) can be mummified by freezing or drying, or be covered in amber or tar.
  - (d) can only be found if they have been buried in alkaline soil.
30. An index fossil and correlation of rock strata
- (a) are both absolute dating methods.
  - (b) rely on the principle of superposition to date a specimen.
  - (c) can only be used at the one archaeological site.
  - (d) would not be affected by geological disturbances.

**End of Section One**



**Section Two: Short answer****50% (100 Marks)**

This section has **seven** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 90 minutes.

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**Question 31****(20 marks)**

- (a) Complete the table below for each of the following scenarios by placing the letter (A, B, or C) in the correct box to show the type of immunity it demonstrates. (3 marks)

- A Catching tetanus from a rusty nail
- B A one month old does not suffer from the cold her mother has
- C Being given an antibody injection after being bitten by a snake

Type of Immunity	Natural Immunity	Artificial Immunity
Active Immunity	A (1)	
Passive Immunity	B (1)	C (1)

- (b) Gene therapy can be used to treat conditions like cystic fibrosis. Healthy individuals have a gene that codes for a channel protein found in the cell membrane of many body cells, including those lining the trachea. People suffering from cystic fibrosis do not have a functioning gene, so their cells do not form these channel proteins.

- (i) Explain how gene therapy could be used in the treatment of cystic fibrosis. (4 marks)

Vector used to deliver healthy copy of gene/replace faulty gene OR to correct/inactivate faulty gene (1)

Channel proteins able to be formed by transcription/translation of new gene (1)

Cell reproduces meaning new cells also have functioning/healthy gene (1)

Reducing/preventing symptoms of cystic fibrosis (1)

**Question 31** (continued)

- (ii) A student suggested his elderly grandmother, who suffers from Alzheimer's, could be treated with gene therapy. His friend suggested she should be treated with cell replacement therapy. Explain who is correct. (3 marks)

The friend is correct (1)

Alzheimer's is not due to a single gene mutation / no known genetic cause (1)

Cell replacement would replace the damage/destroyed cells allow the tissue to function correctly (1)

- (c) Two children were given an injection. They were then tested each day to determine the levels of antibodies in their blood. Their results are shown below.

Time (days)	Levels of antibodies in the blood (kAU)	
	Child 1	Child 2
0	5	5
1	20	190
3	100	170
5	150	130
9	90	30
14	60	10
15	50	3

- (i) Graph this data to show how the antibody level changed over time for each child. (A spare grid can be found at the end of this booklet). (5 marks)

Title: Change in antibody level in the blood for two children over time (1)

Axes named with units (1)

X axis = Time (days)

Y axis = Levels of antibodies in the blood (kAU)

Scales appropriate on both axes (1)

Line graph produced with data points connected by straight lines (1)

Key/lines labelled (1)

- (ii) What was contained in the injection given to Child 2? (1 mark)

Antibodies (1)

- (iii) Explain the immunological response of Child 1 if they came into contact with the same antigen that caused this response, in the future. (2 marks)

Response would be faster / stronger / larger (1)

As they would have had memory cells present from the first introduction to the antigen (1)

- (iv) State **two** ways in which antibodies can act against an antigen. (2 marks)

Agglutination / lysis of antigens / coat bacteria and enhance phagocytosis / prevent viruses from entering cells / make soluble substances insoluble / inhibiting antigen's reaction with other cells (Any 2, 1 mark each)

### Question 32

(16 marks)

People who suffer from Type I and Type II diabetes are encouraged to consume food with a low glycaemic index (GI). The glycaemic index rates food from 0 to 100, indicating how quickly it increases blood glucose concentrations.

To determine the GI of a biscuit, scientists asked 5 people to fast overnight. The next morning, each person consumed one biscuit and blood samples were taken every 15 minutes for 2 hours in order to determine their blood glucose concentration. The mean value of all subjects was used to determine the GI for that food.

- (a) Why were all subjects asked to fast overnight? (2 marks)

As a control (1)

In order to compare this data to their blood glucose level after eating the biscuit (1)

- (b) For the GI calculation to be valid, a number of variables must be controlled. Suggest **two** variables that must have been controlled. (2 marks)

All subjects were healthy / did not have diabetes (1)

All subjects fasted for the same amount of time (1)

All subjects did not perform any activity / exercise (1)

(Any 2, 1 mark each)

- (c) The mean value of all subjects was used to calculate the GI of the biscuit. Explain why the mean value for all subjects was used and suggest one limitation of this method. (2 marks)

In order to show the average blood glucose level for all subjects (1)

Limitation – anomalies / outliers can increase / decrease the mean value (1)

- (d) How could the determination of the GI of the biscuit be made more reliable? (1 mark)

Use more subjects / replication / repeat the experiment / repetition (Any 1, 1 mark)

Older people can develop a condition called Type II diabetes, where they have high blood glucose levels, even though they produce normal amounts of insulin.

- (e) Explain why these people have high blood glucose levels, even though they may produce normal amounts of insulin. (1 mark)

Cells not responsive to insulin / receptors desensitised to insulin (1)

- (f) Suggest **two** symptoms a person would experience if they suffered from Type II diabetes. (2 marks)

Increased urination / fatigue / glucose in urine / thirst / (Any 2, 1 mark each)

- (g) Suggest **two** changes a person suffering from Type II diabetes could make in order to better manage their blood glucose levels. (2 marks)

Increase exercise / decrease dietary intake of high GI food / lose weight (Any 2, 1 mark each)

- (h) Insulin targets the liver. What other main tissue type does insulin target? (1 mark)

Skeletal muscle (1)  
Adipose tissue (1)

- (i) Name the process that occurs in the liver as a result of insulin being present. (1 mark)

Glycogenesis (1)

- (j) State the effect of adrenalin on blood glucose levels and explain why this is required at times. (2 marks)

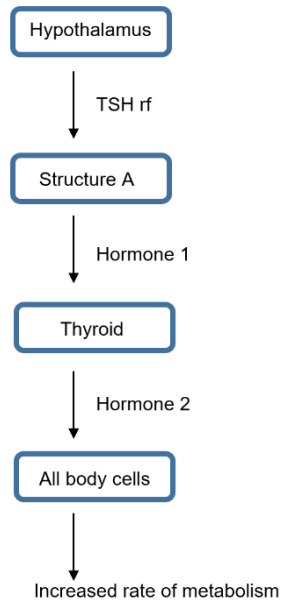
Increases blood glucose levels (1)  
Provide glucose for skeletal muscles / increased cell respiration during flight, fight, fright situations (1)



**Question 33**

**(9 marks)**

The flowchart below shows the endocrine glands and hormones involved in altering the rate of metabolism in a healthy person.



- (a) Name Structure A and describe how TSHrf travels to it. (2 marks)

Anterior pituitary (1)  
Through the bloodstream (1)

- (b) Explain why Hormone 1 only affects the thyroid while Hormone 2 can affect all body cells. (2 marks)

Hormones are specific (1)  
Only thyroid cells have the receptor for Hormone 1 while all body cells have the receptor for Hormone 2 (1)

- (c) In order for Hormone 2 to be produced, it requires a substance in the diet. What is the name of this substance? (1 mark)

Iodine (1)

- (d) Julie was not feeling well and had been losing weight, so she went to her doctor. He gave her a radioactive substance and scanned her thyroid before comparing her result to that of a healthy person. The results are shown below.



Healthy Person



Julie

- (i) What condition is Julie suffering from? (1 mark)

Hyperthyroidism (1)

- (ii) Other than weight loss, name **two** symptoms Julie may be experiencing. (2 marks)

Goitre / bulging eyeballs / fatigue / heat intolerance / increased sweating / increased heart rate / increased blood pressure / hyperexcitability / abnormal brain function (Any 2, 1 mark each)

- (iii) The doctor suggested an operation to remove part of her thyroid. Explain why this would be an appropriate treatment for Julie's condition. (1 mark)

Remove part of the thyroid so not as much thyroxine will be released (1)

**Question 34**

**(16 marks)**

- (a) Explain why the pH of blood can decrease. (3 marks)

Carbon dioxide is produced as a product of cell respiration (1)

Carbon dioxide combines in water to form carbonic acid (1)

Which dissociates to form bicarbonate ions and hydrogen ions (which reduces pH) (1)

- (b) Low pH reduces the affinity for oxygen to bind to haemoglobin in people with sickle cell trait and they suffer a sickle crisis. State **two** symptoms of someone with a sickle crisis. (2 marks)

Pain in joints / breathlessness / weakness / thirst / pale lips / swelling of hands and feet / frequent infections / vision issues / delayed growth (Any 2, 1 mark each)

- (c) Sickle cell anaemia is the result of a mutation and can be passed on to offspring.

- (i) What is a mutation? (1 mark)

Any change in the DNA (1)

- (ii) Explain whether the sickle cell mutation is a gene or chromosomal mutation. (2 marks)

Gene mutation (1)

As there is only one effect / doesn't affect a number of structures (1)

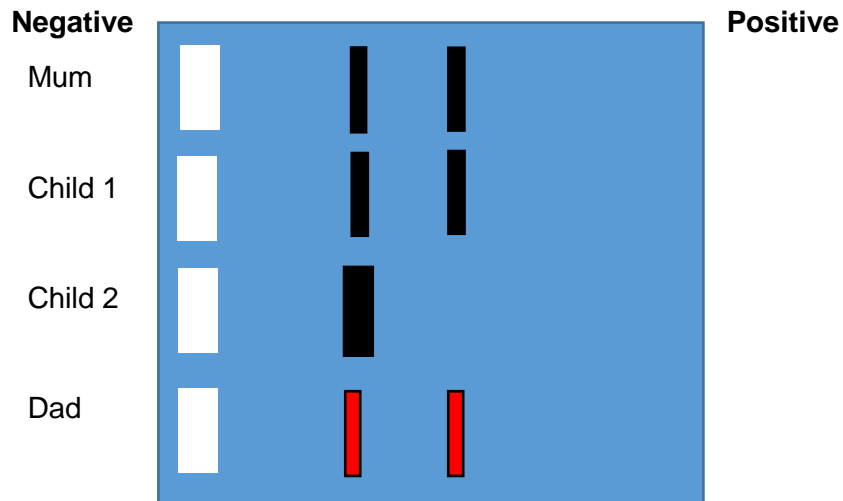
- (d) A gel electrophoresis was conducted for three members of a family.

- (i) Describe the role of the electrical current in gel electrophoresis. (2 marks)

Force the DNA across the gel / away from the well (1)

So it can be separated by size (1)

Gel electrophoresis was carried out for the family to determine whether or not any of them had the sickle cell allele. Their results are shown below.



- (ii) The results showed that Child 2 has sickle cell anaemia, while the rest of the family were carriers of the trait. Complete the Dad's lane in the image above. (1 mark)

Both bands present as shown in the image above / same bands as Child 2 (1)

- (e) Discuss how and provide reasons why the frequency of the sickle cell allele would vary in North America and in Africa. (5 marks)

North America

Sickle cell frequency will be lower (1)

As malaria is not present / no selection pressure from malaria (1)

Africa

Sickle cell frequency will be higher (1)

as malaria is present (1)

and a heterozygote advantage for malaria exists (1)

**Question 35**

**(17 marks)**

Recently, a mining giant funded an archaeological excavation at the Yirra rock shelter near Paraburdoo in the Pilbara of Western Australia, where they retrieved stone tools, charcoal and bone. Six individuals were identified, 4 adults and 2 children. The fossils were dated at 50,000 years. Mitochondrial DNA testing determined that three of the adults and both children were related to each other.

- (a) Explain how these specimens could have been dated. (5 marks)

Carbon 14 dating (1)

From sample of bone / charcoal (1)

Amount of C14 is fixed at death (1)

And decays at a fixed rate / has a half life of 5730 years (1)

Ratio of C14 : C12 decreases over time and determines the age of specimen (1)

- (b) Mitochondrial DNA was used to determine the relatedness of the individuals found in the rock shelter. Explain one advantage and one disadvantage of using mitochondrial DNA rather than nuclear DNA. (3 marks)

Advantages: (Any 1, explained, 2 marks)

Lots of mitochondria present in cells (1)

Which means there is a large amount of DNA for testing (1)

OR

Has a higher mutation rate than nuclear DNA (1)

So relationships can be seen more easily (1)

Disadvantage: (Any 1, explained, 1 mark)

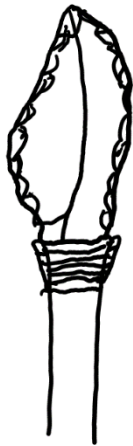
Makes it difficult to determine how some males are related in a mixed group / doesn't indicate the father of children (1)

- (c) At another site in Europe, scientists determined their specimens belonged to *Homo neanderthalensis*. State **one** anatomical and **two** cultural differences that existed between *Homo neanderthalensis* and early *Homo sapiens* (Cro magnon). (6 marks)

	<i>Homo neanderthalensis</i>	<i>Early Homo sapiens</i> (Cro Magnon)
<b>Anatomical</b>	Short and stocky / occipital bun / average cranial capacity 1520cc / large lower jaw and teeth / no chin / weak forehead / thick boned cranium / skull not dolicocephalic (Any 1, 1 mark)	Taller and thinner / no occipital bun / average cranial capacity 1330cc / more delicate lower jaw and teeth / chin present / strong forehead / thin boned cranium / dolicocephalic skull shape (Any 1, 1 mark)
<b>Cultural</b>	Mousterian tool culture / buried their dead / performed rituals (eg: bear clan) (Any 2, 1 mark each)	Aurignacian / Solutrean / Magdalanian tool culture / developed mural and portable art / modern language / performed religious rituals (Any 2, 1 mark each)

- (d) Two tools, excavated from different archaeological sites, were compared. Tool A was found attached to a portion of a stick while Tool B was not. (These images are not to scale).

Tool A



Tool B



- (i) What is the method of attaching tools to wood called? (1 mark)  
**Hafting (1)**
- (ii) Which hominin would have produced Tool B? (1 mark)  
**Homo erectus (1)**
- (iii) Which tool, Tool A or Tool B, would have been produced first? (1 mark)  
**Tool B (1)**

**Question 36**

**(14 marks)**

- (a) Describe one way that both the nervous and endocrine systems can affect breathing rate and explain why being able to use both these systems is an advantage.

(6 marks)

**Nervous**

Autonomic / sympathetic / parasympathetic / voluntary motor control (Any 1, 1 mark)

Causes it to increase / decrease breathing rate / be able to hold breath (1)

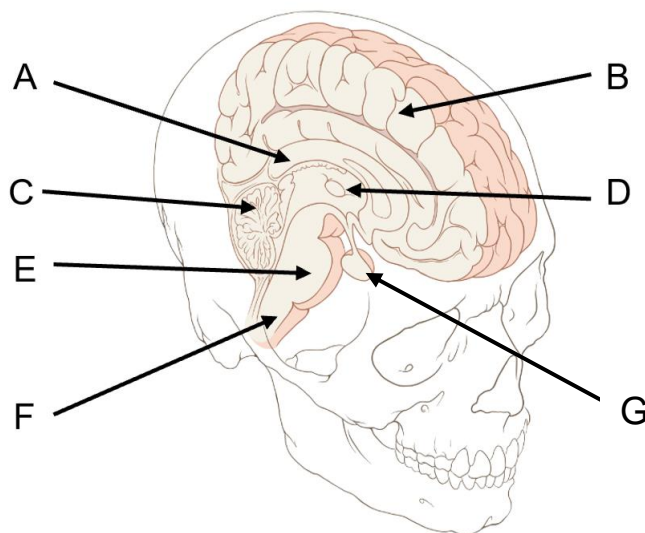
**Endocrine**

Adrenalin (1) - Increases breathing rate (1)

**Advantage –**

Endocrine effects will last longer (1)

Nervous acts quickly (1)



- (b) Name structure A. (1 mark)

Corpus callosum (1)

- (c) Explain how damage to structure G could result in less cortisol being produced. (2 marks)

Damage to the anterior pituitary would produce less ACTH (1)

Which would no longer stimulate the adrenal cortex to release cortisol (1)

- (d) Which structure/s shown on the image above would be involved in playing the violin? (2 marks)

B (1) and C (1)

- (e) Which structure/s shown on the image on the previous page would be involved in smelling dinner cooking and remembering what it was? (1 mark)

B (1)

- (f) Describe how the spinal cord is protected from injury. (2 marks)

Bony vertebral column surrounds the spinal cord to protect from knocks / blows (1)

Meninges surround the spinal cord and cushion the spinal cord (1)

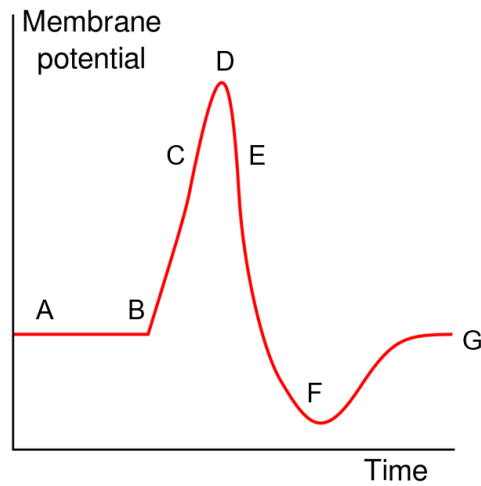
Cerebrospinal fluid acts as a shock absorber (1) (Any 2, 1 mark each)



**Question 37**

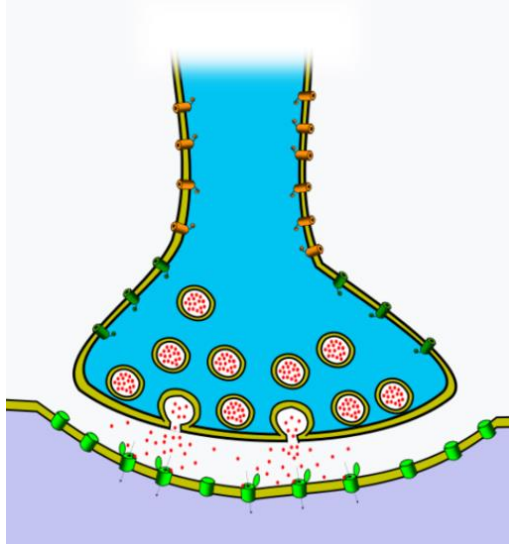
**(8 marks)**

The graph below represents the voltage across the membrane of an axon and the changes that take place during the generation and transmission of an action potential.



- (a) Use the letters A to G to state when each of the following events are occurring. A letter may be used once, more than once or not at all. (4 marks)

Event	Letter/s
Voltage-gated potassium channels are open	E (1)
Depolarisation	C (1)
Potassium ions are <b>actively</b> moved into the neuron	Either A or G, and F (1)
Sodium-potassium pumps are operating	Either A or G, and F (1)



- (b) The image above shows the mechanism by which an action potential crosses a synapse. Describe how this process. (4 marks)

(Any 4, 1 mark each)

- Neurotransmitters held in vesicles in synaptic knob/axon ending (1)
- Nerve impulse / action potential stimulates opening of  $\text{Ca}^{2+}$  channels (1)
- Calcium influx causes vesicles move to the surface (1)
- Release of chemicals is by the process of exocytosis (1)
- Neurotransmitters diffuse across synapse / into intercellular fluid (1)
- Binding to target receptors on post-synaptic neuron (1)

**End of Section Two**

**Section Three: Extended answer****20% (40 Marks)**

This section contains **four** questions. You must answer **two** questions.

Questions 38 and 39 are from Unit 3. Questions 40 and 41 are from Unit 4. Answer **one** question from Unit 3 and **one** question from Unit 4.

Responses could include clearly labelled diagrams with explanatory notes; lists of points with linking sentences; clearly labelled tables and graphs; and annotated flow diagrams with introductory notes.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 50 minutes

**UNIT 3**

Choose **either** Question 38 **or** Question 39. **Do not answer both.**

Indicate the question you will answer by ticking the box next to the question. Write your answer on the pages that follow.

**Question 38****(20 marks)**

Vaccines were first developed by Edward Jenner in 1796 when he observed that milk maids who milked cows suffered from a mild cowpox but did not suffer from the severe smallpox disease. In order to protect a young boy from the dangerous smallpox disease, Jenner scratched the boy's skin with the mild cowpox disease.

- (a) Compare and contrast the live attenuated and dead micro-organism vaccines and give an example of each type. (8 marks)

<b>Attenuated living</b>	<b>Dead micro-organism</b>
Eg: polio / tuberculosis / rubella / mumps / measles (1) - compulsory	Eg: Cholera / typhoid / whooping cough (1) - compulsory
Contain a live but weakened version of the pathogen/antigen (1)	Contain a dead version of the pathogen/antigen (1)
Last longer (1)	Do not last as long (1)
Provide a stronger immune response / memory (1)	Provide a weaker immune response / memory (1)
Weakened by heat / chemicals / ultraviolet light (1) Produce memory cells (1) Given before catching the disease (1) Artificial (1) Active (1) Can be injected (1) (Any 4, 1 mark each)	

- (b) The formation of subunit vaccines requires the use of recombinant DNA technology. Describe in detail how a subunit vaccine, such as that for Hepatitis B, is produced and briefly explain why it is not possible for people receiving a subunit vaccine to catch the disease from the vaccination. (12 marks)

Protein specific to that antigen must be identified (1)

Gene that produces that protein must be identified (1)

Gene is isolated by restriction enzymes (1)

Plasmid harvested from bacterial cell (1)

The same restriction enzyme is used to cut open the plasmids (1)

DNA ligase is used to join the gene and the plasmids to create recombinant DNA (1)

Plasmids are introduced back into bacteria (1)

Bacteria are grown on agar / agar that contains antibiotics (1)

Recombinant bacteria are provided appropriate conditions to grow (1)

They produce the protein specific to the antigen which is harvested (1)

These proteins are given as subunit vaccines (1)

(Any 11 marks, 1 mark each)

It is not possible to actually suffer from the disease as only the protein is contained in the vaccine, not the whole organism (1, compulsory mark)

**Question 39**

**(20 marks)**

John was in need of a kidney transplant. Doctors tested his family members for the possibility of one of them being a living donor.

- (a) People who received donor organs must take immunosuppressants to avoid the new organ being rejected. Describe the immune response John would have to the new kidney if no immunosuppressants were provided. **(10 marks)**

<b>Original marking key</b>	<b>Alternate marking key</b>
<p><b>(Any 6 points, 1 mark each)</b>                      B cells / macrophages encounter a non-self antigen (1)                      engulf it, digest and process it and then present small fragments of it on their surface (1)                      They then present it to T cells (1)                      If the T cell recognises the antigen it becomes activated and sensitised (1)                      increases in size and divides, producing clones (1)                      Killer T cells migrate to the site of infection (1)                      and act by attaching to the antigen and secreting chemicals that destroy it (1)</p> <p>Helper T cells act by secreting chemicals / cytokines (1) that...</p> <p><b>(Any 2 points, 1 mark each)</b>                      attract lymphocytes / macrophages to the area (1)                      sensitise these lymphocytes to act like these T cells (1)                      intensify the process of phagocytosis (1)                      promote the action of killer T cells (1)</p> <p><b>(Any 2 points, 1 mark each)</b>                      Memory T cells remember the antigen for the future and initiate a very rapid response (1)                      Suppressor T cells take part when the immune response is excessive or no longer required (1)                      and act by secreting chemicals that inhibit T and B cell activity, slowing the immune response (1)</p>	<p><b>(Any 6 points, 1 mark each)</b>                      Macrophages encounter a non-self antigen (1)                      engulf it, digest and process it and then present small fragments of it on their surface (1)                      They then present it to B cells (1)                      If the B cell recognises the antigen it becomes activated and sensitised (1)                      increases in size and divides, producing clones (1)                      Helper T-cells release cytokines to activate B-cells (1)                      B-cells become plasma cells (1)                      Plasma cells secrete antibodies (1) which...</p> <p><b>(Any 2 points, 1 mark each)</b>                      Antibodies combine with antigen to form antigen-antibody complex (1)                      Causes antigens to clump together (agglutination) (1)                      Coat antigen (1)                      Making them easier to be phagocytose (1)</p> <p><b>(Any 2 points, 1 mark each)</b>                      Antibody levels decline over time (1)                      Memory B cells remember the antigen for the future and initiate a very rapid response (1)</p>

- (b) The kidney is a target for both aldosterone and antidiuretic hormone. Differentiate between the modes of action of these two hormones. **(10 marks)**

**Any 5, matching**

<b>Aldosterone</b>	<b>Antidiuretic Hormone</b>
Soluble in lipids	Soluble in water
Active for a long time	Active for a shorter time
Travel in blood attached to a protein	Travel in blood dissolved in plasma
Enter cells	Do not enter cells
Receptors in cytoplasm / on organelles / in nucleus / on DNA	Receptors in / on cell membrane
Does not use a secondary messenger	Uses a secondary messenger
Alters gene functioning	Alters enzyme functioning

## Unit 4

Choose either Question 40 or Question 41. Do not answer both.

Indicate the question you will answer by ticking the box next to the question. Write your answer on the pages provided.

### Question 40

(20 marks)

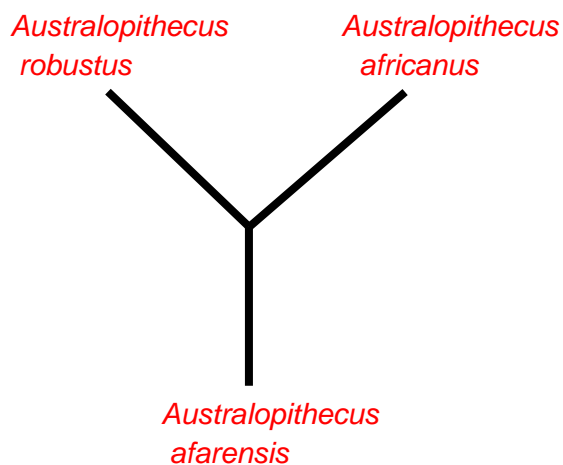
- (a) *Australopithecus robustus* and *Australopithecus africanus* were considered to be closely related to each other and derived from a common ancestor, *Australopithecus afarensis*. After careful analysis, *Australopithecus robustus* was reclassified as *Paranthropus robustus*.

Draw and label a phylogenetic tree to show the relationship between these three species **before** analysis and describe the key anatomical aspects of the robust form that might have resulted in the change in classification.

(6 marks)

### Before the analysis

(2 marks for the phylogenetic tree, 1 mark for correct organisation, 1 mark for labelling)



### Anatomical aspects

Larger body size / larger molars and premolars / thick jaw / larger cranial capacity / has a sagittal crest / heavy zygomatic arches (Any 4, 1 mark each)

- (b) *Homo habilis* was the first hominin specimen considered to be fully upright and bipedal. Describe the characteristics of the pelvis, vertebral column and cranium that allowed this hominin to stand and move in this way. (14 marks)

(Any 14, 1 mark each)

<b>Body region</b>	<b>Characteristics</b>	<b>Allow bipedalism</b>
<b>Pelvis</b>	Short	To support abdominal organs when erect
	Broad	
	Bowl shaped	
	Acetabulum (socket that femoral head connects to) positioned more laterally (to the side/wider)	to allow greater carrying angle/ distribute weight centrally
<b>Vertebral column</b>	Wedge shaped lumbar	To allow for double curvature
	S shaped	To improve balance/allow skull to balance on spine/neck more easily
<b>Cranium</b>	Smaller lower jaw	To allow skull to balance on spine
	Reduced prognathism	
	Centrally placed foramen magnum	
	Reduction in size of zygomatic arches	



**Question 41**

**(20 marks)**

- (a) Population A, a large population with gene flow, began with an allele frequency of 50% H and 50% h. Population B, a small, isolated population, also began with an allele frequency of 50% H and 50% h.

At the end, Population A had become 58% H and 42% h, while Population B has become 70% H and 30% h.

Explain what processes are occurring in each population that resulted in the final allele frequencies. (10 marks)

Population A - Natural Selection is occurring (1, compulsory mark)

(Any 5 marks, 1 mark each)

There is variation in their allele frequency (1)

More individuals are born than survive to maturity (1)

A species usually maintains its numbers over time (1)

Some features are adaptive - they aid survival (1)

Selective forces are in play / a struggle for existence occurs (1)

Selective forces kill off / reduce the fertility of less well adapted organisms (1)

The well adapted individuals survive and reproduce (1)

So this favourable feature is passed on to the next generation (1)

And therefore increases in frequency from one generation to the next (1)

Population B - Random genetic drift is occurring (1, compulsory mark)

(Any 3 marks, 1 mark each)

A random non-directional variation in allele frequencies (1)

Inbreeding / lack of gene flow occurs as the population is isolated (1)

The H allele has by chance become more frequent in the small population (1)

It may not provide a selective advantage to the individual (1)

Its frequency may, by chance, change over time (1)



- (b) Ebola is a virus that caused over 11,000 deaths in West Africa between 2014 and 2016. The DNA of the Ebola virus has a rapid rate of mutation. Since the first outbreak, scientists have been working hard to develop a vaccine against the disease.
- (i) Outline how DNA sequencing and bioinformatics could be used as part of the development of a vaccine against Ebola. (4 marks)

**DNA sequencing (Any 2 marks, 1 mark each)**

DNA sequencing allows the nitrogen base sequence of different Ebola mutations to be determined (1)  
to find gene sequences common to all the strains (1)  
that could be used to develop the protein for the vaccine (1)

**Bioinformatics (Any 2 marks, 1 mark each)**

Bioinformatics is the field in which biology, computer science, mathematics and information technology merge into a single discipline (1)  
This discipline analyses and interprets large volumes of biological data (1)  
Can be used to determine differences / common areas between Ebola strains in terms of amino acid or DNA sequences (1)  
making comparisons between different Ebola strains easier / automatic (1)

- (ii) Describe the process of PCR and indicate why it would be useful when developing a vaccine. (6 marks)

The gene that the Ebola virus strains have in common is replicated to create enough copies to be used in recombinant DNA processes (1) – compulsory point

Heating to 96°C causes denaturing / DNA double helix strands to separate (1)  
Lowering the temperature / 50-65°C allows primers to bind to their complement on the template DNA strand (1)  
The temperature is then raised / 72°C so DNA polymerase binds to the DNA (1) and builds the double helix using the available nucleotides (1)  
the cycle is repeated to copy the gene of interest multiple times (1)

**End of questions**