



Quality Assessment Tasks

NAME: \_\_\_\_\_

## VCE® BIOLOGY

### UNITS 3 & 4 Practice Written Examination

Reading time: 15 minutes

Writing time: 2 hours 30 minutes

#### 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	11	11	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 allowed in this examination.

#### Materials supplied

- Question and answer book of 46 pages.
- Answer sheet for multiple-choice questions.

#### Instructions

- Write your **name** in the space provided above on this page.
- Detach the answer sheet for multiple-choice questions during reading time.
- Write your **name** on your answer sheet for multiple-choice questions.
- All written responses must be in English.

#### At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

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

**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** for 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.

**Question 1**

Which of the following best describes endocytosis?

- A. Secretion of enzymes by vesicle formation.
- B. Movement of glucose via a protein channel.
- C. Engulfing of foreign material by pathogens.
- D. Vesicles containing neurotransmitter fuse with membrane.

Questions 2 to 4 refer to the following information.

		Second Position									
		U		C		A		G			
		code	Amino Acid	code	Amino Acid	code	Amino Acid	code	Amino Acid		
First Position	U	UUU	phe	UCU	ser	UAU	tyr	UGU	cys	U	Third Position
		UUC		UCC		UAC		UGC		C	
		UUA	leu	UCA		UAA	STOP	UGA	STOP	A	
		UUG		UCG		UAG	STOP	UGG	trp	G	
	C	CUU	leu	CCU	pro	CAU	his	CGU	arg	U	
		CUC		CCC		CAC		CGC		C	
		CUA		CCA		CAA	CGA	A			
		CUG		CCG		CAG	CGG	G			
	A	AUU	ile	ACU	thr	AAU	asn	AGU	ser	U	
		AUC		ACC		AAC		AGC		C	
		AUA	ACA	AAA		AGA	A				
		AUG	met	ACG		AAG	lys	AGG	arg	G	
	G	GUU	val	GCU	ala	GAU	asp	GGU	gly	U	
		GUC		GCC		GAC		GGC		C	
		GUA		GCA		GAA	GGA	A			
		GUG		GCG		GAG	GGG	G			

Source: <http://butterflyandbiotech.blogspot.com.au/2012/09/dna-translation.html>

Consider the DNA sequence: ATG CGA GGA CCT TGA ATT

**Question 2**

The complementary mRNA sequence is

- A. TAC GCT CCT GGA ACT TAA
- B. UAC GCU CCU GGA ACU UAA
- C. TAC GCU CCU GGA ACU UAA
- D. UAC GCA CCT GGA ACT TAA

**Question 3**

Production of mRNA would begin at the region of the DNA starting at the:

- A. operon.
- B. DNA polymerase binding site.
- C. promoter region.
- D. start codon.

**Question 4**

The number of amino acids that would be translated from the sequence is

- A. 5.
- B. 6.
- C. 15.
- D. 18.

**Question 5**

Which of the following is not an example of post-transcription modification?

- A. Alternative splicing.
- B. Exon rearrangement.
- C. Addition of a methyl guanosine cap.
- D. Alternative protein folding.

**Question 6**

Which statement with regards to enzyme inhibition is correct?

- A. Poisons can be irreversible competitive inhibitors.
- B. Non-competitive inhibition is permanent.
- C. All competitive inhibition is reversible.
- D. Non-competitive inhibitors bind to the active site.

**Question 7**

The lac operon is an example of gene regulation in bacterial cells. The accurate description of an operon is

- A. a repressor protein that binds to the operator.
- B. enzymes such as galactase.
- C. a promoter region.
- D. structural and regulatory genes transcribed together.

**Question 8**

An example of paired molecules in the cycling of coenzymes is

- A. anabolic and catabolic reactions.
- B. NAD and NADP.
- C. ADP and ATP.
- D. DNA and RNA.

**Question 9**

Which is not a part of apoptosis?

- A. Blebbing.
- B. Activation of caspase.
- C. Cell swelling.
- D. Signalling of macrophages.

**Question 10**

Identify the true statement for enzyme activity.

- A. at temperatures above or below optimal, enzymes will denature.
- B. at low pH, all enzymes will denature.
- C. fewer enzyme-substrate complexes will form at low temperatures.
- D. enzymes have optimal temperatures close to 37° C.

*Questions 11 and 12 refer to the following information.*

Casein is a protein in milk that causes milk to have an opaque white appearance. In the presence of trypsin enzyme, casein is broken down into amino acids and the milk becomes transparent.

**Question 11**

An accurate description of this reaction is an

- A. endergonic, catabolic reaction.
- B. endergonic, anabolic reaction.
- C. exergonic, catabolic reaction.
- D. exergonic, anabolic reaction.

**Question 12**

An experiment was designed to investigate the effects of pH on trypsin activity. Which of the following factors would be a valuable method of control in this experiment?

- A. Large number of participants.
- B. Same amount of enzyme in each test.
- C. Same pH for each test.
- D. Increasing temperature as pH increases.

**Question 13**

Enzymes belong to a group of biomacromolecules called

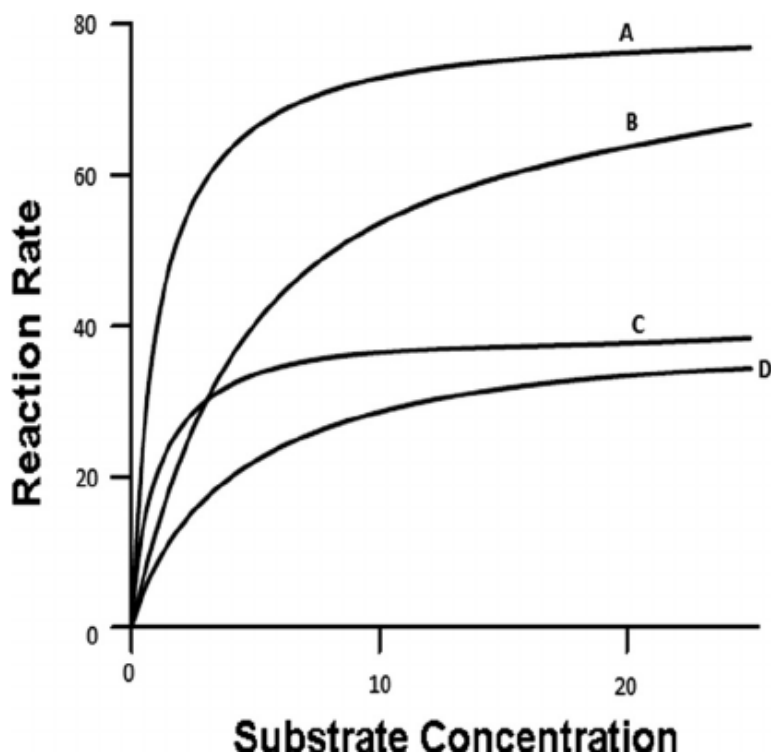
- A. co-factors.
- B. nucleic Acids.
- C. polysaccharides.
- D. proteins.

**Question 14**

The graph below shows a representations of the following reactions involving enzymes.

The graphs represent the following situations. They are not in order.

- With non-competitive inhibition
- Without inhibition
- With competitive inhibition
- With a poison



Source: <https://www.researchgate.net/>

Which of the lines above best represents a graph to show an enzyme reacting in the presence of a competitive inhibitor?

- A. Line A.
- B. Line B.
- C. Line C.
- D. Line D.

**Question 15**

As evidence for the bacterial origins of mitochondria a number of comparisons can be made between them. The feature that is not shared between both bacteria and mitochondria is

- A. DNA.
- B. ribosomes.
- C. cell membranes.
- D. a similar size.

**Question 16**

As a phase of cellular respiration, the electron transport chain could produce

- A. 36 ATP and carbon dioxide.
- B. 36 ATP and water.
- C. 32 ATP and carbon dioxide.
- D. 32 ATP and water.

**Question 17**

Interferon is an example of a

- A. hormone.
- B. neurotransmitter.
- C. cytokine.
- D. pheromone.



**Question 18**

Rabies is a viral disease that kills thousands of people every year, predominantly in Africa and Asian countries. The disease is transmitted through the bites of infected dogs and foxes. One strategy that could be effective in reducing deaths from rabies could be by improving

- A. purification of the water supplies.
- B. hygienic practices.
- C. vaccination programs of dogs.
- D. drugs that increase the number of mast cells in people.

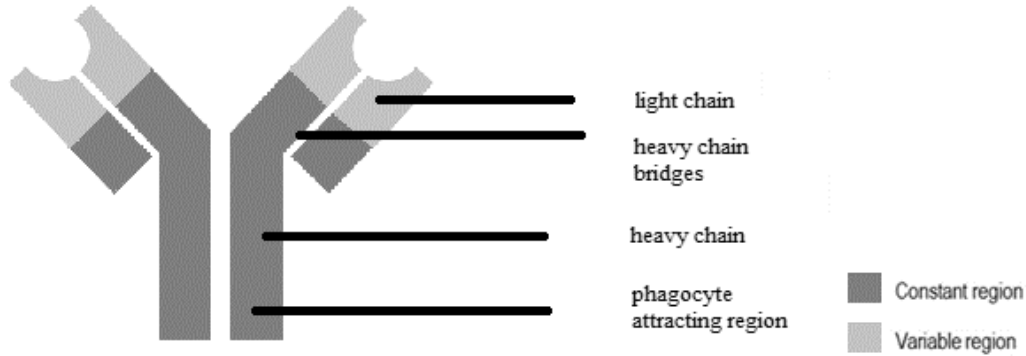
**Question 19**

Complement proteins can play an important role in defending the body against disease by

- A. attracting antibodies.
- B. causing inflammation.
- C. puncturing holes in viral membranes.
- D. attracting macrophages.

**Question 20**

The following diagram is of an antibody.



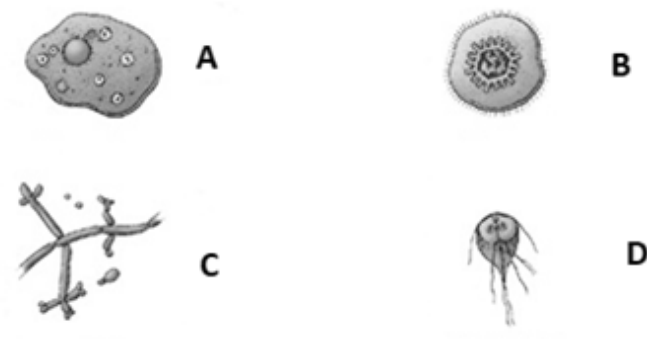
Source: <http://www.innate-pharma.com>

The region that would bind the drug associated with monoclonal antibodies is best represented by the

- A. light chain.
- B. variable region.
- C. phagocyte attracting region.
- D. heavy chain bridges.

**Question 21**

HIV is known for its ability to significantly reduce the functioning of the immune system, resulting in the disease known as AIDS. HIV is best represented by



Source: <https://www.researchgate.net>

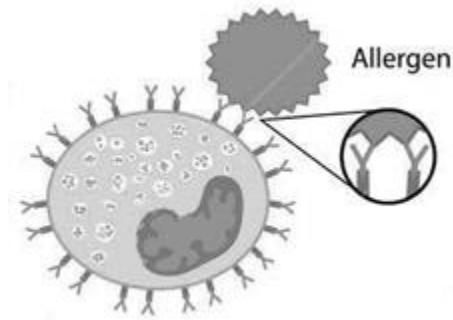
**Question 22**

A person, who has a bacterial infection, could experience inflammation in the tonsils. This is because

- A. the tonsils are the site where T-cells mature.
- B. the tonsils are releasing cytokines.
- C. there are T-cells and B-cells interacting with pathogens.
- D. complement proteins are causing agglutination.

**Question 23**

The response of the cell pictured, would be to;

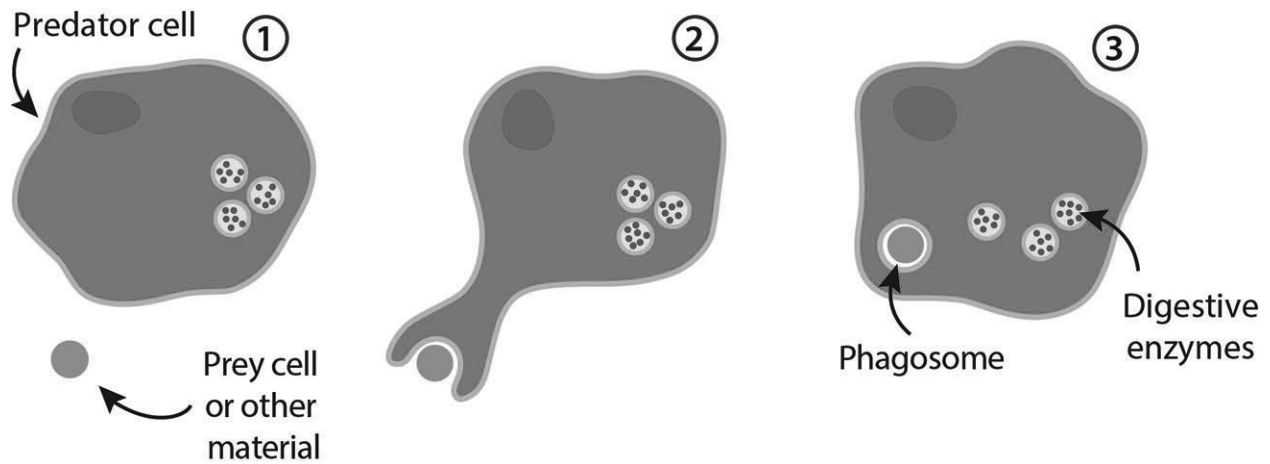


Source: googlestockimages

- A. undergo clonal expansion.
- B. begin rapid antibody production.
- C. release histamine.
- D. destroy opsonised allergens.

Questions 24 and 25 refer to the following diagram.

The following diagram shows an important process in the immune response.



Source: <https://askabiologist.asu.edu>

### Question 24

Another name for a 'predator cell' could be

- A. macrophage.
- B. B Memory Cell.
- C. cytotoxic T Cell.
- D. NK Killer Cell.

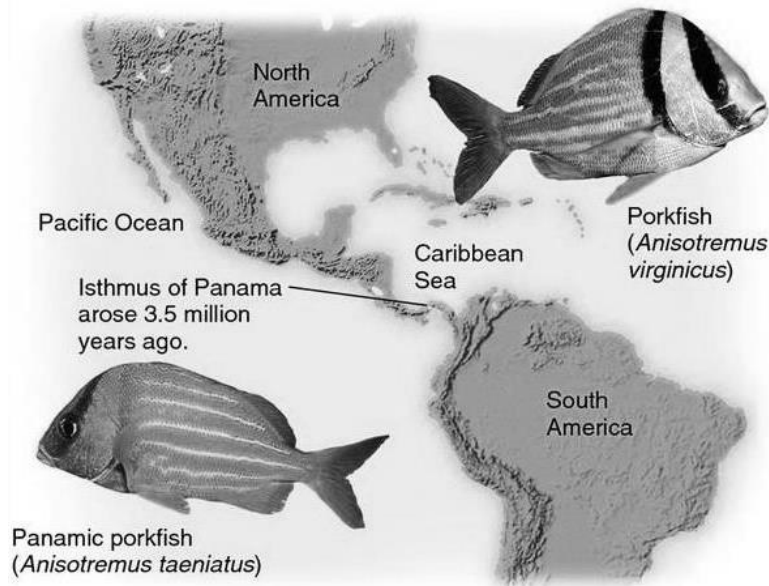
### Question 25

The 'digestive enzymes' would be

- A. released by exocytosis.
- B. released by osmosis.
- C. released by endocytosis.
- D. able to catalyse a catabolic reaction.

Questions 26 and 27 refer to the following information.

Two types of porkfish can now be considered to be separate species, and are separated by a land bridge that joins North and South America. Both species are descended from a recent common ancestor.



### Question 26

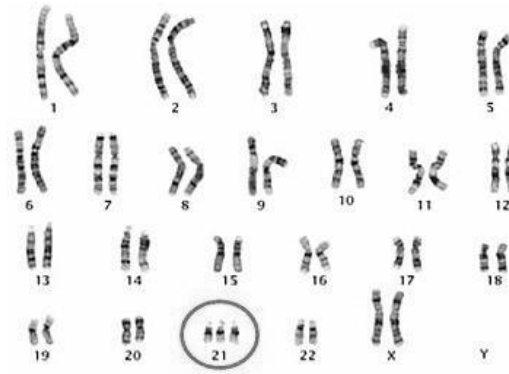
A contributing factor to the speciation of the porkfish might include

- A. being subjected to the same climate.
- B. increased gene flow between the two populations caused by the land bridge.
- C. different food availability for each species.
- D. their ability to produce fertile offspring.

### Question 27

Conditions that favour fossilisation of species such as the common ancestor of the porkfish include

- A. a quick death of the organism.
- B. an environment with many bacteria.
- C. having large bones.
- D. exposure to water.

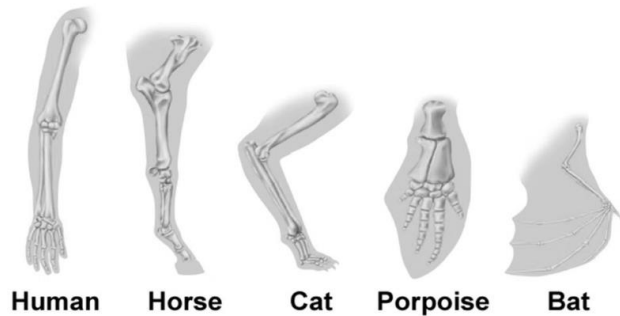
**Question 28**

The human karyotype above shows an example of

- A. aneuploidy.
- B. polyploidy.
- C. frameshift mutations.
- D. block mutations.

**Question 29**

The image below shows the forelimbs of some vertebrates.



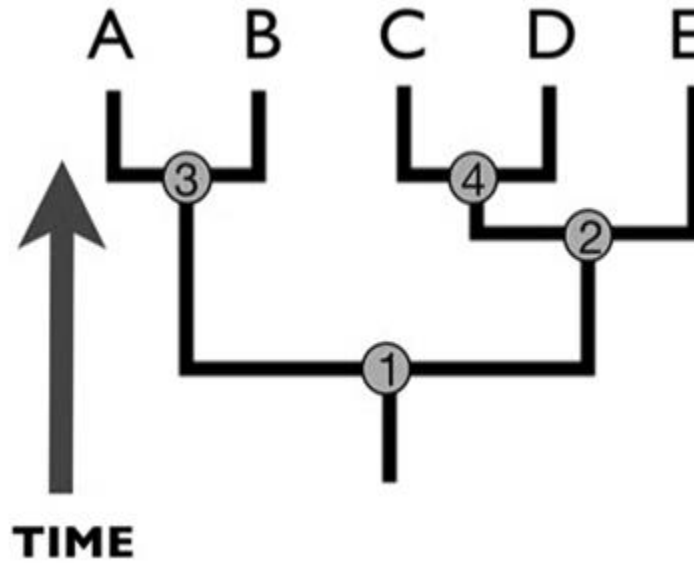
Source: <http://slideplayer.com/slide/4656744/>

This is an example of

- A. analogous structures.
- B. homologous structures.
- C. vestigial structures.
- D. transitional fossils.

**Question 30**

The most recent common ancestors for A and C, and C and E are found at which numbered positions, respectively.



Source: <http://brcr.bio.umass.edu>





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

**Question 31**

Which term best describes humans and their direct extinct ancestors?

- A. Humanoid.
- B. Hominin.
- C. Primate.
- D. Hominoid.

Questions 32 and 33 both relate to the following table of information.

Cactus finch	Large cactus finch	Medium ground finch	Large Ground Finch
			
Low BMP4	Moderate BMP4	Moderate BMP4	High BMP4
Very High Calmodulin	High Calmodulin	Low Calmodulin	Low Calmodulin

### Question 32

Predict the BMP4 and Calmodulin expression amounts for the following sharp-beaked ground finch that has not yet been tested. High Calmodulin levels cause the beak to be pointier.



- A. Moderate BMP and high calmodulin.
- B. High BMP and low calmodulin.
- C. Very high BMP and high calmodulin.
- D. Low BMP and low calmodulin.

### Question 33

A factor that could increase the genetic variation contained within each species of finch could include:

- A. bottlenecks.
- B. natural selection.
- C. gene Flow.
- D. genetic drift.



**Question 34**

The best evidence that exists to prove the mating of *Homo sapiens* and *Homo neanderthalensis* is that they both share similar

- A. geographic locations.
- B. DNA.
- C. cultural evolution.
- D. mating customs.

**Question 35**

What process allows the comparison of DNA of different species to be made?

- A. Comparative anatomy.
- B. DNA-DNA hybridisation.
- C. Polymerase Chain Reaction.
- D. Molecular Clock.

**Question 36**

Genetic studies surrounding the evolutionary relationships of the Flamingo have shown that its closest relative is not another long legged wading bird, such as the African Spoonbill, but the 'Crested Grebe' (shown below).



Flamingo



African Spoonbill



Crested Grebe

**Source:** <http://www.foxnews.com>, <https://www.hbw.com>, <https://en.wikipedia.org>

What results from the comparison of their DNA would support the statement above?

- A. Flamingo DNA and Crested Grebe DNA have the same temperature of separation.
- B. Hybrid Flamingo and Crested Grebe DNA have a higher temperature of separation than hybrid DNA of the Crested Grebe and African Spoonbill.
- C. Hybrid Flamingo and African Spoonbill DNA have a higher separation temperature than Hybrid flamingo and Crested Grebe DNA.
- D. There are more similarities between the DNA of the African Spoonbill and Flamingo, than the Crested Grebe and Flamingo.

**Question 37**

Recombinant plasmids can be directly used

- A. to transform bacterial cells.
- B. as vectors to transform eukaryotic cells.
- C. decrease the variation of bacterial populations.
- D. to produce genetically modified crops.

**Question 38**

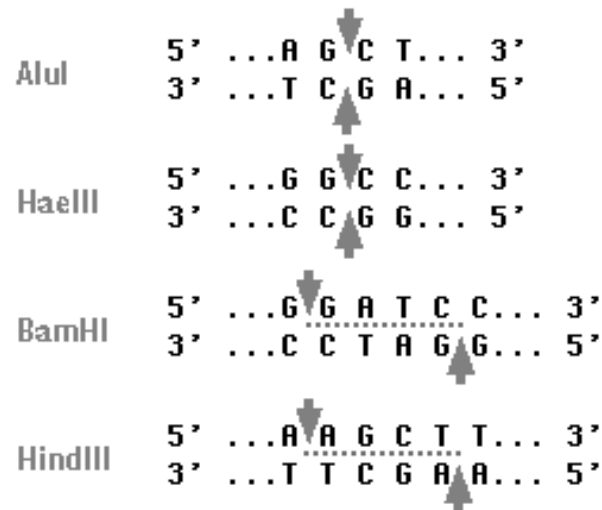
A consideration when designing an experiment, the most important factor is to

- A. ensure that all variables are controlled.
- B. check the health of all participants
- C. conduct it in sterile conditions
- D. ensure that only the independent variable is tested

**Question 39**

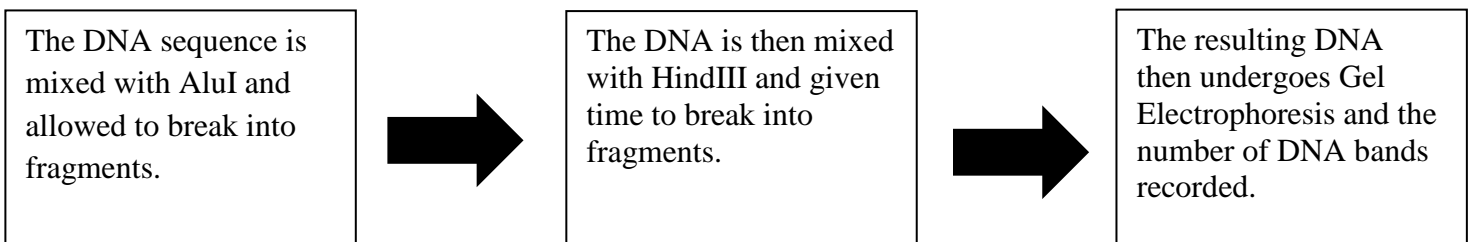
Consider the DNA sequence and list of restriction enzymes:

5' ATCGATCGGATAGGCCGTTAGCGATGAAGCTTCGATCTCGATAGCG 3'  
 3' TAGCTAGCCTATCCGGCAATCGCTACTTCGAAGCTAGAGCTATCGC 5'



Source: <http://www.biology-pages.info/R/RestrictionEnzymes.html>

Consider the following flow diagram.



How many bands of DNA will be observed?

- A. 2.
- B. 3.
- C. 4.
- D. 5.

**Question 40**

When trying to identify bodies after mass disasters such as a burning building, the best technique to help with the identification of the unknown persons would be

- A. DNA hybridisation.
- B. DNA profiling.
- C. genetic screening.
- D. gene cloning.

**SECTION B – Short Answer Questions****Instructions for Section B**

Answer this section in **pen**.

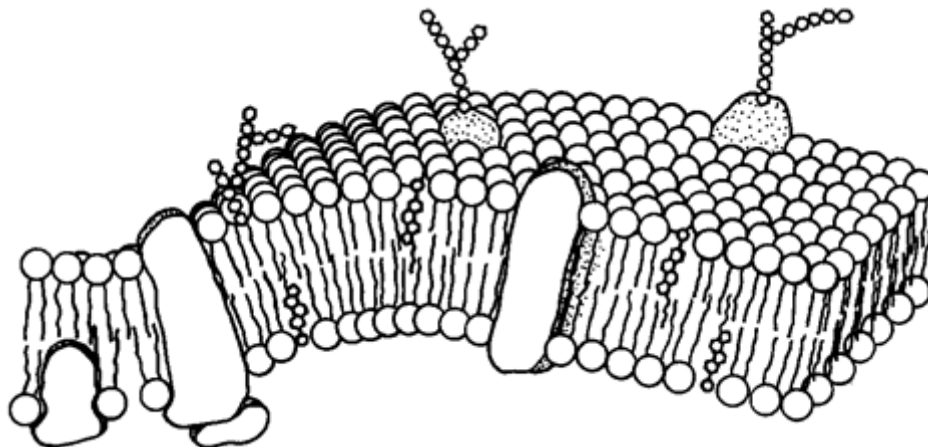
Answer **all** questions in the spaces provided.

**Question 1** (11 marks)

Rheumatoid arthritis is an autoimmune disease that affects a large number of people. Research is being conducted into a treatment for this disease using components of scorpion venom. Cells called fibroblast-like synoviocytes (FLS) have a role in secreting inflammatory molecules that result in joint damage, leading to inflammation and pain associated with rheumatoid arthritis. There is a membrane channel that allows the movement of potassium ions in and out of the cell. The venom contains hundreds of different components and there is a particular protein, iberiotoxin, that is used to block the potassium channel of the FLS without inhibiting other essential channels. In rats affected with rheumatoid arthritis, treatment with iberiotoxin has shown a reduction in the severity of symptoms and increase in mobility with no side effects.

- a. On the diagram below, circle and label the following structures:  
Cholesterol, protein channel, phospholipid, glycoprotein

2 marks



**b.** The potassium channel allows the movement of ions, such as potassium, that can cross the membrane in both active and passive processes.

- i. Name and describe the process of passive movement of potassium ions in and out of FLS. 2 marks

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

Description: \_\_\_\_\_

\_\_\_\_\_

- ii. State a property of potassium ions that would result in their movement as described in part i. 1 mark

\_\_\_\_\_

**c.** Fibroblast-like synoviocytes secrete proteins such as iberiotoxin. Name two organelles and describe their role in the production and secretion of iberiotoxin. 2 marks

Organelle: \_\_\_\_\_

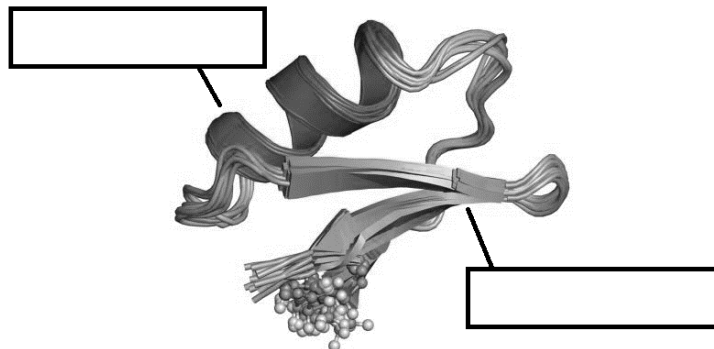
Role: \_\_\_\_\_

Organelle: \_\_\_\_\_

Role: \_\_\_\_\_

The structure of a scorpion venom toxin molecule is shown below. The arrows are pointing to two different secondary structures.

**d.** Name these secondary structures in the boxes provided. 2 marks



**Source:** <https://en.wikipedia.org/wiki/Charybdotoxin>

- e. This molecule can be described as having a tertiary structure. Define the tertiary structure of a protein. 1 mark

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- f. Describe how rheumatoid arthritis could be described as an autoimmune disease. 1 mark

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**Question 2** (8 marks)

RNA polymerase is an enzyme essential for protein synthesis and its role in ageing is being investigated. In past studies, the inhibition of RNA polymerase III is linked to a 10% extension in lifespan in flies and worms. As RNA polymerase has the same structure and role in other organisms, its inhibition is thought to increase lifespans in mammals, including humans.

- a.** Describe how enzymes facilitate biological reactions. 2 marks

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- b.** In the boxes below, draw and label diagrams to show the following reactions of RNA polymerase: 2 marks

Enzyme-substrate complex:

Non-competitive inhibition of RNA polymerase:

c. Does RNA polymerase catalyse an anabolic or catabolic reaction in protein synthesis?

Circle:                      Anabolic                      Catabolic

Explain the reason for your choice. 1 mark

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d. Describe a condensation reaction that is facilitated by RNA polymerase. Include the role of RNA polymerase in your response. 3 marks

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**Question 3** (6 marks)

In the last couple of years scientists have been re-examining the non-coding regions of RNA that are produced within cells. It appears that many of these regions, particularly the longer RNA segments do have a role. Alistair Forrest from the University of Western Australia said “By integrating the improved gene models with data from gene expression, evolutionary conservation and genetic studies, we find compelling evidence that the majority of these long non-coding RNAs appear to be functional.”

- a. What is the name given to the non-coding regions of RNA? 1 mark

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- b. Describe the way in which these regions are separated from the primary mRNA transcript. 1 mark

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One of the roles of the non-coding regions appears to be regulating the mRNA that is produced before it undergoes translation. One way this is achieved, appears to be that the short non-coding segment is complementary to a region of the larger RNA transcript. When the non-coding segment binds, a double stranded section is created on the messenger RNA and translation does not take place.

- c. Describe the nucleotide pairing that would occur between individual nucleotides to create double stranded RNA? 2 marks

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- d. Aside from messenger RNA, name a different type of RNA and describe its role in a cell. 2 marks

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**Question 4** (7 marks)

Chlorella (*Chlorella vulgaris*) are a single celled algae that are able to photosynthesise. They can be grown in a basic glass fish tank with water. In order to survive the water needs to be constantly aerated and they need to be stirred daily to move them around.

- a. Explain why aerating the water is needed for the survival of the chlorella? 1 mark

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The chlorella can then be suspended in an alginate gel, and made into small gelatinous balls. The alginate balls allow gases to enter and exit and have no negative effect on the chlorella. The alginate balls allow for the chlorella to be moved more easily for experimentation.

6 test tubes are then made, each filled with pH indicator solution and a carbon source. 20 chlorella and alginate balls are added to each test tube. Each test tube is placed at a distance from a UV light source as indicated in the table below.

Test Tube #	Distance from light source (cm)	Predicted Results
1	0	
2	25	
3	50	
4	75	
5	100	
6	Kept in a dark cupboard	

The colour of each test tube will change due to changes in CO<sub>2</sub> levels in the indicator solution. As carbon dioxide is removed from the solution it becomes more alkaline (purple colour). As the solution gains more carbon dioxide it becomes more acidic (yellow colour).

- b. What is the likely hypothesis for this experiment? 1 mark

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- c. Why was test tube #6 included in this experiment? 1 mark

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The starting pH of the solution is neutral. The test tubes were allowed to incubate for 40 minutes at their respective distances from the light source.

- d. i. Complete the predicted results in Table 1 for test tubes #1 and #6 describing the predicted final pH of the solution as acidic, neutral or alkaline. (test tube 2-4 result predictions are not required) 1 mark
- ii. Explain the reasoning for your choices of results for both test tubes. 2 marks

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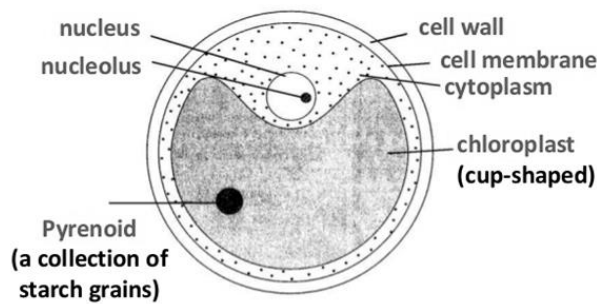


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The following diagram shows the structure of a chlorella.



Source: <https://www.slideshare.net>

- e. Draw an arrow on the diagram to indicate where the glucose that make up a pyrenoid would be broken down for cellular respiration. 1 mark

**Question 5** (9 marks)

When a tattoo is performed, pigments that make up the ink are injected into the skin. New research has investigated the role of macrophages in tattoos. When the wound is created as a result of the skin being punctured, macrophages are present at the site of the wound. The research has found that the macrophages move to the site where they capture the pigment and remain there until they die. They become trapped, due to the size of the pigment, and the pigment is then released. This creates a cycle, that is continually repeated when another macrophage then arrives to take up the pigment and subsequently dies. Prior to this research, it was thought that dermal cells in the skin had permanently trapped the pigment.



- a.** Explain the steps of the inflammation process and its importance for tattooing.

2 marks

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- b.** By what process would the macrophage 'capture' the pigment in the ink?

1 mark

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- c.** Explain the process for how the pigment would be identified as foreign by the macrophages. 2 marks

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- d.** Why is there no adaptive response to the ink pigments by the body? 2 marks

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These researchers continued their experiments on mice where an area of tattooed skin was cut out, and grafted onto another mouse. The recipient mouse was again able to continue to supply the macrophages for the process to continue. The recipient mouse was given immunosuppressant drugs in order for the graft to be successful.

- e.** Name a cell involved in transplant rejection, and explain its expected response to the grafted tissue. 2 marks

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**Question 6** (6 marks)

Plant material in salads contains remnants of the signalling molecules that are produced by plants to regulate their growth, development and nutrient levels. Scientists have recently proposed that microbes living in the human gut may respond to the plant hormones. One such interaction is that of abscisic acid (ABA), which has been found to reduce inflammation in animals.

ABA binds to receptors, called peroxisome proliferator-activated receptor (PPAR), such as those found on macrophages, preventing normal ligand specific activation of cells with this receptor.

**a.** What does this suggest about the structure of ABA?

1 mark

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**b.** PPAR are found on the nuclear membrane. What does this suggest about the properties of the regular signalling molecules that bind to PPAR and explain how the binding regulates gene expression?

2 marks

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*Avandia* is the trade name of a drug that has been designed, by rational drug design, to block the PPAR. *Avandia* has been linked to serious adverse effects on the cardiovascular system.

**c.** Define rational drug design.

1 mark

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The PPAR class of receptors are the target of a range of therapeutical drugs, such as those used to treat heart disease and diabetes in humans. Scientists are investigating the use of ABA as a therapeutic avenue of treatment for medical conditions.

**d.**

- i)** What would scientists be hoping to achieve by further investigations of the effects of ABA in human trials?

1 mark

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- ii)** What is the role of abscisic acid in healthy plants?

1 mark

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**Question 7** (7 marks)

A recent 2018 study has found genetic evidence of evolution through studying many generations of milkweed (*Asclepias syriaca*). The ancestors of this species produced a chemical called pyrrolizidine alkaloid that is quite toxic to mammals and was able to deter the herbivores that ate them. The research has since found that the most recent common ancestors of this plant have since evolved to stop producing this chemical. This feature of evolution has occurred independently in a number of species. The structural gene that produces the toxin no longer produces a protein. In addition to this, the study has also discovered that while toxic to mammals, the chemical is in fact attractive to insects such as butterflies and is not a deterrent. The monarch butterfly visits the milkweed to collect the pyrrolizidine alkaloid.



Source: <https://robinseeds.com>

- a. Name and describe how a single nucleotide change in the DNA of the ancestral milkweed could result in a non-functional gene. 2 marks

Name of change: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- b.** Describe one advantage the milkweed receives by no longer producing pyrrolizidine alkaloids. 1 mark

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- c.** Using your knowledge of natural selection, explain how a change in an environmental selection pressure could have occurred to explain why the non-functional gene could be still present in common ancestors today. 3 marks

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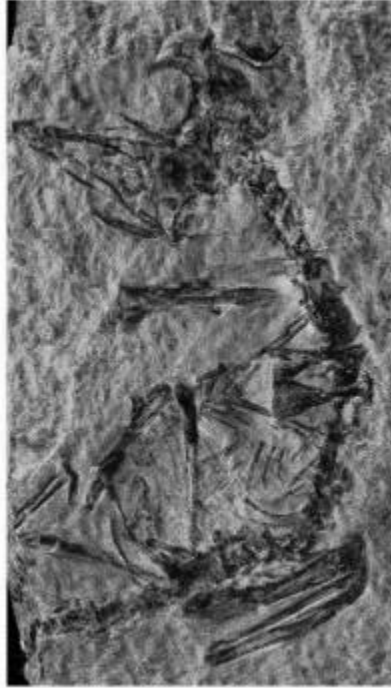
- d.** Name another chemical defence that the plant might have against the butterflies and other insects? 1 mark

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**Question 8** (7 marks)

A fossil of a tiny baby bird is being used to research the evolution of birds. The fossil, shown below, is 127 million years old, being among the smallest fossils found from this era. It is less than 5cm in size and the bird died not long after its birth, based on the stage of bone development.



**Source:** <https://www.sciencedaily.com/releases/2018/03/180305093012.htm>

This specimen is one of the smallest fossils found, dating back to the Mesozoic era. The Mesozoic era can be further divided in the Triassic, Jurassic and Cretaceous periods, spanning from 252- 66 millions of years ago.

**a.** What major group of animals evolved during this era?

1 mark

- b.** What method of absolute dating would have been used to determine the age of this fossil – carbon 14 dating or Potassium-Argon dating? Justify your choice.

1 mark

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- c.** Describe the process that would have resulted in fossilisation of this baby bird.

2 marks

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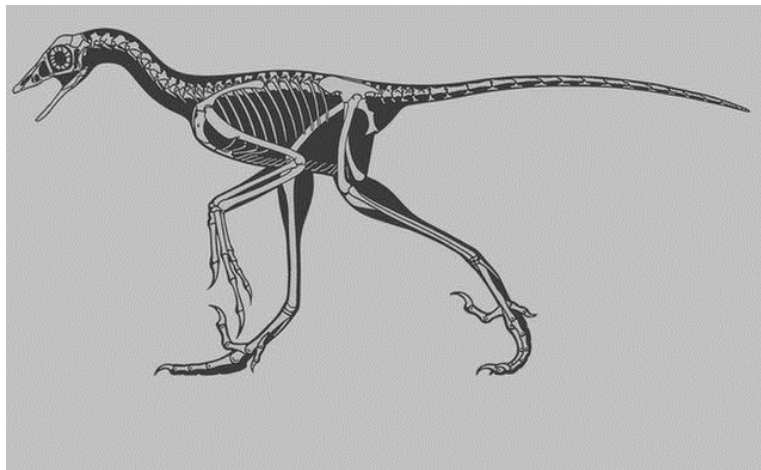


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Archaeopteryx, fossil shown below, is a transitional fossil that occurs in the fossil record in the Jurassic period.



**Source:** <https://www.livescience.com/24745-archaeopteryx.html>

- d.** Explain why Archaeopteryx could be referred to as a transitional fossil.

2 marks

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e. What type of evolution describes the relationship between birds and dinosaurs? Explain.

1 mark

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**Question 9** (5 marks)

Research published has overturned the long-held view that the Przewalski horses (*Equus przewalski*), native to the Eurasian steppes of Northern Europe are the last wild horses on earth. Instead the research shows that these are in fact feral horses, descended from the earliest domestication from the Botai people of northern Kazakhstan 5,500 year ago. This research was able to be completed by comparison with DNA from bones extracted from ancient Botai sites where ancestral horses were slaughtered for their meat and the bones buried. From the DNA analysis, it is revealed that the Botai horses were bred to have 'leopard spots'. Unfortunately, the gene responsible for the leopard spots is also responsible for night blindness in horses and has therefore not continued in the population of horses. The Przewalski horses were likely descended from horses that escaped from the Botai herds.



**Source:** <http://www.independent.co.uk>

The study has found that there were two separate domestication events. (Modern) Domesticated horses (*Equus Ferus caballus*) are thought to have come from a now extinct Tarpan also called European wild horse (*Equus ferus*).

- a.** Explain how mtDNA analysis (molecular clock) is done to build a phylogenetic tree of the horses from the common ancestor? 2 marks

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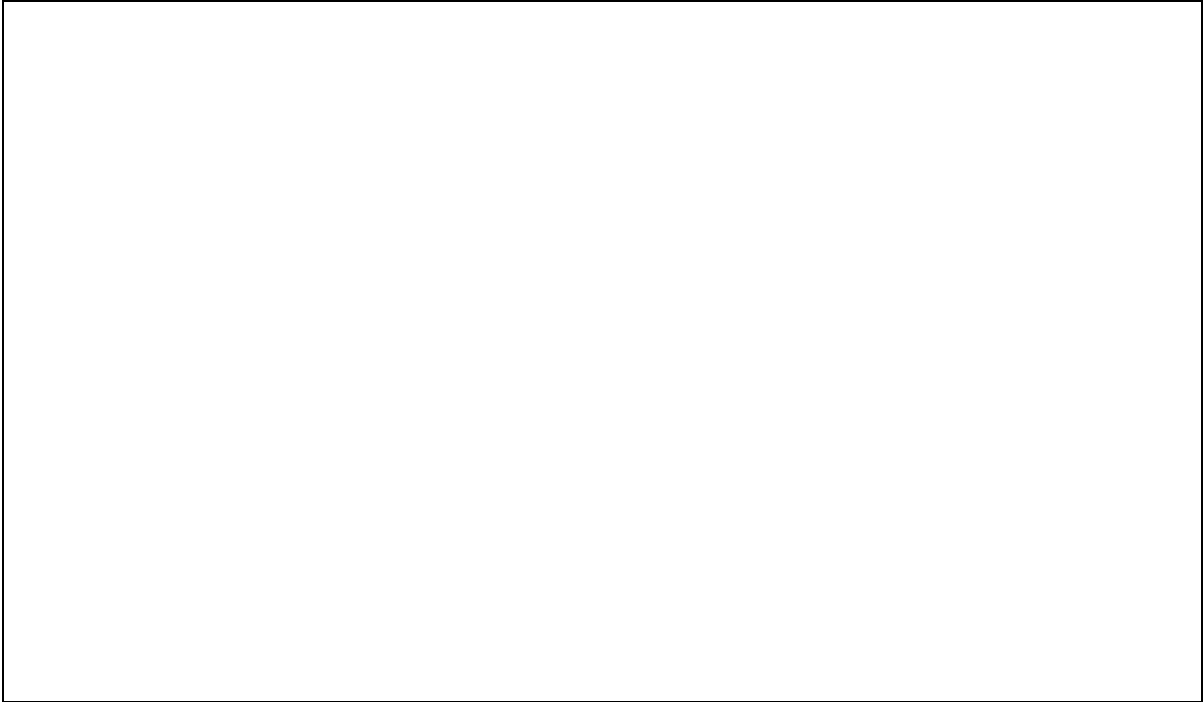
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**b.** In the space provided construct a phylogenetic tree (cladogram) to show the relationship between the following horses: European Wild, Domesticated, Przewalkski and Botai.

2 marks



**c.** Explain how the Botai people could manipulate the gene pool of their horses to produce herds with leopard spots.

1 mark

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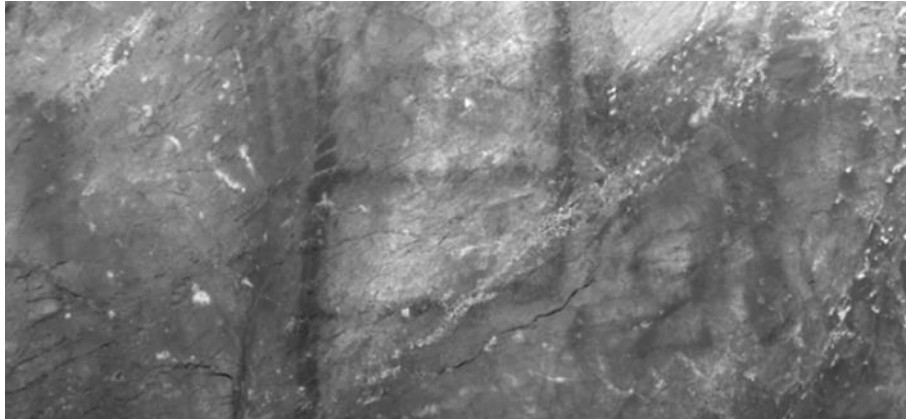
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**Question 10** (7 marks)

Scientists have discovered three caves in Spain that contain paintings dated to be older than 64,000 years. Each of the caves is 700 kilometres away from each other. The caves are quite dark, and the walls inside cannot be seen by normal daylight with the scientists needing head torches in order to see them. The paintings contained images of animals, dots, geometric designs and hand stencils. They were painted in red and black colours, presumably from the resources available to them.



Source: <https://www.sciencedaily.com>

This painting is the oldest known cave painting to be discovered, showing red lines that form squares, an animal and a humanoid figure, and is the oldest by many thousands of years. The pigments were made from ochre and other minerals from the soil. This painting and the others in the caves are significant as they were made by Neanderthals (*Homo neanderthalensis*) and not humans.

- a.** How could scientists have known that it was made by a Neanderthal species and not humans? 1 mark

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- b.** Describe how a cave painting could represent cultural evolution. 1 mark

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An early proposed name for the Neanderthal species was *Homo stupidus*, which was suggested in 1866. Since then our ‘brutish’ perception of the Neanderthals has changed significantly, to much more closely resemble that of *Homo sapiens*.

- c. Give 3 pieces of evidence related to the cave paintings and explain what the evidence shows about the possible behaviours and lifestyle of the Neanderthals. 3 marks

Evidence	Suggestions about the Neanderthals

- d. Define hominoid. 1 mark

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- e. On the Homo evolutionary tree, explain the evolutionary relationship between humans and Neanderthals? 1 mark

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**Question 11** (7 marks)

The table below shows the results from 3 samples in an electrophoresis gel run. A '+' in the results table represents a band present on the gel, at the corresponding position to DNA ladder known fragment sizes.

Bases (kb)	DNA Ladder	Sample 1	Sample 2	Sample 3
15	+	+		
12	+	+	+	
8	+			
5	+			
3	+	+		+

a. On the gel below, draw the results.

You must show and label: wells, direction of movement, DNA ladder fragment sizes and bands for the ladder and all 3 samples. 2 marks



The 3 samples that have been run in the gel described are:

Sample 1: Contains plasmid, gene and DNA ligase

Sample 2: Contains plasmid

Sample 3: Contains an isolated gene

- b.** Sample 1 shows 3 separate bands. Explain how it is possible for this sample to produce these results. 2 marks

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- c.** In order to produce useable and testable questions of DNA, an artificial process of amplifying DNA is performed in a laboratory. Outline this process. 3 marks

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**END OF QUESTION AND ANSWER BOOK**

**MULTIPLE CHOICE ANSWER SHEET**      **Name:**.....

Instructions: Shade the letter corresponding to the correct response for each question

<b>Question 1</b>	A	B	C	D
<b>Question 2</b>	A	B	C	D
<b>Question 3</b>	A	B	C	D
<b>Question 4</b>	A	B	C	D
<b>Question 5</b>	A	B	C	D
<b>Question 6</b>	A	B	C	D
<b>Question 7</b>	A	B	C	D
<b>Question 8</b>	A	B	C	D
<b>Question 9</b>	A	B	C	D
<b>Question 10</b>	A	B	C	D
<b>Question 11</b>	A	B	C	D
<b>Question 12</b>	A	B	C	D
<b>Question 13</b>	A	B	C	D
<b>Question 14</b>	A	B	C	D
<b>Question 15</b>	A	B	C	D
<b>Question 16</b>	A	B	C	D
<b>Question 17</b>	A	B	C	D
<b>Question 18</b>	A	B	C	D
<b>Question 19</b>	A	B	C	D
<b>Question 20</b>	A	B	C	D
<b>Question 21</b>	A	B	C	D

<b>Question 22</b>	A	B	C	D
<b>Question 23</b>	A	B	C	D
<b>Question 24</b>	A	B	C	D
<b>Question 25</b>	A	B	C	D
<b>Question 26</b>	A	B	C	D
<b>Question 27</b>	A	B	C	D
<b>Question 28</b>	A	B	C	D
<b>Question 29</b>	A	B	C	D
<b>Question 30</b>	A	B	C	D
<b>Question 31</b>	A	B	C	D
<b>Question 32</b>	A	B	C	D
<b>Question 33</b>	A	B	C	D
<b>Question 34</b>	A	B	C	D
<b>Question 35</b>	A	B	C	D
<b>Question 36</b>	A	B	C	D
<b>Question 37</b>	A	B	C	D
<b>Question 38</b>	A	B	C	D
<b>Question 39</b>	A	B	C	D
<b>Question 40</b>	A	B	C	D