



2020 Trial Examination

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STUDENT
NUMBER

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Letter

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BIOLOGY

Units 3 & 4 – Written examination

Reading time: 15 minutes

Writing time: 2 hours and 30 minutes

QUESTION & ANSWER BOOK

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	40	40	40
B	10	10	80
			Total 120

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is permitted in this examination.

Materials supplied

- Question and answer book of 36 pages.

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the examination room.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions. Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

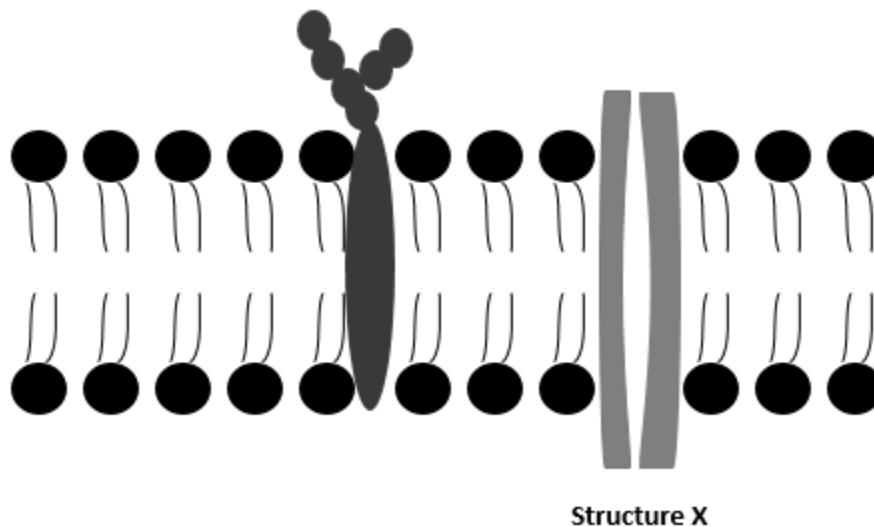
Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Use the following information for Questions 1 & 2

The following diagram is a simplified sketch of the plasma membrane.



Question 1

Structure X would contain monomers that have the following chemical composition

- A. carbon, hydrogen, oxygen, nucleic acids
- B. carbon, hydrogen, oxygen, phospholipids
- C. carbon based sugar, phosphate group, nitrogenous base
- D. carbon, hydrogen, amine group, carboxyl group, variable R group

SECTION A - continued

Question 2

Substances that would be able to cross the plasma membrane of a cell via simple diffusion would include

- A. hydrophilic molecules
- B. large carbohydrate molecules
- C. lipid soluble molecules
- D. small ions

Question 3

The formation of a complex protein involves the addition of amino acid molecules. When these amino acids are joined which of the following is most likely to occur?

- A. a catabolic condensation reaction involving the production of water molecules
- B. a hydrolysis reaction using water molecules to form new chemical bonds
- C. an anabolic reaction involving condensation polymerisation
- D. a catabolic reaction involving the hydrolysis of the adjoining monomers

Question 4

NADP⁺ is an example of a coenzyme. Which of the following molecules from the list is not a type of coenzyme that has stored energy for use in metabolic processes?

- A. ATP
- B. ADP
- C. NADH
- D. NADPH

Question 5

The complete set of proteins that is expressed by an organism during its lifespan is known as the

- A. genome
- B. genomic sequence
- C. proteome
- D. proteomic sequence

SECTION A - continued
TURN OVER

Use the following information for Questions 6 & 7

Consider the following two molecules. Molecule A is a double stranded nucleic acid molecule and Molecule B is a single stranded nucleic acid molecule that contains both introns and exons.

Question 6

A key similarity between these molecules would include

- A. both of the molecules contain coding that is made of the same chemical structures
- B. both of the molecules would contain coding that is not used in the primary production of a polypeptide.
- C. both of the molecules would be found in the cytoplasm of a eukaryotic cell that is undergoing the translation of a polypeptide
- D. both of the molecules are able to code for the production of a structural protein only in eukaryotic cells

Question 7

The following table was constructed to show the chemical structure of both molecules. Select the row which correctly identifies the characteristics of the molecules.

	Only found in Molecule A	Only found in Molecule B	Found in both
A.	uracil, ribose	thymine, deoxyribose	guanine, cytosine, adenine, phosphate group, complementary pairing of bases
B.	uracil, deoxyribose, complementary pairing of bases	thymine, ribose	guanine, cytosine, adenine, phosphate group
C.	thymine, deoxyribose, complementary pairing of bases	uracil, ribose	guanine, cytosine, adenine, phosphate group
D.	thymine, ribose	uracil, deoxyribose	guanine, cytosine, adenine, phosphate group, complementary pairing of bases

Question 8

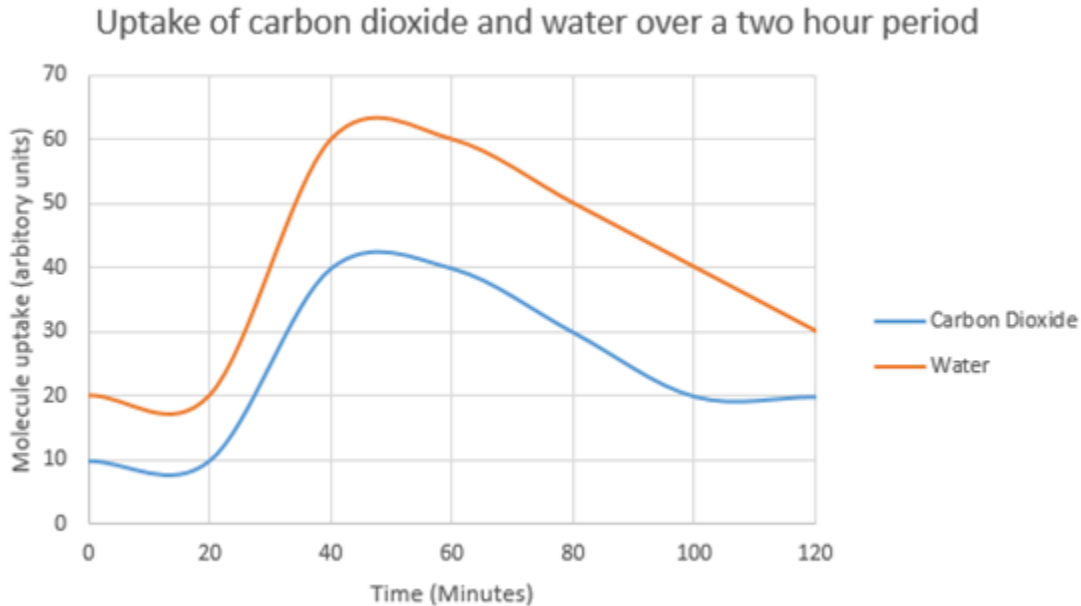
Which of the following molecules would only be found within the nucleus of a somatic body cell?

- A. pre-mRNA
- B. mtDNA
- C. tRNA
- D. mRNA

SECTION A - continued

Use the following information for Questions 9 & 10

A controlled experiment was developed to demonstrate the rate of photosynthesis in *Agapanthus* leaves under laboratory conditions. The graph below shows the results of the experiment over a two-hour period.



Question 9

It could be determined from this graph that

- A. the rate of photosynthesis is continuously increasing over the two hour period
- B. at 15 minutes a light was turned on that resulted in the increased rate of photosynthesis and increased uptake of water into the granum of the chloroplast.
- C. at 17 minutes there was a net uptake of water for use in the stroma of the chloroplast
- D. the reduction of carbon dioxide from 60-100 minutes is due to the catabolic reactions that occur in the grana.

Question 10

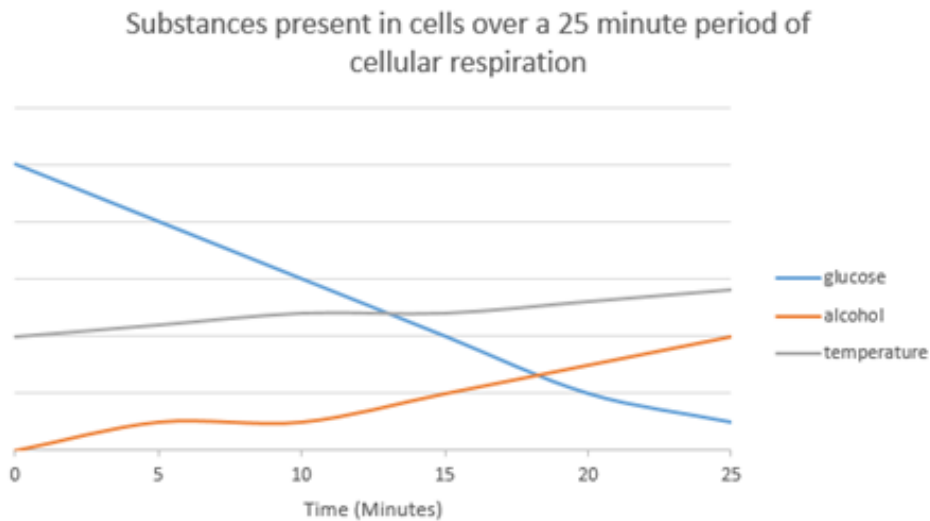
As a result of photosynthesis new molecules are produced. Which molecules are produced as a result of the phase that does not require the input of light energy?

- A. water and ATP
- B. glucose, oxygen, ADP + Pi, NADPH,
- C. carbon dioxide, ATP and NADPH
- D. water, glucose, ADP + Pi, NADP

SECTION A - continued
TURN OVER

Use the following information for Questions 11 & 12

An experiment was conducted to determine the concentration of substances present in a sample of cells undergoing cellular respiration over a period of 25 minutes. The following graph demonstrates the net amount of substances measured during this process and the relative temperature.

**Question 11**

Which type of cells would not be found in the sample?

- A. human muscle cells
- B. yeast cells
- C. bacterial cells
- D. spinach leaf cells

Question 12

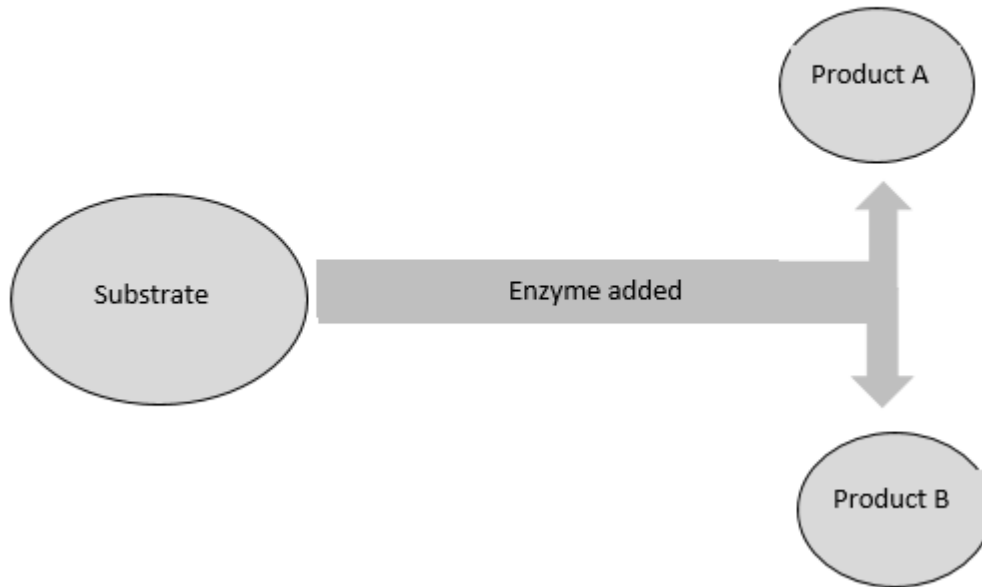
If the cells were deprived of oxygen, which of the following would not occur during this experiment

- A. the amount of ATP produced would decrease
- B. the net amount of pyruvate would continually increase
- C. the amount of carbon dioxide would increase
- D. the net amount of lactic acid produced would decrease

SECTION A - continued

Use the following information for Questions 13 & 14

Consider the following biological pathway for an enzyme.



Question 13

A simple set up was designed to show this reaction taking place in a laboratory.

It would be reasonable to conclude that

- A.** Increasing the concentration of enzyme used would result in a faster rate of product A and product B production.
- B.** The concentration of product A and product would decrease when the amount of enzyme is increased
- C.** The rate that product A and product B is produced would increase when the concentration of substrate is also increased.
- D.** Increasing the concentration of substrate would result in a slower rate of product A and product B production.

SECTION A - continued
TURN OVER

Question 14

Enzyme inhibitors can be used to stop the breakdown of the substrate. The enzyme has an active site with two regions that bind with the substrate molecule to enable hydrolysis to occur. Enzyme inhibitors bind to one region of this active site and are able to be released after a period of time.

This type of enzyme inhibitor is

- A. Demonstrating the induced fit model of the enzyme lock and key
- B. A non-competitive inhibitor that stops the production of product A and product B.
- C. A coenzyme that enhances the hydrolysis of the substrate molecule
- D. Reversible and acting as a competitive inhibitor molecule

Question 15

During the production of a structural protein, modifications are made to the genetic material. Which of the following occurs?

- A. the mRNA molecule has had introns spliced out
- B. the double stranded DNA molecule is unwound by DNA ligase
- C. the promoter region is activated for translation to occur in the mRNA molecule
- D. exons are removed from pre-mRNA

Question 16

The steroid hormone estrogen is produced by the ovaries and stimulates the development of secondary sex characteristics throughout the body in females.

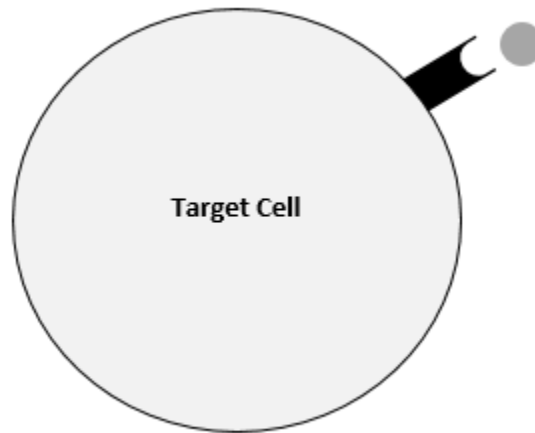
Estrogen is best described as an example of

- A. endocrine signaling
- B. paracrine signaling
- C. autocrine signaling
- D. neurotransmitter signaling

SECTION A - continued

Question 17

The following diagram shows the pathway of a signaling molecule interacting with its target cell.



An example that would not demonstrate this type of signaling pathway is

- A. the action of cytokines to stimulate the immune system to produce a response
- B. the release of dopamine neurotransmitter across the synapse in brain tissue to target post synaptic receptor sites
- C. the secretion and formation of the androgen-receptor complex in the lipid-based sex hormone testosterone
- D. the reception and signal transduction of hydrophilic signaling molecules in transmembrane chemosensory receptors found in olfactory neurons

Question 18

Whooping cough is a highly contagious disease caused by the bacteria *Bordetella pertussis* that can result in severe respiratory distress with a common 'whooping' sound cough and can even lead to death in some individuals.

In Australia an immunisation program has been set up to reduce the spread of whooping cough among vulnerable individuals. During infancy, multiple doses of the vaccination are given and then when a person reaches adulthood it is recommended to have a booster every 10 years if in contact with vulnerable individuals, like babies or small children.

Why are booster shots in adulthood required for whooping cough?

- A. the vaccination does not produce enough memory cells
- B. after initial action of mast cells, the number with specific antigens to *Bordetella pertussis* has reduced.
- C. the T cells are no longer able to produce adequate amounts of cytokines and antibodies to agglutinate *Bordetella pertussis* antigens
- D. following vaccination, the B memory cell numbers have depleted and can no longer produce antibodies against *Bordetella pertussis* antigens

SECTION A - continued

TURN OVER

Question 19

In a limited number of individuals immunisation cannot occur for medical reasons. Which of the following best describes how herd immunity protects children in daycare who cannot receive the immunisation from contracting *Bordetella pertussis*?

- A. saliva from the toys of other children that have been vaccinated against *Bordetella pertussis* contains passive immunity for the unvaccinated child
- B. having the Australian population vaccinated against *Bordetella pertussis* results in the bacteria no longer existing in Australia so less people need to be vaccinated against it
- C. the unvaccinated child would still have passive natural immunity against *Bordetella pertussis* antigen due to both of their parents being vaccinated prior to birth
- D. if many individuals have been vaccinated against *Bordetella pertussis* then the bacteria will be less likely to be present in order to be spread to a child that attends daycare

Question 20

The following diagram shows the mode of action under the skin in response to a prick test from a food allergen.



Which type of antibody would be present in high numbers at the prick site?

- A. immunoglobulin A
- B. immunoglobulin D
- C. immunoglobulin E
- D. histamines

Question 21

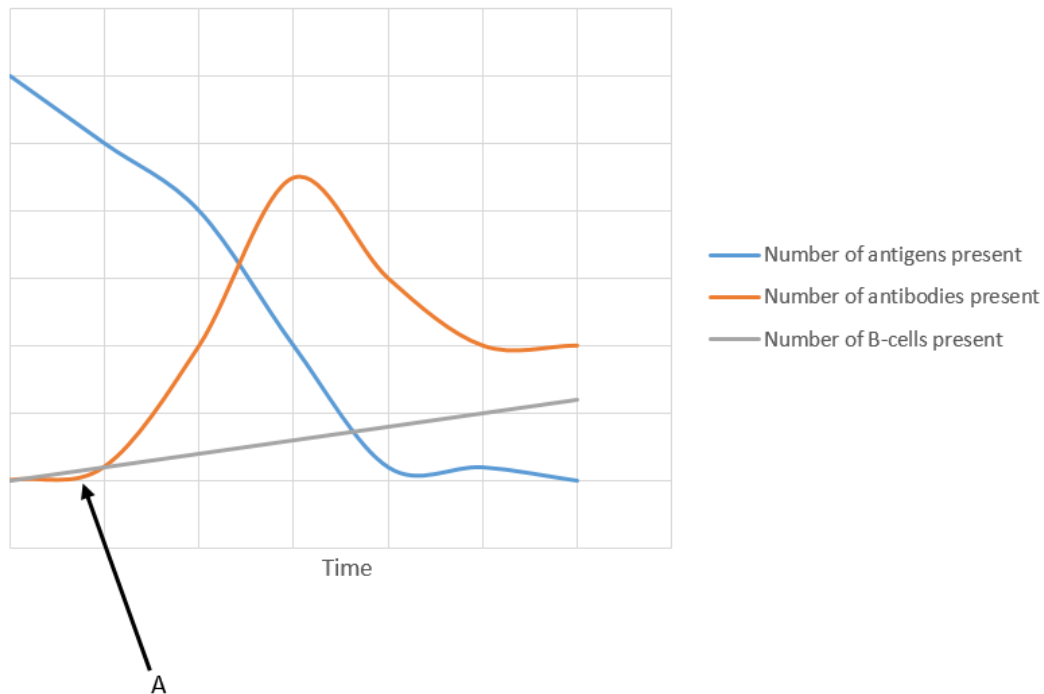
Immune cells are often actively seeking and destroying foreign material. Which of the cells below have the primary role of actively engulfing and destroying non-self material as part of the second line of defence?

- A. complement proteins
- B. macrophage
- C. B cells
- D. cytotoxic T cells

SECTION A - continued

Use the following information for Questions 22 & 23

Consider the graph below of an immune response to a specific antigen.



Question 22

The type of immunity shown in the diagram is

- A. artificial passive immunity involving the first line of defence.
- B. natural passive immunity involving the third line of defence.
- C. artificial active immunity involving the second line of defence.
- D. natural active immunity involving the third line of defence.

Question 23

Which type of cell would also be expected to be increasing prior to point A?

- A. plasma cells as they secrete antibodies to agglutinate the antigen.
- B. cytotoxic T cells as they secrete cytokines that reduce the numbers of antigens present
- C. cell mediated helper T lymphocytes that promote inflammation in the infected that allows more T cells to produce higher numbers of antibodies
- D. dendritic cells that are stimulated by the production of antibodies

Question 24

Monoclonal antibodies can be used in immune system therapy to target cancer cells. Monoclonal antibodies that contain two different antigen binding sites are known as

- A. conjugated monoclonal antibodies
- B. bispecific monoclonal antibodies
- C. chimeric monoclonal antibodies
- D. transgenic monoclonal antibodies

SECTION A – continued
TURN OVER

Question 25

The following is a table of amino acids.

		Second Position							
		U		C		A		G	
First Position	U	UUU UUC	Phe	UCU UCC UCA UCG	Ser	UAU UAC UAA-Stop UAG-Stop	Tyr	UGU UGC	Cys
	C	CUU CUC CUA CUG	Leu	CCU CCC CCA CCG	Pro	CAU CAC	His	CGU CGC CGA CGG	Arg
	A	AUU AUC AUA AUG-Start	Ile	ACU ACC ACA ACG	Thr	AAU AAC	Asn	AGA AGG	Arg
	G	GUU GUC GUA GUG	Val	GCU GCC GCA GCU	Ala	GAU GAC	Asp	GGU GGC GGA GGG	Gly

Consider the following amino acid sequences for colour production in alpacas.

Normal colour production - Met-Glu-Phe-Ile-Ser-Lys

Mutated colour production - Met-Glu-Phe-Ile-Pro-Lys

The mutation that occurred is most likely due to a

- A.** silent mutation
- B.** missense mutation
- C.** nonsense mutation
- D.** frameshift mutation

SECTION A - continued

Question 26

Familial Down syndrome is the result of a chromosomal abnormality where chromosome number 21 contains genetic material from chromosome number 15. In this case the individual still has a karyotype that contains the same number of chromosomes as the unaffected parents.

This is an example of

- A. a translocation mutation
- B. an insertion mutation
- C. a deletion mutation
- D. an inversion mutation

Use the following information for Questions 27 & 28

Population 1	Population 2	Population 3	Population 4
Blue 80% Orange 20%	Green 75% Blue 20% Green-Blue Speck 5%	Green 100%	Green 60% Blue 10% Orange 10% Green-Blue speck 20%

Question 27

If a selective event occurred in relation to the green colouration, which population would exhibit the most rapid rate of change?

- A. population 1
- B. population 2
- C. population 3
- D. population 4

Question 28

The populations were initially one single group of individuals with little genetic variation. and Migration occurred and separate populations formed, with mutations occurring over a long period of time, giving rise to new genotypes. The migratory pathway would most likely be in the order:

- A. 3,2,4,1
- B. 3,4,1,2
- C. 3,2,1,4
- D. 4,1,2,3

SECTION A - continued
TURN OVER

Question 29

The number of individuals in a gene pool of a population can be seen in the table below.

Genotype	Number of individuals with the genotype		
	1 st Generation	5 th Generation	10 th Generation
AA	50	60	165
Aa	42	38	0
aa	73	63	0

It would be correct to conclude that the mechanism for changes within this population is due to which of the following scenarios?

- A. random mating of individuals within this group has reduced the genetic variation
- B. a small group of this population has migrated to another area leading to the founder effect
- C. a selective agent has resulted in a higher rate of mutation over the generations
- D. genetic isolation of this population and a chance event has resulted in a population bottleneck

Use the following information for Questions 30 & 31

There are four main species and subspecies of Australian coastal banksia:

Banksia integrifolia compar, *Banksia integrifolia monticola*, *Banksia integrifolia integrifolia* and *Banksia aquilonia*. *Banksia integrifolia* and its subspecies range from Victoria to southern Queensland, with overlapping regions. *Banksia aquilonia* is only found in northern tropical Queensland and does not have any overlapping regions with *Banksia integrifolia*.

Question 30

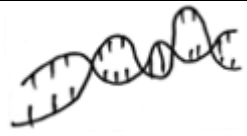
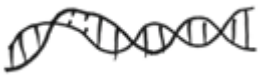
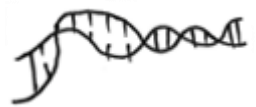
The study of biogeography involving these *Banksia* species primarily examines:

- A. the selective pressures and other factors that have led to the distribution of the banksia
- B. the genetic differences between the banksia subspecies
- C. the structural morphology of the banksia that is mapped over a period of time
- D. the mechanisms of convergent evolution in the banksia subspecies

SECTION A - continued

Question 31

DNA hybridization was carried out on a segment of DNA of these four types of banksia. Based on the information given, the two banksia that were the most closely related are:

	Species used in hybridization	Diagram of DNA
A.	<i>Banksia aquilonia</i> and <i>Banksia integrifolia compar</i>	
B.	<i>Banksia integrifolia monticola</i> and <i>Banksia integrifolia integrifolia</i>	
C.	<i>Banksia integrifolia monticola</i> and <i>Banksia integrifolia compar</i>	
D.	<i>Banksia integrifolia compar</i> and <i>Banksia integrifolia integrifolia</i>	

Use the following information for Questions 32 & 33

Restriction enzymes can be used to modify genetic material. The following piece of double stranded DNA is used in the manipulation process.

5' G C T T C G G A T C C G G C C 3'
3' C G A A G C C T A G G C C G G 5'

The following restriction enzymes and their cutting sites are available for use in this process.

Restriction enzyme	Recognition cutting site marked with an asterix
BamHI	5' G*G A T C C 3' C C T A G*G
EcoRI	5' G*A A T T C 3' C T T A A*G
HaeIII	5' G G*C C 3' C C*G G
HindIII	5' A*A G C T T 3' T T C G A*A

SECTION A - continued
TURN OVER

Question 32

The goal of this genetic modification is to produce two fragments of complementary DNA to allow a further ligation involving a vector to occur.

This would include the use of the restriction enzyme/s

- A. EcoRI
- B. HindIII
- C. HindIII and BamHI
- D. HaeIII and BamHI

Question 33

Which restriction enzyme would be best suited to a transformation involving a ligation of a vector?

- A. BamHI
- B. EcoRI
- C. HaeII
- D. HindIII

Question 34

Scientists often need to make many copies of a DNA strand. The process for making these strands is Polymerase Chain Reaction (PCR).

Which of the following is incorrect about PCR?

- A. To separate the DNA strands, the sample is heated to 98°C
- B. Taq polymerase is the enzyme that copies DNA
- C. After 2 PCR cycles, there will be 8 strands of DNA
- D. The DNA strands are extended at 72°C

Question 35

Neuraminidase inhibitors:

- A. are used to inhibit the breakdown of neurotransmitter at the synaptic cleft preventing infection of the nervous system
- B. are antibiotics that stop the spread of bacteria by breaking down the cell wall
- C. are vaccinations that activate B and T memory cells to give short term immunity against pathogens
- D. are used to block the active site and prevent reproductive budding of viruses from the host cell

SECTION A - continued

Question 36

Scientists have been able to identify and, using CRISPR techniques, remove a section of DNA from tomato plants to make them resistant to mildew, which spoils the outer appearance of tomatoes. This makes them more appealing to customers to purchase and prevents food wastage. The DNA target section was located by examining mutations that occur naturally in some wild tomato plant populations. These wild tomatoes are used to selectively breed small artesian tomato crops. The laboratory altered tomatoes look no different to the selectively bred tomatoes.

Determine which statement is most correct

- A.** As the laboratory tomatoes have had their DNA manipulated at a cellular level, they are transgenic organisms
- B.** The tomatoes bred in the laboratory are better than selectively bred tomatoes as they contain additional DNA that assists in their disease resistance
- C.** The laboratory grown tomatoes are mutant tomatoes as they have different DNA to the selectively bred tomatoes
- D.** Both the selectively bred and the laboratory type tomatoes are examples of genetically modified organisms

Question 37

Przewalski's horse is one of the only non-domesticated horses found in the world. Examination of its DNA in comparison to domestic horses indicate that it is an ancestral species. It was originally found in Central Asia but was actively hunted and declared extinct in natural habitats and only found in small numbers in captivity. As a result of an extensive breeding program the horses have been able to reintroduced to the wild in a national park in Mongolia. They must, however, be closely monitored to ensure that population numbers do not decrease due to selective pressures on a diminished genetic diversity.

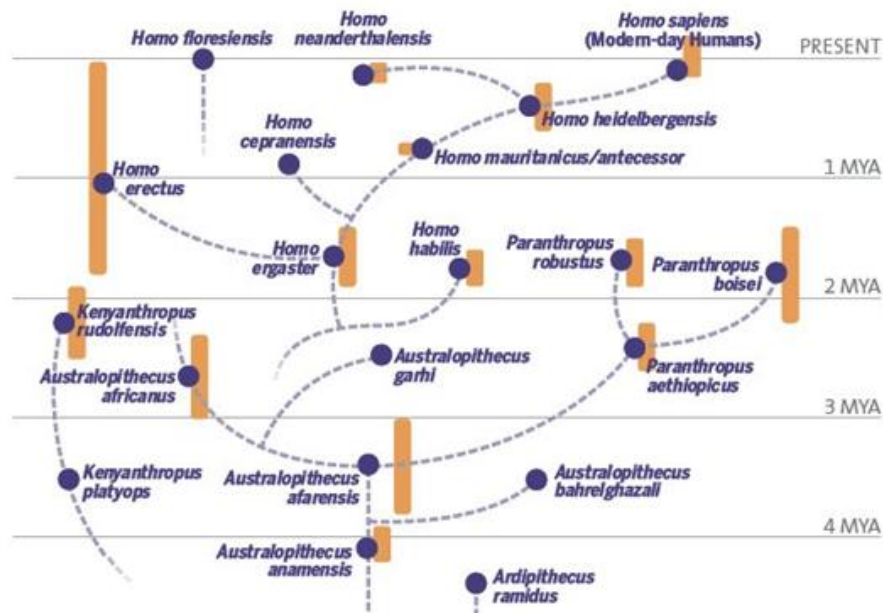
It is likely that the process responsible for this diminished genetic diversity is

- A.** the founder effect
- B.** population bottleneck
- C.** genetic drift
- D.** allopatric speciation.

SECTION A - continued
TURN OVER

Use the following information to answer Questions 38, 39& 40

The following diagram was created from various pieces of evidence to show the evolutionary processes that have led to modern day humans. This includes evidence from the Laetoli footprints of two bipedal hominins found in fossilized volcanic ash in Tanzania, East Africa. These footprints have been dated to approximately 3.6 million years old.



Question 38

Based on the phylogenetic tree above which of the following statements is correct?

- A. *Homo heidelbergensis* and *Homo cepranensis* shared a recent common ancestor
- B. *Homo ergaster* is the most recent common ancestor of *Homo habilis*
- C. *Homo erectus* and *Homo habilis* existed in the same period of time
- D. the most recent common ancestor for *Homo neanderthalensis* and *Homo sapiens* is *Homo mauritanicus*.

Question 39

Based on the data provided, which hominin could be ruled out as not being a possible source of these footprints?

- A. *Australopithecus afarensis*
- B. *Australopithecus africanus*
- C. *Australopithecus bahrelghazali*
- D. *Kenyanthropus platyops*

SECTION A - continued

Question 40

The Laetoli footprints are an example of which type of fossil?

- A. impression fossil
- B. mineralized fossil
- C. trace fossil
- D. cast fossil

END OF SECTION A
TURN OVER

SECTION B - Short-answer questions

Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black pen.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (5 marks)

Neurons are excitatory cells that are integral components of the human body allowing the quick transmission of messages to ensure survival. It relies on an electrochemical process involving the movement of specific molecules in and out of the cell at various points.

During the excitatory phase sodium ions rapidly enter the cell and potassium ions rapidly exit. At the axon terminal calcium ions enter the cell and trigger the release of neurotransmitters. This process transmits the message from one neuron to another nearby neuron.

- a.** Explain why sodium ions require a protein channel in order to enter the cell.

1 mark

- b.** Name the process that neurotransmitters use to leave the cell.

1 mark

- c.** Describe the series of events that occur in the process named in part **b.**

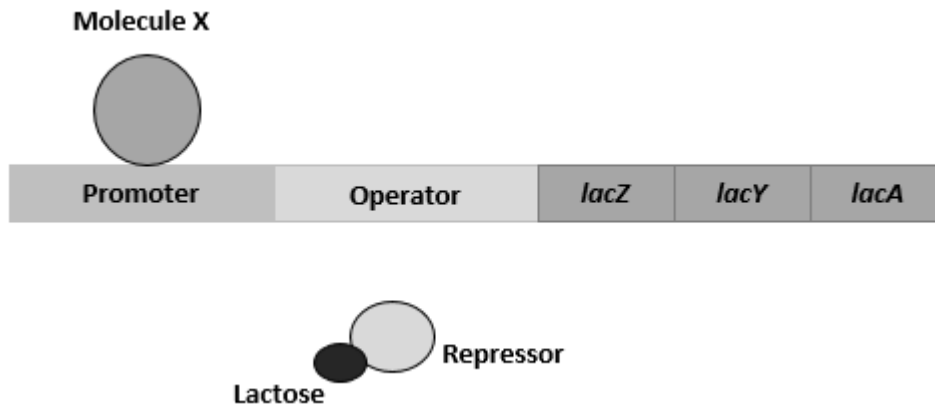
3 marks

SECTION B - continued

Question 2 (14 marks)

Lactose is a disaccharide molecule comprised of glucose and galactose monomers. In *E.coli* it can be metabolized by the enzyme lactase into its individual subunits, allowing glucose to be freely available for cellular processes. This enzyme is produced through the expression of a group of genes with a single promoter region known collectively as the *lac* operon.

The following diagram represents the genes involved in production of lactase in an *E.coli* cell.



- a. Identify molecule X in the diagram shown.

1 mark

- b. Explain if the diagram shown would or would not result in the expression of the *lacZ*, *lacY* and *lacA* genes.

3 marks

- c. Determine if the *lac* operon model shown is an example of a structural or regulatory gene or both and explain your choice.

2 marks

SECTION B – continued
TURN OVER

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Humans are also able to produce the lactase enzyme through a different series of genetic expressions due to a single gene found on chromosome 2.

- d.** The genetic code is said to be degenerate. Explain with reference to this statement how a mutation in this code could still result in the production of the enzyme lactase.

2 marks

- e.** Describe the series of events that occur in the cytosol that lead to the production of the polypeptide that forms the basis of lactase

3 marks

- f.** Once the polypeptide is fully formed it must undergo further modifications in order to be a functional enzyme that interacts with extracellular lactose molecules. Describe the actions of the cell that take place in order for this to occur.

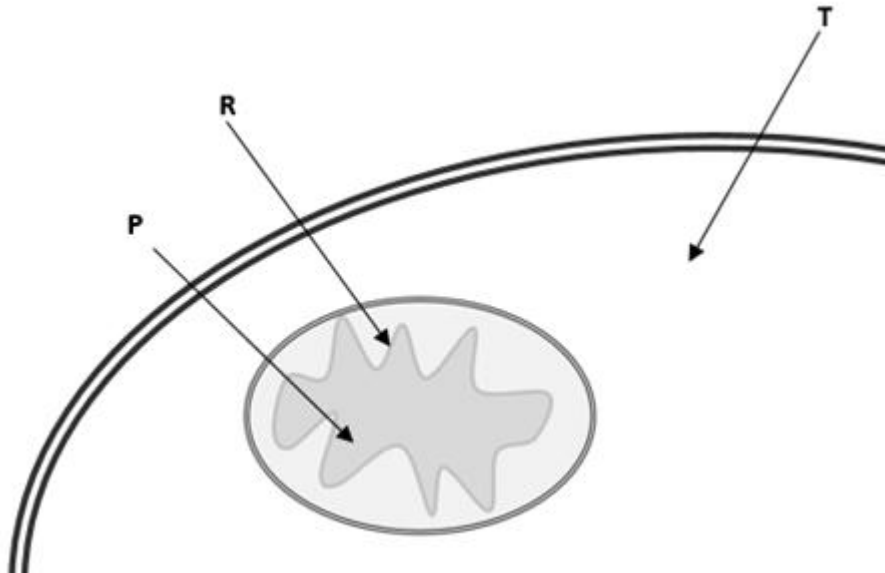
3 marks

SECTION B - continued

Question 3 (10 marks)

Mitochondrial encephalopathy is an inherited disorder that is the result of a mutation in mitochondrial DNA that results in the inability to produce proteins required for cellular respiration to occur. Individuals with this condition have reduced activity of ATP within the muscular tissue and an increased chance of neuronal signal transduction impairment leading to further disability.

The following is a diagram of the mitochondria within a eukaryotic cell.



- a. Determine the location, an input and an output (excluding ATP yield) of respiration occurring in the cell diagram above.

3 marks

	Letter of location	Input	Output
Electron transport chain			
Krebs cycle			
Glycolysis			

SECTION B - continued
TURN OVER

- b.** Name a protein-based molecule that would be used within the mitochondria to assist the production of energy and describe its hierarchical structure.

2 marks

Mitochondria are not the only organelle outside the nucleus that contain DNA in eukaryotes.

- c.** Name another organelle that also has its own DNA.

1 mark

- d.** Give two pieces of evidence, other than containing its own DNA, that support the bacterial origin of mitochondria and the organelle named in part c.

1 mark

- e.** Given the nature of inheritance from parent to offspring, explain how this particular form of mitochondrial disease is inherited.

1 mark

- f.** In vitro fertilisation (IVF) embryo screening is one method perspective parents can use to prevent the occurrence of mitochondrial disease in their offspring. Pre-implantation embryos are screened for the mitochondrial mutations and only low risk embryos are implanted into the mother.

Outline one ethical and one biological implication of using embryonic screening.

2 marks

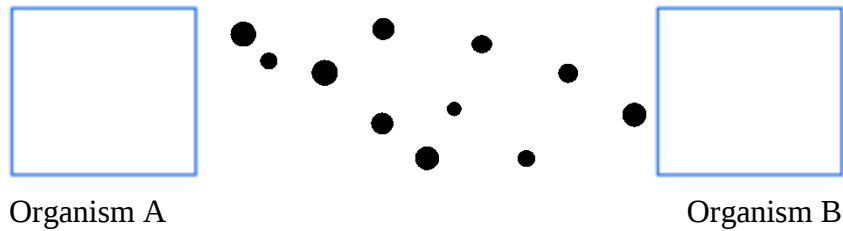
Ethical

SECTION B - continued

Biological

Question 4 (2 marks)

The pathway of a signaling molecule is shown in the diagram below:



- a. Explain what type of signaling molecule does the diagram demonstrate?

1 mark

Bait traps containing this type signaling molecule are often used to deter pests from nesting in trees by confusing them and this acts as a natural pesticide to prevent plants being eaten. Occasionally some of the pests will not be deterred and make it to the plant where it consumes parts of it.

- b. Name and outline a defensive mechanism that the plant might have to protect itself from pest attack.

1 mark

SECTION B – continued
TURN OVER

Question 5 (8 marks)

There are two major types of T-cells within the human body that assist in the defence against disease, those that display CD-4 proteins on their surface and those that display CD-8. CD-8 T cells are well known for regulating foreign material and infected cells within the body and CD-4 T cells are involved in immune responses against self-cells.

- a. What is the name of the fragments that CD-8 proteins are designed to recognize?

1 mark

- b. Draw a labeled diagram of the immunological protein that would be produced as a result of a humoral immune response against self-cells.

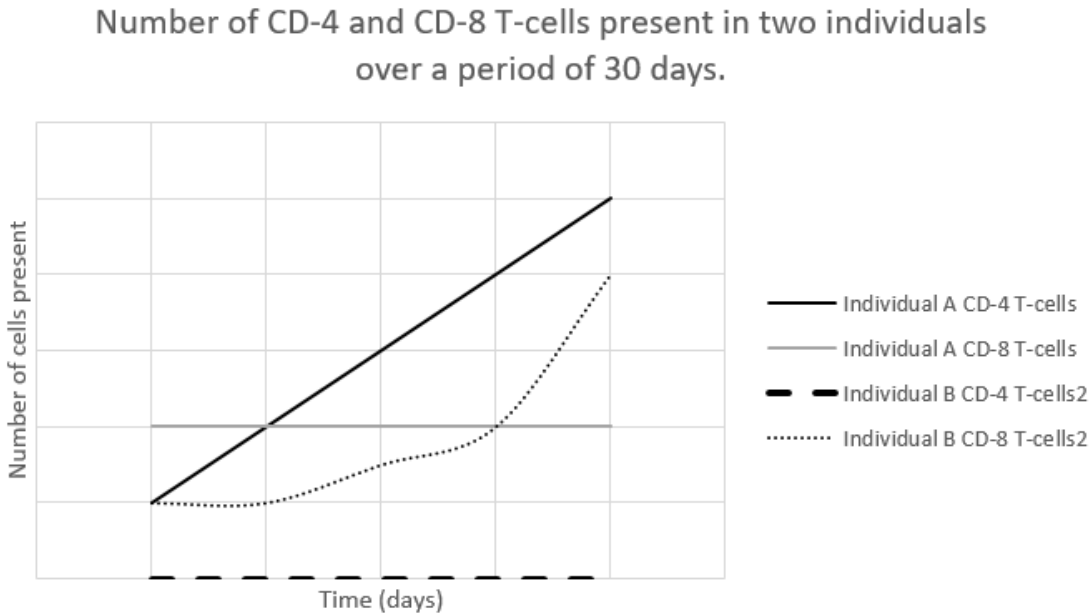
3 marks

- c. Once CD-8 T cells bind with their recognition fragments a series of events occur within the individual. Outline one event this binding process would initiate.

1 mark

SECTION B - continued

In individuals with coeliac disease a cascade of immune responses occurs in response to gluten proteins. Two individuals were examined to determine the production of CD-4 T cells and CD-8 T cells in response to gluten exposure to develop targeted therapy to assist those living with the disease.



- d. Using evidence, determine which individual has coeliac disease and explain what type of disease coeliac disease is.

2 marks

- e. Explain a likely cause of the increase in individual B's CD8 T cell numbers.

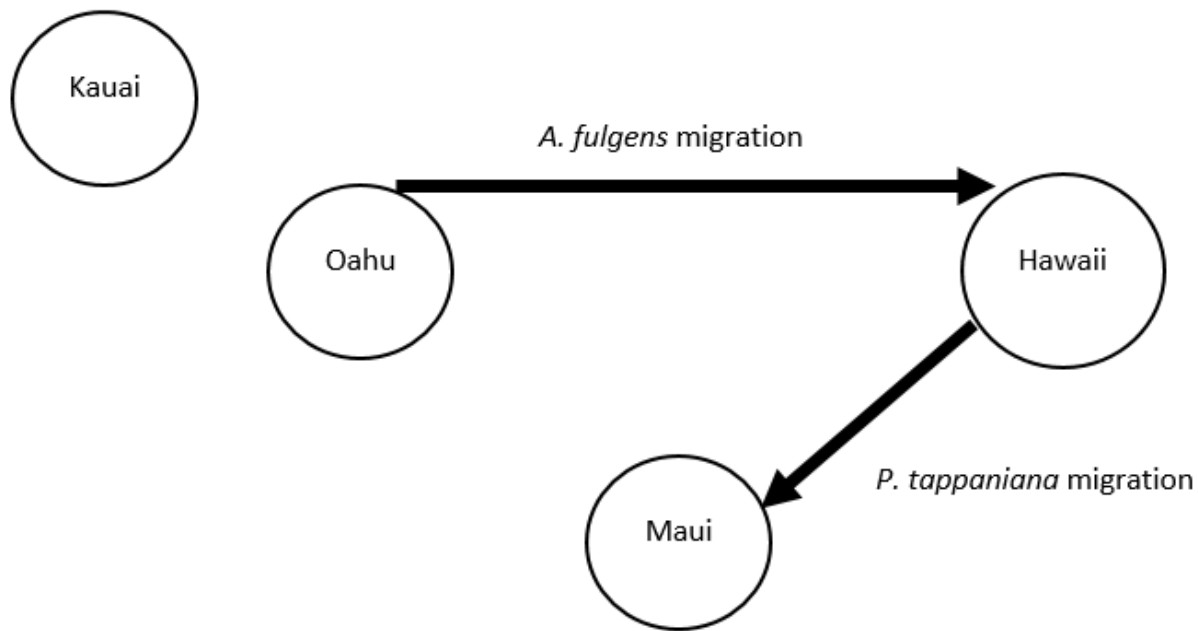
1 mark

SECTION B - continued
TURN OVER

Question 6 (11 marks)

Hawaiian tree snails are molluscs belonging to the family *Achatinellidae* which is endemic to the Hawaiian Islands. They are colourful snails that live in trees and brushy areas on many of the islands. Many species are considered to be threatened or critically endangered. Most species of these snails arose due to geographic isolation through ever changing landscapes and volcanic activity in the area.

The following diagram and table represent the location and distribution of one particular lineage of snails within this family.



Species within the <i>Achatinellidae</i> family	Location found
<i>Newcombia cumingi</i>	Maui
<i>Partulina redfieldi</i>	Maui
<i>Partulina tappaniana</i>	Maui
<i>Partulina physa</i>	Hawaii
<i>Achatinella fulgens</i>	Oahu

(adapted from Cowie and Holland (2008) Review. Molecular biogeography and diversification of the endemic terrestrial fauna of the hawaiian islands, *Philosophical Transactions of The Royal Society B Biological Sciences*. 363(1508):3363-3376 · November)

SECTION B - continued

- a. Draw a phylogenetic tree to represent the evolution of tree snail species

2 marks

- b. Which two species share the most recent common ancestor?

1 mark

- c. Explain the process that has resulted in the two species *Achatinella fulgens* and *Partulina physa*.

3 marks

- d. What is the name of the process that resulted in these two species?

1 mark

SECTION B - continued
TURN OVER

- e. DNA hybridization was used to determine the genetic linkage between these species. Explain how this process would be carried out.

4 marks

Question 7 (4 marks)

Naracoorte is a small town located in South Australia near mountains and caves that form a national park. The caves maintain a constant temperature of approximately 17°C all year. The caves are the location of an array of fossils that have been dated to over 400,000 years old. One cave in particular had a small opening at the top where animals would fall in. This formed a large pile of remains that were covered by slowly falling sediment from the internal structure eroding, creating layers. The sediment eventually filled the entrance and the remains were undisturbed until the late 1800s. Fossils of Australian megafauna and other extinct animals such as the Thylacine have been found along with many other still living mammal, reptile and bird species.

- a. Explain how the conditions of the caves have led to such a large portion of fossils being preserved in such good condition.

1 mark

- b. Use a labeled diagram to show where the oldest and youngest fossils would be found in the cave

1 mark

SECTION B - continued

- c. Explain the rationale behind your diagram drawn in part b.

1 mark

- d. The globalisation of modern humans was accompanied by a significant reduction in mega fauna. Suggest a possible explanation for this.

1 mark

Question 8 (8 marks)

Antibiotic resistance is a growing issue within society due to the reliance of antibiotics to treat common bacterial conditions since the 1930s. There is now a push to find alternative pathways to treat bacterial infections.

A researcher conducting investigations set up a simplified virtual experiment to raise awareness and educate the public about antibiotic resistance.

The first part of the simulation involved the culturing of a single strain of bacteria in three petri dishes to develop lawn growth. The simulation then added antibiotic solution A into dish two and antibiotic solution B into dish three. These drops only cover $\frac{1}{8}^{\text{th}}$ of the lawn growth. The simulation was then run over a period of time, with the antibiotic solution replaced weekly in the exact same location. Bacterial growth and death was then visualized. Dish one had no change to bacterial lawn growth. Dish two had reduced growth around the antibiotic site and this did not change throughout the experiment. Dish three had initial reduced growth around the antibiotic site at the start of the simulation, however, this then looked similar to dish one for the remainder of the experiment.

The simulation then had an extension to show the genetic changes that resulted in the third dish regaining lawn growth and demonstrating antibiotic resistance. The simulation showed the removal of plasmid DNA from the three dishes and a restriction digest using three restriction enzymes that are able to function on the original bacteria's plasmid DNA.

- a. Describe what a restriction enzyme is.

1 mark

SECTION B – continued
TURN OVER

- b.** Following the restriction digest the DNA was prepared for gel electrophoresis to analyse the sample following polymerase chain reaction.

- i. Give a reason why polymerase chain reaction may have been used in this part of the simulation.

1 mark

- ii. Name two reagents that would be used during this part of the preparation.

1 mark

- c.** The gel electrophoresis was conducted and the lanes for dish 1 and 2 showed clear banding patterns consistent with the expected outcomes, and dish 3 showed one less band present and one of the bands was significantly larger than the fragments found in the other samples.

- i. Explain why this may have been the case.

2 marks

- ii. Construct a diagram of what the gel electrophoresis may have looked like following the experiment, by adding the fragments to gel below. Include any necessary labels.

3 marks



SECTION B - continued

Question 9 (10 marks)

From 1970 onwards there have been many well documented fossil discoveries of early hominins within the African region, in particular Ethiopia. These discoveries have changed and shaped many ideas surrounding Hominin evolution and the divergent pathways that have led to the *Homo sapiens* we see today.

Significant bones found in this region have been dated between 3.2 and 3.6 million years old.

- a. Identify a dating technique and briefly explain how it would be used to date the bones found to determine their approximate age.

2 marks

- b. What evidence could be found to determine that the bones belong to a hominin and not a hominid?

1 mark

The following diagrams represent the hip, leg and foot structure of two hominin species that have been found in this Ethiopian region.

Hominin A



Hominin B



SECTION B - continued
TURN OVER

- c. As hominins evolved and environments changed, increased agility and a more streamlined walking gait that supported running and traveling long distances has been observed.

i. Identify which hominin would be best at traveling long distances.

1 mark

ii. Give two pieces of evidence from the diagram that supports a more streamlined walking gait.

2 marks

iii. Explain one possible advantage of this streamlined walking gait.

1 mark

Examination of fossilized teeth of these two hominins found that one of their diets contained mostly soft fruit and leaf material and the other contained a significantly higher proportion of meat products.

- d. Explain how the structure of the cranium would differ between the two hominins to support this different in diet.

2 marks

- e. Other than body structure, what other piece evidence could scientists use to support the idea that a hominin consumes meat as a part of their diet.

1 mark

SECTION B - continued

Question 10 (8 marks)

The enzyme lactase is available for purchase through some laboratory supply stores and is also available to the general public as a medication to promote lactose digestion in humans that are unable to produce the enzyme themselves.

A group of students designed an experiment to determine the effects of the lactase at various temperatures to assess its optimal functioning temperature. It was hypothesized by the group that lactase will have an optimal functioning temperature of 37°C as this is consistent with human body temperature where the enzyme can naturally be found.

One issue with designing experiments to determine the optimal functioning temperature of lactase is that glucose is used in small amounts during the lactose manufacturing process. This glucose can be found in the initial lactase samples.

The following equipment is available to the students: beakers, adjustable heating mats, thermometers, glucose data logger, lactose solution, lactase solution.

a. Design an experiment that can test the students' hypothesis.

4 marks

b. State two variables in the experiment that must be kept constant.

1 mark

c. Explain how one of these variables would impact the final results if it is not controlled.

1 mark

SECTION B - continued
TURN OVER

- d. If the student's hypothesis is correct and the optimal functioning temperature of lactase is 37°C, describe what would happen to the enzyme lactase at temperatures well above this.

2 marks

END OF QUESTION AND ANSWER BOOK