



Victorian Certificate of Education
Trial Examination

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER Letter

2023 BIOLOGY

Written trial examination – Units 3/4

Reading time: (15 minutes)

Writing time: (2 hours 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	Number of questions	Number of questions to be answered	Number of marks
A	40	40	40
B	8	8	80
			120

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

Materials supplied

- Question and answer book
- Answer sheet for multiple-choice questions
- Additional space is available at the end of the book if you need extra space to complete an answer

Instructions

- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct and sign your name in the space provided to verify this.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- 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 mobile phones and/or any other unauthorised electronic devices into the examination room.

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STUDENT NUMBER

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 Letter

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Datasheet for multiple-choice questions

Question				
1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D
21	A	B	C	D
22	A	B	C	D
23	A	B	C	D
24	A	B	C	D
25	A	B	C	D

**Datasheet for multiple-choice questions**

Question				
26	☐ A	☐ B	☐ C	☐ D
27	☐ A	☐ B	☐ C	☐ D
28	☐ A	☐ B	☐ C	☐ D
29	☐ A	☐ B	☐ C	☐ D
30	☐ A	☐ B	☐ C	☐ D
31	☐ A	☐ B	☐ C	☐ D
32	☐ A	☐ B	☐ C	☐ D
33	☐ A	☐ B	☐ C	☐ D
34	☐ A	☐ B	☐ C	☐ D
35	☐ A	☐ B	☐ C	☐ D
36	☐ A	☐ B	☐ C	☐ D
37	☐ A	☐ B	☐ C	☐ D
38	☐ A	☐ B	☐ C	☐ D
39	☐ A	☐ B	☐ C	☐ D
40	☐ A	☐ B	☐ C	☐ D

Signed: _____

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.

Question 1

The nucleic acids, RNA and DNA, have similarities and differences in their structure and function. Which of the following statements is **incorrect**?

- A. RNA is single stranded and contains the nucleotide uracil instead of thymine, whilst DNA is double stranded and contains the nucleotide thymine instead of uracil.
- B. RNA can be found in the nucleus and cytosol of a cell, whilst DNA can be found only in the nucleus and some specific organelles.
- C. RNA nucleotides contain phosphate groups, deoxyribose sugars and the nitrogenous bases adenine, thymine, guanine and uracil, whilst DNA nucleotides contain phosphate groups, ribose sugars and the nitrogenous bases adenine, cytosine, guanine and thymine.
- D. tRNA can bring amino acids to a ribosome to create a polypeptide chain, whilst DNA can unwind in the nucleus to expose the genetic code required to be transcribed into mRNA.

Question 2

The enzyme involved in transcribing the DNA code into messenger RNA in the nucleus of cells is

- A. RNA polymerase.
- B. taq polymerase.
- C. DNA polymerase.
- D. reverse transcriptase.

Question 3

Transcription of a gene during the process of gene expression involves the creation of a messenger RNA molecule (mRNA). Before mRNA can leave the nucleus, RNA processing must occur. RNA processing involves the removal of

- A. exons, joining of introns, and the addition of a poly-A cap and methyl tail.
- B. introns, joining of exons, and the addition of a poly-A tail and methyl cap.
- C. exons, joining of introns, and the addition of a poly-A tail and methyl cap.
- D. introns, joining of exons, and the addition of a poly-A cap and methyl tail.

Question 4

Which option correctly identifies the sequence of organelles involved in insulin protein production and export out of a cell?

- A. Golgi body, secretory vesicle, rough endoplasmic reticulum, transport vesicle, exocytosis
- B. transport vesicle, rough endoplasmic reticulum, secretory vesicle, Golgi body, exocytosis
- C. rough endoplasmic reticulum, transport vesicle, Golgi body, secretory vesicle, exocytosis
- D. rough endoplasmic reticulum, secretory vesicle, Golgi body, transport vesicle, endocytosis

Question 5

The switching on and off of a gene is essential to the regulation of gene expression in living organisms. Which of the following genes is responsible for producing a factor that can stop the transcription of a gene?

- A. promoter gene
- B. structural gene
- C. operator gene
- D. regulatory gene

Question 6

The trp operon in *Escherichia coli* (*E. coli*) bacteria is a simplified model of gene regulation in prokaryotes. *E. coli* can manage the availability of the essential amino acid tryptophan when it is high or low in its environment. Which of the following statements is correct when tryptophan levels are low in the environment of *E. coli*?

- A. RNA polymerase binds to the promoter region of the trp operon to enable transcription of the structural genes involved in tryptophan biosynthesis.
- B. RNA polymerase binds to the operator region of the trp operon to restrict transcription of the structural genes involved in tryptophan biosynthesis.
- C. A repressor protein binds to the operator region of the trp operon to prevent transcription of the structural genes involved in tryptophan biosynthesis.
- D. A repressor protein binds to the promoter region of the trp operon to enable transcription of the structural genes involved in tryptophan biosynthesis.

Question 7

The inherent function of the CRISPR-Cas9 endonuclease in bacteria is to act as an

- A. innate immune response against other competing bacteria.
- B. adaptive immune response against viruses.
- C. innate immune response against invading viruses.
- D. adaptive immune response against other competing bacteria.

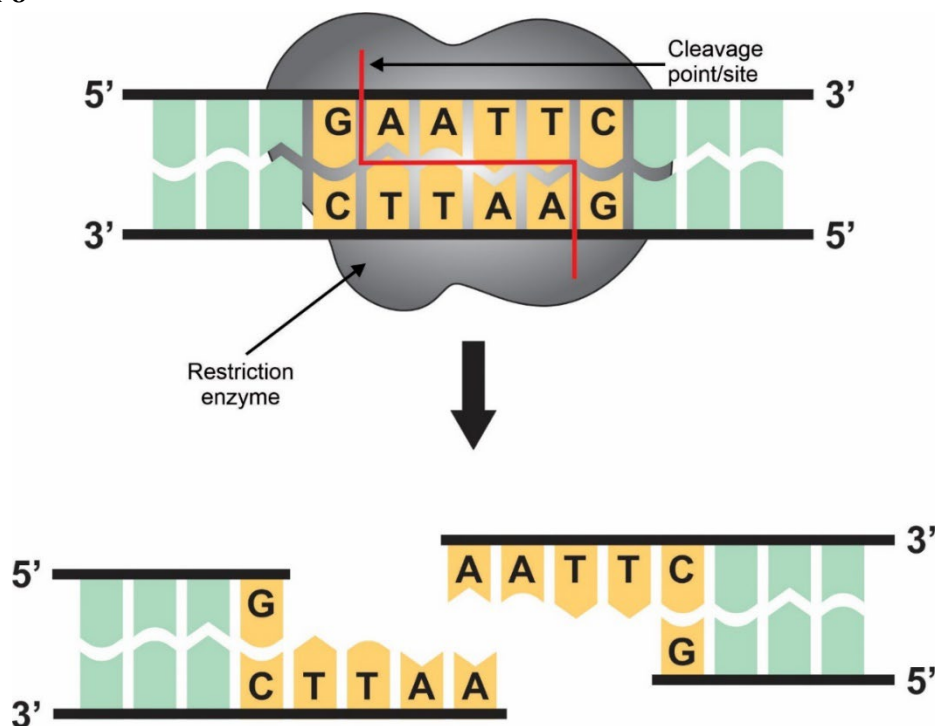
Question 8**Figure 1**

Figure 1 shows a restriction enzyme cutting a

- A. DNA molecule and producing blunt ends.
- B. DNA molecule and producing sticky ends.
- C. RNA molecule and producing blunt ends.
- D. RNA molecule and producing sticky ends.

Question 9

Polymerase chain reaction gene technology will produce how many DNA molecules from three cycles?

- A. 4
- B. 6
- C. 8
- D. 16

Question 10

The function of DNA primers in the polymerase chain reaction is to anneal to the DNA strands and promote the

- A. synthesis of the new strand at 95 °C.
- B. formation of hydrogen bonds at 55 °C.
- C. breaking of hydrogen bonds at 95 °C.
- D. synthesis of the new strand at 55 °C.

Question 11

Many pharmaceutical drugs are designed to act as competitive inhibitors for specific enzymes. The enzyme in plays a role in a particular disease process and scientists have created a drug that can competitively inhibit its activity.

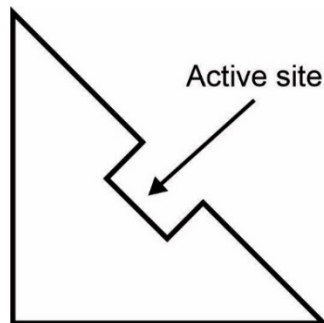
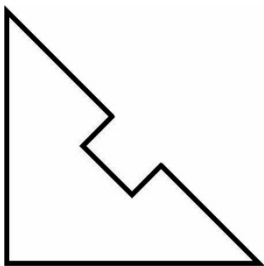


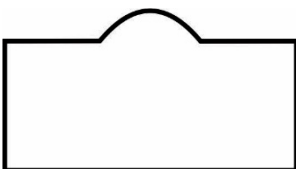
Figure 2

Which of the following drug molecule designs would the scientists need to create to treat this particular disease process?

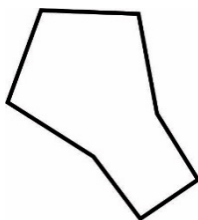
A.



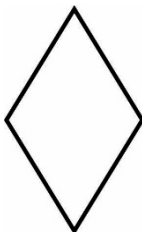
B.



C.

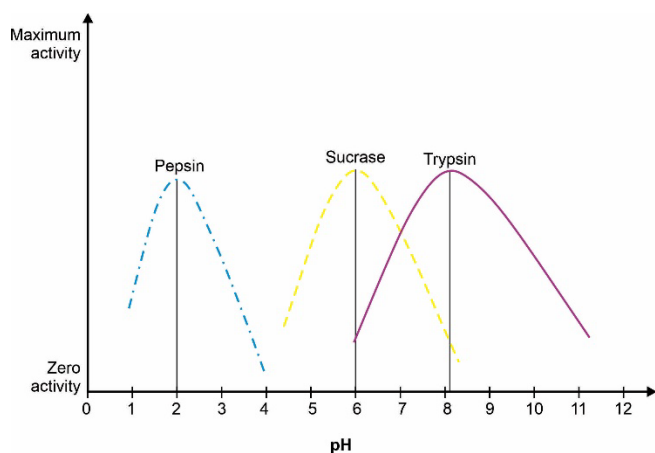
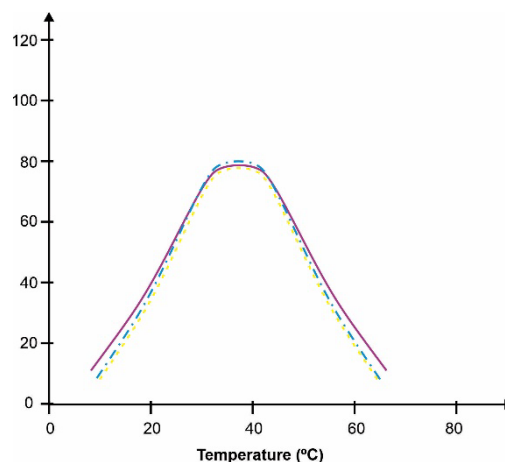


D.



Question 12

Enzymes operate most efficiently at specific pH levels and temperatures. What can be inferred from the graphs below?

**Figure 3****Figure 4**

- A. The optimal pH of pepsin, sucrase and trypsin respectively is 2, 6 and 8. The optimal temperature of pepsin, sucrase and trypsin is 37 °C, with all enzymes denaturing below this temperature.
- B. The optimal pH of trypsin, sucrase and pepsin respectively is 2, 6 and 8 with all enzymes denaturing at a pH of 6. The optimal temperature of trypsin, sucrase and pepsin is 37 °C, with all enzymes denaturing below this temperature.
- C. The optimal pH of pepsin, sucrase and trypsin respectively is 2, 6 and 8. The optimal temperature of pepsin, sucrase and trypsin is 37 °C, with all enzymes denaturing above this temperature.
- D. The optimal pH of pepsin, sucrase and trypsin respectively is 2, 8 and 6. The optimal temperature of pepsin, sucrase and trypsin is 37 °C, with all enzymes denaturing above this temperature.

Question 13

Which of the following factors does not affect the rate of cellular respiration in human cells?

- A. light
- B. oxygen concentration
- C. temperature
- D. glucose availability

Question 14

The biochemical reaction of aerobic cellular respiration includes glycolysis, the Krebs cycle and the electron transport chain. Which of the following statements is correct in relation to aerobic cellular respiration?

- A. Glycolysis involves the splitting of a glucose molecule into two pyruvate molecules with the production of ADP and inorganic phosphate.
- B. The Krebs cycle involves the production of six carbon dioxide molecules per molecule of glucose.
- C. The electron transport chain involves the production of carbon dioxide and water.
- D. Aerobic cellular respiration produces a net total of 2 ATP molecules per glucose molecule.

Question 15

Bioethanol is a biofuel produced through the

- A. fermentation of biomass, resulting in lower carbon emissions compared to fossil fuels.
- B. aerobic cellular respiration of biomass, resulting in a non-renewable energy.
- C. fermentation of biomass, resulting in a non-renewable energy.
- D. aerobic cellular respiration of biomass, resulting in lower carbon emissions compared to fossil fuels.

Question 16

Many respiratory viruses are air-borne pathogens that have the ability to bind to receptors on human cells in the respiratory tract. There, they enter the cells and cause disease. Which of the following is not an effective control for minimising the spread of a respiratory virus?

- A. frequent handwashing using soap and water for 20 seconds
- B. quarantining symptomatic individuals during their infectious period
- C. prescribing antibiotics to treat virally infected patients
- D. wearing a well-fitted, high-quality mask during social interactions

Question 17

Physical and chemical barriers against infection form an essential part of the immune system's ability to prevent disease in humans. Which of the following is **not** an example of a physical barrier to infection?

- A. interferon
- B. intact skin
- C. mucous membranes
- D. ciliated cells which line the respiratory and nasal tract

Question 18

Which of the following immune system components plays a role in activating the adaptive immune response?

- A. mucous membranes
- B. interferon
- C. inflammation
- D. dendritic cells

Question 19

Which of the following sequences of events best describes the process that occurs when an antigen presenting cell comes into contact with a pathogen?

- A. engulfment of pathogen → phagolysosome production → enzymatic breakdown of pathogen → surface antigen presentation → exocytosis
- B. engulfment of antigen presenting cell → phagolysosome production → enzymatic breakdown of pathogen → surface antigen presentation → endocytosis
- C. engulfment of pathogen → phagolysosome production → enzymatic breakdown of pathogen → endocytosis → surface antigen presentation
- D. surface antigen presentation → pathogen engulfment → phagolysosome production → enzymatic breakdown of pathogen → exocytosis

Question 20

The primary lymphatic organs of the body include

- A. white blood cells.
- B. antigen presenting cells such as B cells and natural killer cells.
- C. the thymus where T cells mature, and bone marrow where B cells mature.
- D. lymph nodes, lymph vessels and lymph.

Question 21

Plants do not have a circulatory system like humans do, however, they do have physical and chemical mechanisms to defend themselves against pathogen infection. The defence mechanisms against infection in plants includes

- A. the presence of waxy cuticles on leaves which act as a chemical barrier.
- B. the release of chemical compounds into the air that acts on surrounding plants of the same species to make them physically protected.
- C. structures such as thorns and prickles which act as a physical barrier.
- D. the release of complement proteins which act as a chemical barrier.

Question 22

Allergens cause a/an

- A. hypersensitive response involving IgE antibodies, mast cells and histamine.
- B. innate response involving IgE antibodies, mast cells and histamine.
- C. passive immune response involving IgA antibodies and mast cells.
- D. active immune response involving IgA antibodies and mast cells.

Question 23

Which of these pathogen examples can be described as cellular?

- A. prion
- B. bacteriophage
- C. virus
- D. bacteria

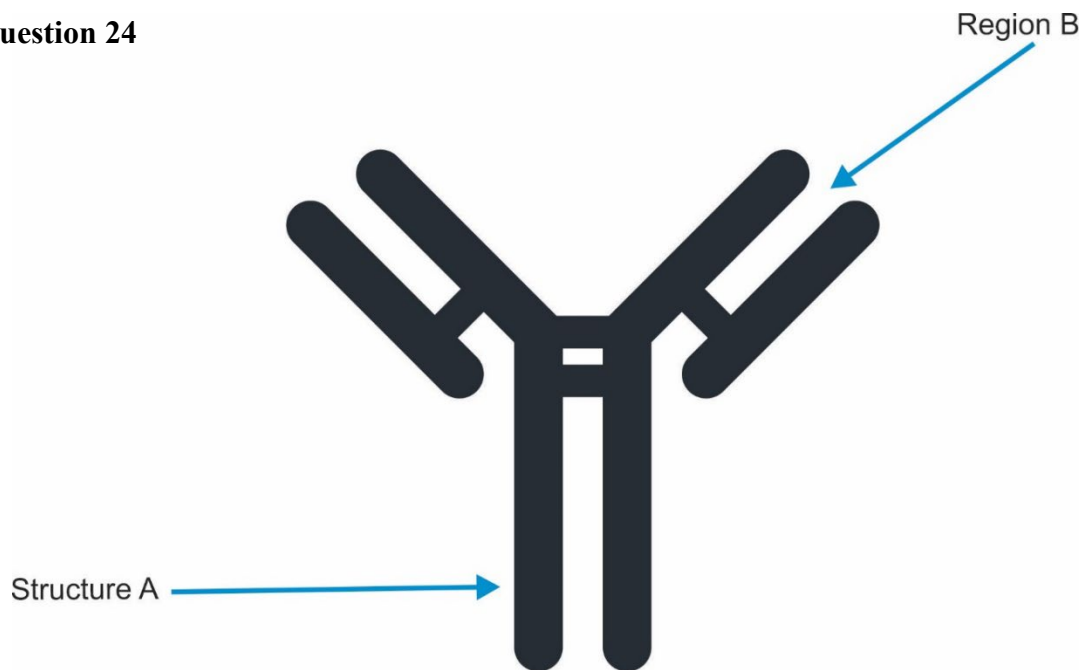
Question 24

Figure 5

Figure 5 depicts an

- A. antigen, with Structure A being the heavy chain and region B showing the antigen binding site.
- B. antibody, with Structure A being the heavy chain and region B showing the antigen binding site.
- C. antibody, with Structure A being the light chain and region B showing the antigen binding site.
- D. allergen, with Structure A being the heavy chain and region B showing the antigen binding site.

Question 25

Indigenous Australians are understood to have reached Australia approximately 10,000 years after migration out of Africa. Researchers have traced the maternal line of the first arrivals and found that Indigenous Australians migrated around 55,000 years ago, rapidly spreading around Australia before finally settling in distinct areas with little migration between populations. Which of the following types of DNA did the researchers use to track the migration patterns of Indigenous Australians?

- A. mitochondrial DNA
- B. nuclear DNA
- C. satellite DNA
- D. non-coding DNA

Question 26

European arrival in Australia resulted in the emergence of new pathogens into the Indigenous Australian population. Smallpox is a highly lethal disease that was introduced into the population in 1789 and led to extremely high death rates in Indigenous Australian communities. Which of the following statements best explains the vulnerability of Indigenous Australians to smallpox compared to the European colonists?

- A. Indigenous Australians had no previous exposure to the smallpox pathogen, so no innate immune response was present, whereas European colonists had previous exposure to the smallpox pathogen and a well-developed innate immune response.
- B. Indigenous Australians had no previous exposure to the smallpox pathogen, so no memory B cells were present, whereas European colonists had previous exposure to the smallpox pathogen and possessed the specific memory B cells.
- C. Indigenous Australians had no previous exposure to the smallpox pathogen and no interferon was produced, whereas European colonists had previous exposure to the smallpox pathogen and interferon was released to provide protection.
- D. Indigenous Australians had no previous exposure to the smallpox pathogen and therefore no natural killer cells, whereas European colonists had previous exposure to the smallpox pathogen and therefore a large store of natural killer cells to fight the specific pathogen.

Question 27

When a high proportion of individuals in a population have immunity against disease through vaccination or previous infection, the indirect protection given to those who lack immunity is referred to as

- A. natural active immunity.
- B. active passive immunity.
- C. natural passive immunity.
- D. herd immunity.

Question 28

Short term immunity induced via antibody injection into a person can best be described as being

- A. natural and active.
- B. active and artificial.
- C. artificial and passive.
- D. natural and passive.

Question 29

An organism that has more than two complete sets of chromosomes in its cells is referred to as

- A. aneuploid.
- B. polyploid.
- C. haploid.
- D. diploid.

Question 30

The reproducibility of an experiment refers to an experiment

- A. that was carried out by the same individual, following the same method, using the same equipment, at the same location and time.
- B. that was carried out by different individuals, following the same method, using different equipment at a different time and yielding comparable results.
- C. that demonstrates a high level of closeness to the true value in the results.
- D. that successfully investigates the aim, controlling all known variables.

Question 31

A gene pool and a proteome can respectively be described as the total

- A. amount of alleles in a population and the total set of proteins in an organism.
- B. set of proteins in a population and the total amount of alleles in an organism.
- C. set of DNA in an organism and the total amount of alleles in an organism.
- D. amount of alleles in a population and the total set of DNA in an organism.

Question 32

The non-functional remnants of a structure, such as human wisdom teeth, and the difference in function between a human forelimb and a whale limb are examples of (respectively)

- A. homologous structures and vestigial structures.
- B. molecular homology and homologous structures.
- C. vestigial structures and homologous structures.
- D. vestigial structures and molecular homology.

Question 33

A phylogenetic tree shows the evolutionary relationship between species. Using the phylogenetic tree outlined in **Figure 6**, which two species share the most recent common ancestor?

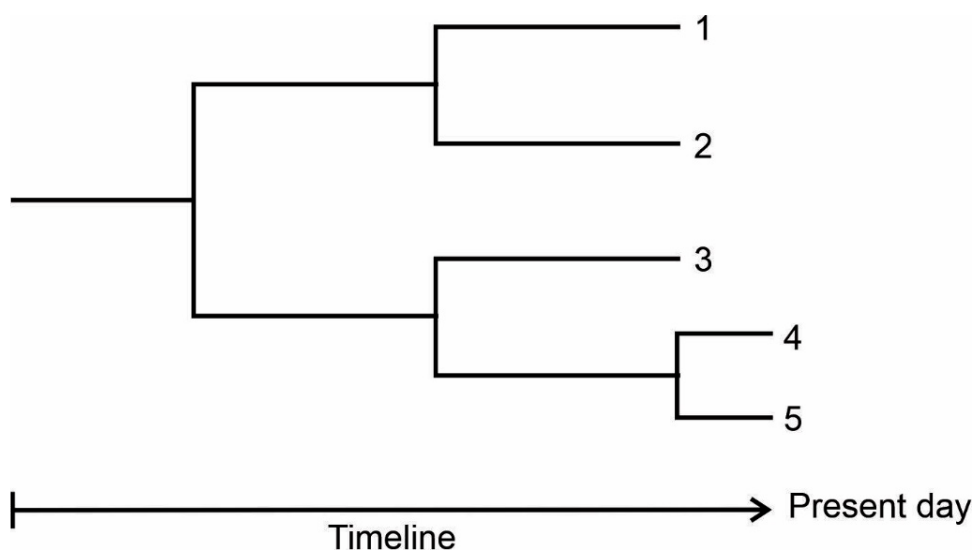


Figure 6

- A. 1 and 3
- B. 3 and 4
- C. 4 and 5
- D. 1 and 2

Question 34

Fossilised faeces is an example of

- A. an index fossil.
- B. a biosignature.
- C. a trace fossil.
- D. a transitional fossil.

Question 35

The Archaeopteryx fossil was found in a limestone quarry in Germany in 1861. It provided direct evidence that birds were descendants of dinosaurs. It had teeth and a long bony tail like other dinosaurs in the Theropod family but also possessed characteristics of modern birds like feathers and a wishbone. Archaeopteryx is best described as being a/an

- A. transitional fossil.
- B. index fossil.
- C. homologous structure.
- D. vestigial structure.

Question 36

Which of the following statements correctly differentiates hominoids from hominins?

- A. Hominoids rely solely on bipedal locomotion, while hominins rely solely on brachiation.
- B. Hominoids include humans, while hominins include only extinct ape species.
- C. Hominoids have a larger brain volume compared to hominins.
- D. Hominins are a subdivision of the hominoid group that includes modern humans and their ancestors.

Question 37

In hominin evolution, which of the following features has increased over time?

- A. decentralisation of the foramen magnum
- B. brain volume and skull rounding
- C. canine and molar size
- D. angle between the big toe and the other toes

Question 38

Figure 7 shows the pelvis, femur and tibia arrangement in a mammal.

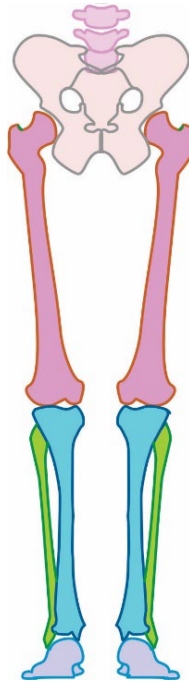


Figure 7

The organism to which this skeleton belongs is most likely a

- A. modern human, as the pelvis is narrow and the angle between the femur and tibia is reduced.
- B. chimpanzee, as the pelvis is narrow and the angle between the femur and tibia is reduced.
- C. modern human, as the pelvis is bowl-shaped and the angle between the tibia and femur is great.
- D. chimpanzee, as the pelvis is bowl-shaped and the angle between the tibia and femur is great.

Question 39

The Lord Howe Island Palms are one of the best-known examples of the process of sympatric speciation. Two different species of these palms have arisen due to divergencies in their soil preferences, which has led to variations in the flowering times of these two species. The isolating mechanism that has led to this type of speciation is

- A. reproductive isolation preventing gene flow.
- B. geographic isolation preventing gene flow.
- C. reproductive isolation allowing gene flow.
- D. geographic isolation allowing gene flow.

Question 40

A group of Biology students cut up liver squares containing catalase and placed them in test tubes containing the same amount of the substrate hydrogen peroxide. The test tubes were placed in water baths at 0, 20, 40 and 60 degrees Celsius, respectively. The students kept the pH the same and recorded the reaction rate. Which of the following statements correctly identifies the aim, independent variable and the dependent variable of the experiment?

- A. to find the optimal pH of catalase; temperature; reaction rate
- B. to find the optimal temperature of catalase; temperature; reaction rate
- C. to find the optimal pH of catalase; reaction rate; temperature
- D. to find the optimal temperature of catalase; reaction rate; temperature

SECTION B**Instructions for Section B**

Answer all questions in the spaces provided.

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

Question 1 (10 marks)

Figure 8 represents one of the processes involved in the production of a protein in eukaryotic cells.

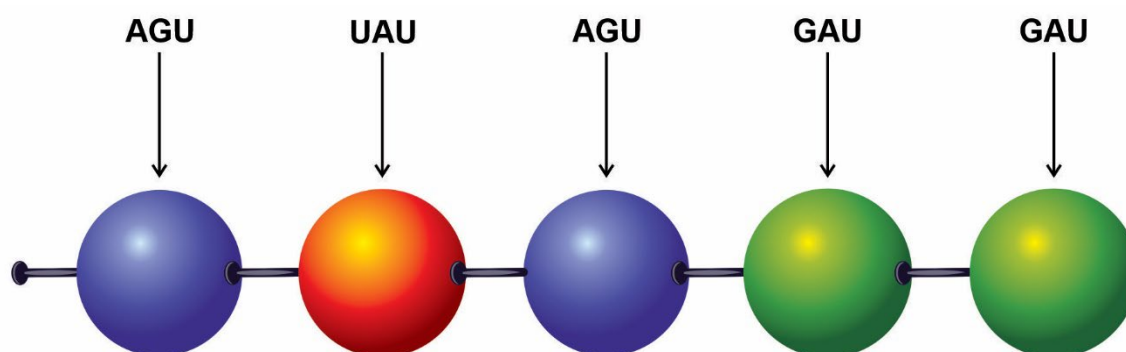


Figure 8

- a. State one difference between the nitrogenous bases in the nucleotides of DNA and RNA sequences.

1 mark

- b. State the name given to a set of three nucleotides in DNA.

1 mark

- c. Use the mRNA codon table provided in **Figure 9** to translate the mRNA sequence given in **Figure 8** above.

1 mark

RNA CODON TABLE											
			Second letter								
			U C A G								
First letter	U	UUU	Phenylalanine	UCU		UAU	Tyrosine	UGU	Cysteine	Third letter	U
		UUC		UCC	Serine	UAC		UGC			C
		UUA	Leucine	UCA		UAA	STOP	UGA	STOP		A
		UUG		UCG		UAG		UGG	Tryptophan		G
C	C	CUU		CCU		CAU	Histidine	CGU		Third letter	U
		CUC	Leucine	CCC	Proline	CAC		CGC	Arginine		C
		CUA		CCA		CAA	Glutamine	CGA			A
		CUG		CCG		CAG		CGG			G
A	A	AUU		ACU		AAU	Asparagine	AGU	Serine	Third letter	U
		AUC	Isoleucine	ACC	Threonine	AAC		AGC			C
		AUA		ACA		AAA	Lysine	AGA	Arginine		A
		AUG	START Methionine	ACG		AAG		AGG			G
G	G	GUU		GCU		GAU	Aspartic acid	GGU		Third letter	U
		GUC	Valine	GCC	Alanine	GAC		GGC	Glycine		C
		GUA		GCA		GAA	Glutamic acid	GGA			A
		GUG		GCG		GAG		GGG			G

Figure 9

- d. On **Figure 8**, identify and label an amino acid.

1 mark

- e. Proteins have various levels of structure:

- i. Label the growing polypeptide chain produced during translation on **Figure 8**.

1 mark

- ii. Name the level of protein structure present upon completion of the growing polypeptide chain.

1 mark

- iii. Justify your answer.

1 mark

- f. Describe the events that occur during the process occurring in **Figure 8**.

3 marks

Question 2 (10 marks)

Figure 10 shows the Calvin cycle occurring in a plant that uses the C₃ pathway of photosynthesis.

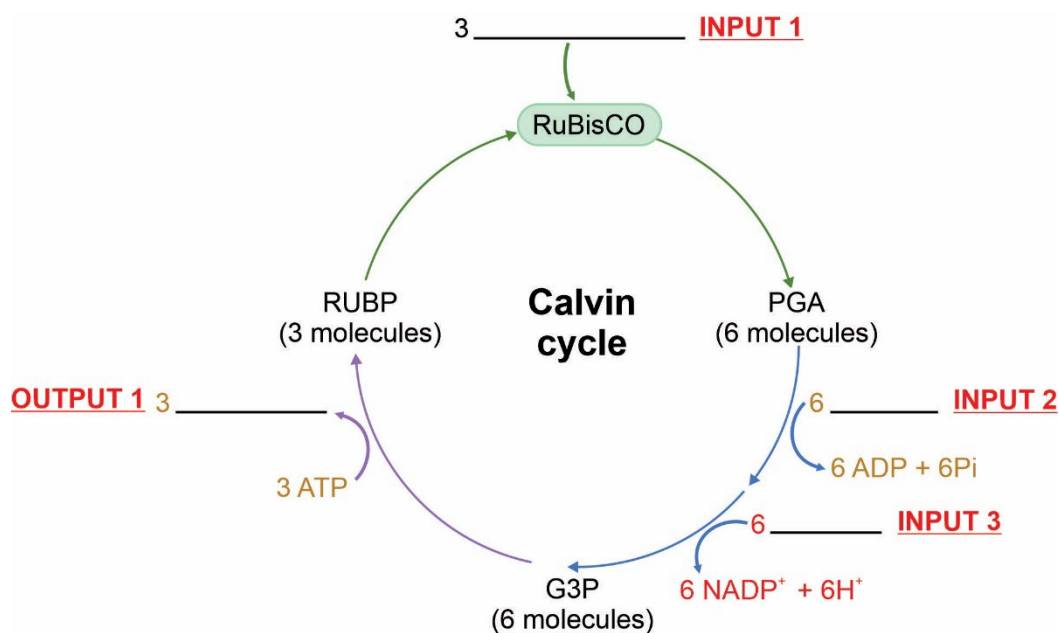


Figure 10

- a. Identify the 3 inputs and 1 output indicated by the arrows in **Figure 10**.

4 marks

Figure 11 shows the photosynthetic pathway of a different plant.

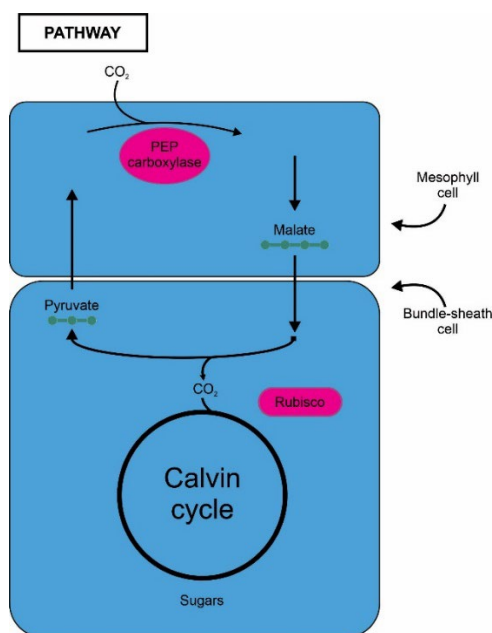


Figure 11

- b.** In **Figure 11**, identify the type of photosynthetic pathway undertaken in this plant. 1 mark

- c.** Describe how the plant in **Figure 11** is able to prevent the wasteful process of photorespiration. 3 marks

- d.** CAM plants are best adapted to very arid, hot environments. Explain why CAM plants do not undergo photorespiration. 2 marks

Question 3 (10 marks)

The Polymerase chain reaction (PCR) is a genetic manipulation tool used for a variety of purposes. One of those purposes is to help diagnose infectious disease such as Influenza A. A nasal swab is taken from the patient containing potential viral particles. Influenza A is an RNA virus, so the next step requires the conversion of this RNA into DNA called copy DNA (cDNA), which is then placed into an automated machine that undertakes the process shown in **Figure 12**.

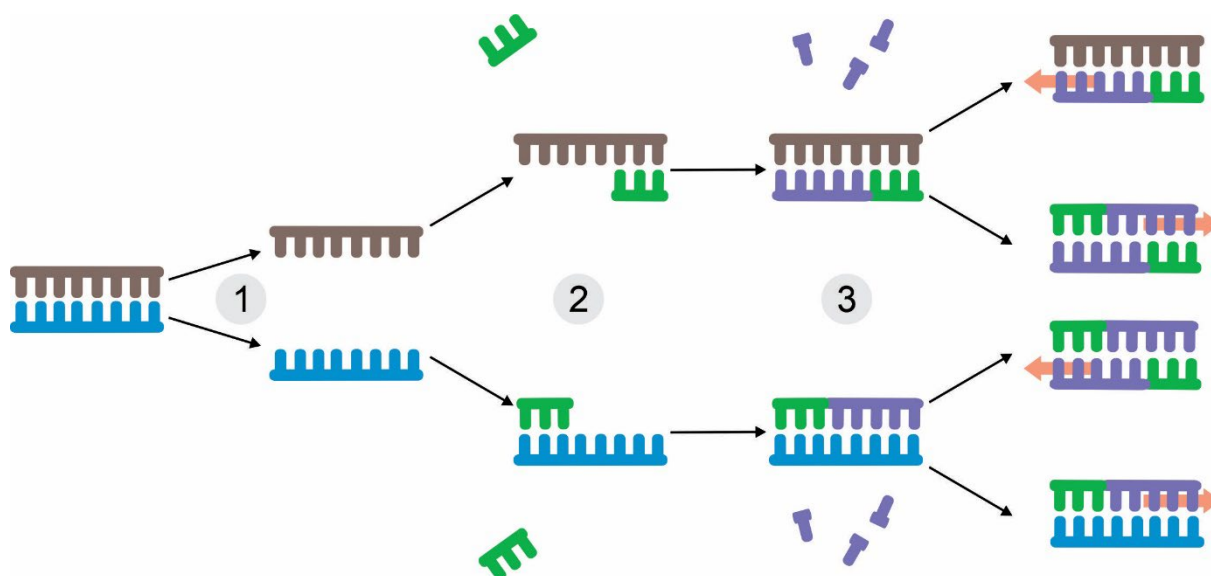


Figure 12: Polymerase chain reaction (PCR)

- a. State the purpose of PCR in the process of diagnosis of Influenza A.

1 mark

- b. Describe the 3 main stages of PCR with reference to the numbers in the diagram in **Figure 12**.

3 marks

1. _____

2. _____

3. _____

Following PCR, the patient's sample must be run in a gel electrophoresis. **Figure 13** shows the gel electrophoresis results of three patients being investigated for influenza infection.

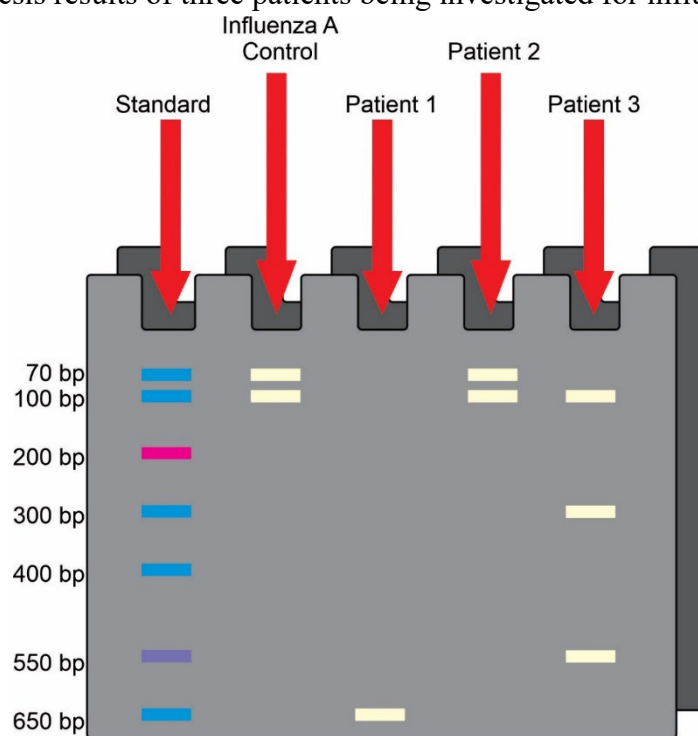


Figure 13

- c. Describe the purpose of the standard used in this gel electrophoresis process.

2 marks

- d. Using the data in **Figure 13**, identify which patient is infected with Influenza A and justify your reasoning. 2 marks

- e. State the total size of the Influenza A DNA fragment used in this gel to identify a positive influenza patient. Justify your response. 2 marks

Question 4 (8 marks)

CRISPR-Cas9 gene technology has the potential to increase photosynthetic efficiency of a variety of crops, including tomatoes, potatoes, rice, bananas and cotton. Scientists have been exploring CRISPR-Cas9 as a gene-editing tool to increase crop yield to help feed the growing human population. Rice plants have been genetically modified to be gluten free, enabling individuals with the autoimmune condition coeliac disease to be able to consume them. This has been done by creating a single guide RNA (sgRNA) molecule and coupling this to Cas9 which acts to knock out the alpha gliadin gene by inducing mutation. The alpha gliadin gene codes for the protein gliadin which makes up 70% of gluten and which causes the immune response in those who have coeliac disease.

- a. Describe the role of the Cas9 enzyme and sgRNA in the ‘knocking out’ of the alpha gliadin gene. 3 marks

- b.** Define ‘autoimmune disease’. 1 mark
-
-
-
- c.** The Cas9 enzyme requires a specific sequence located adjacent to the alpha gliadin target gene to enable correct binding. Name this sequence. 1 mark
-
- d.** Describe one benefit of using CRISPR Cas9 technology over other gene technologies. 2 marks
-
-
-
- e.** State the role of the CRISPR Cas 9 system in bacteria. 1 mark
-

Question 5 (12 marks)

The origin of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has been heavily debated. Genomic data have shown similarity in the RNA sequence between a coronavirus that infects pangolins and a coronavirus that infects bats. Pangolins are a highly prized animal in Asia, with many people believing that they provide healing and medicinal cures for some illnesses. They are also valued in countries such as Africa and Vietnam for their meat, which can be sold in restaurants for \$350 per kilogram, and their scales, which are used to create boots and handbags.

In 2019, wildlife personnel confiscated some Malayan pangolins that were being illegally trafficked through China's Guangdong province. They noted poor health and respiratory distress and well over half of the seized pangolins died. Scientists took tissue samples from the deceased pangolins and found segments of RNA belonging to a group of coronaviruses. Their study concluded that it was possible their deaths were the result of a coronavirus, and that the virus might have the ability to jump species.

Genomic sequencing found that part of this pangolin viral RNA was 99% similar to the receptor binding site domain of the SARS-CoV-2. This means that the pangolin virus also binds to ACE 2 receptors located on cells in human lung tissue. Another group of scientists put forward an alternate possible hypothesis for the origin of SARS-CoV-2. The second theory suggested that the coronavirus in pangolins could have undergone a recombinant event where different strains combined to produce the novel SARS-CoV-2 virus.

- a.** From the information provided above, give one scientific strategy and one social strategy that could be applied to prevent the spread of the coronavirus found in Malayan pangolins.

2 marks

- b.** Identify whether SARS-CoV-2 was a result of antigenic drift or antigenic shift. Explain your reasoning.

2 marks

- c. What did the observation that the SARS-CoV-2 could also bind to ACE-2 receptors on human cells indicate about its mode of transmission? Provide one measure that would be effective in controlling the spread. 3 marks

- d. Name the molecule on all nucleated cells that enables the immune system to distinguish self cells from non-self cells. 1 mark

- e. Describe the humoral response that would have occurred in the Malayan pangolins experiencing respiratory distress and suggest why they died. 4 marks

Question 6 (10 marks)

The Galapagos archipelago is a group of 13 islands located in the Pacific Ocean. The islands are home to a diversity of plant and animal life, including the well-known Galapagos finches. There are 13 different species of finch found throughout these islands, and they all look physically different and have beaks adapted to their food source. Molecular evidence shows that all the finches on the Galapagos islands arose from one ancestral finch population that flew from the mainland to the islands many years ago, as they are more closely related to each other than those found on the mainland, approximately one thousand kilometres away.

- a.**
- i.** Name the type of speciation that occurred to produce the 13 different species of finch in the Galapagos islands. 1 mark
- _____
- ii.** Outline the process of the type of speciation evident in the Galapagos finches. 3 marks
1. _____
- _____
- _____
2. _____
- _____
- _____
- _____
3. _____
- _____
- _____
- _____

In the year 1976, a drought occurred on the Galapagos islands that lasted 18 months. The graphs below show the changes in average beak depth of the medium ground finch on one of these islands in 1976 compared to 1978, 6 months after the drought ended.

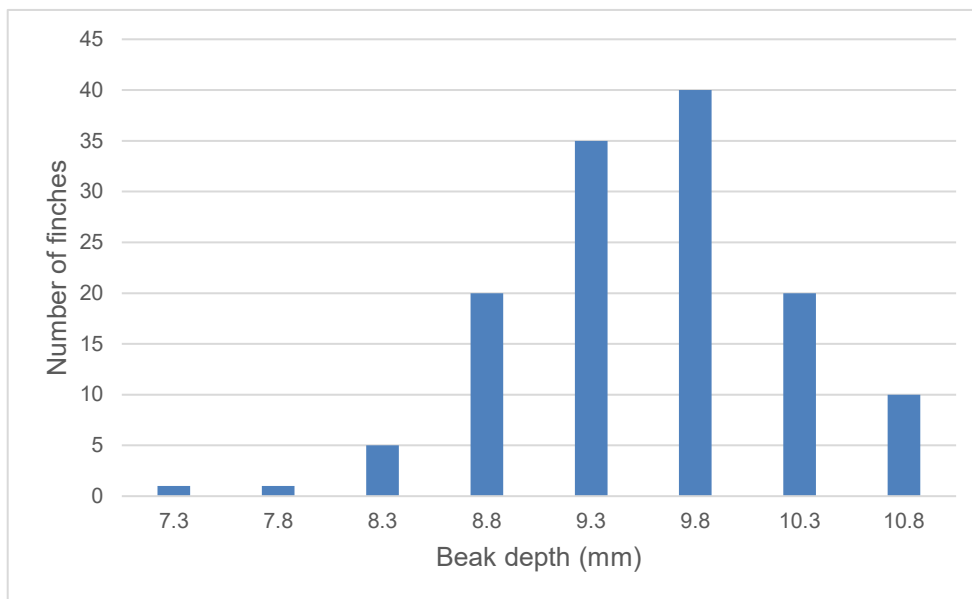


Figure 14: The beak depths in medium ground finches in 1976 during drought conditions

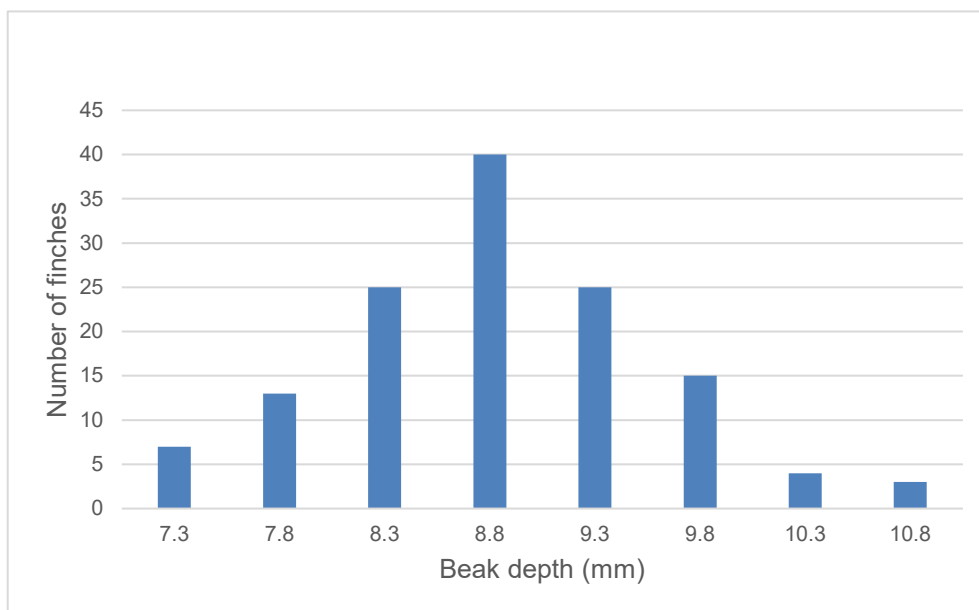


Figure 15: The beak depths in medium ground finches in 1978

- b.** Describe the relationship between survival of the medium ground finches during the drought and beak depth over the 1976-1978 period. 2 marks
- _____
- _____
- _____
- _____
- _____
- _____
- c.** State the selective pressure acting on the beak size of the medium ground finches in 1976. Justify your answer. 3 marks
- _____
- _____
- _____
- _____
- _____
- d.** Name one possible molecular technique that may have been used as evidence to show that the 13 species of Galapagos finch all arose from a single common ancestor. 1 mark
- _____

Question 7 (10 marks)

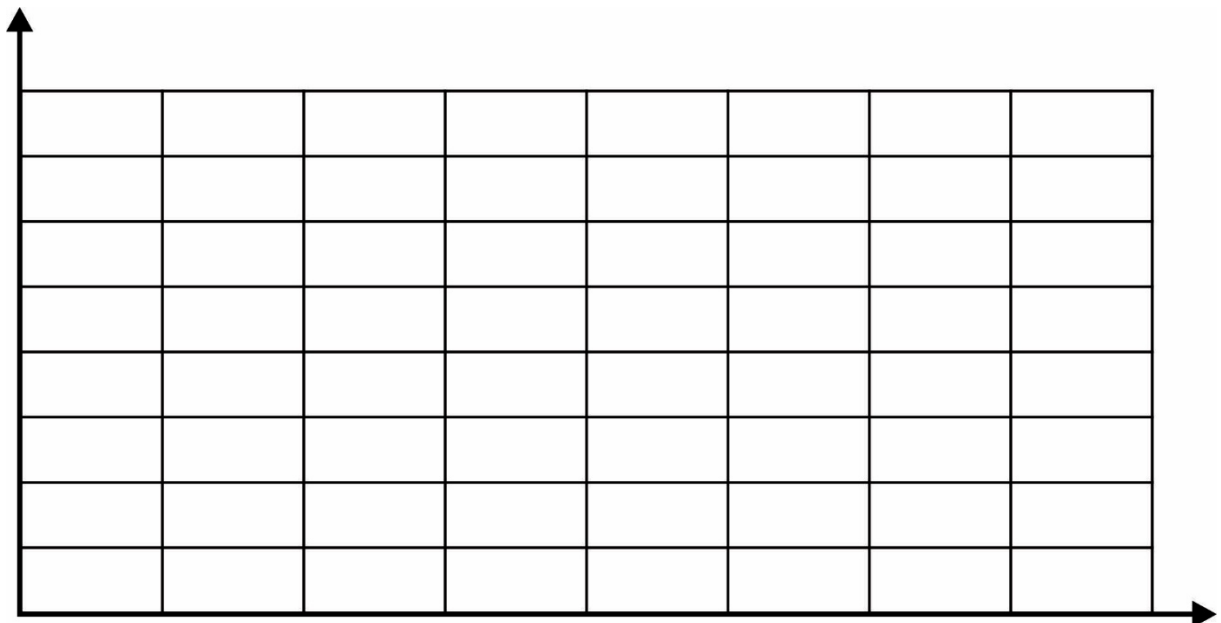
Human evolution has taken place over millions of years. **Table 1** compares the brain volume of different hominin species and the approximate time in which they lived.

Hominin species	Approximate time in which the species lived (million years ago)	Average Brain volume (cm ³)
<i>Australopithecus afarensis</i>	3.5	380
<i>Australopithecus africanus</i>	2.5	420
<i>Homo heidelbergensis</i>	0.5	1000
<i>Homo neanderthalensis</i>	0.3	1450
<i>Homo sapiens</i>	0.2	1350

Table 1

- a. Draw a line graph on **Figure 16** to represent the data in **Table 1**.

4 marks

**Figure 16**

- b.** With reference to the graph drawn in **part 7a**), describe the change in brain capacity over time.

2 marks

- c.** Name and outline the process that led to the change in brain volume in the different hominin species.

4 marks

Question 8 (10 marks)

A group of Biology students investigated anaerobic cellular respiration. **Figure 17** shows the setup the students used to conduct their experiment. The amount of carbon dioxide produced at each temperature was recorded in 5-minute intervals. Their results are presented in **Table 2**.

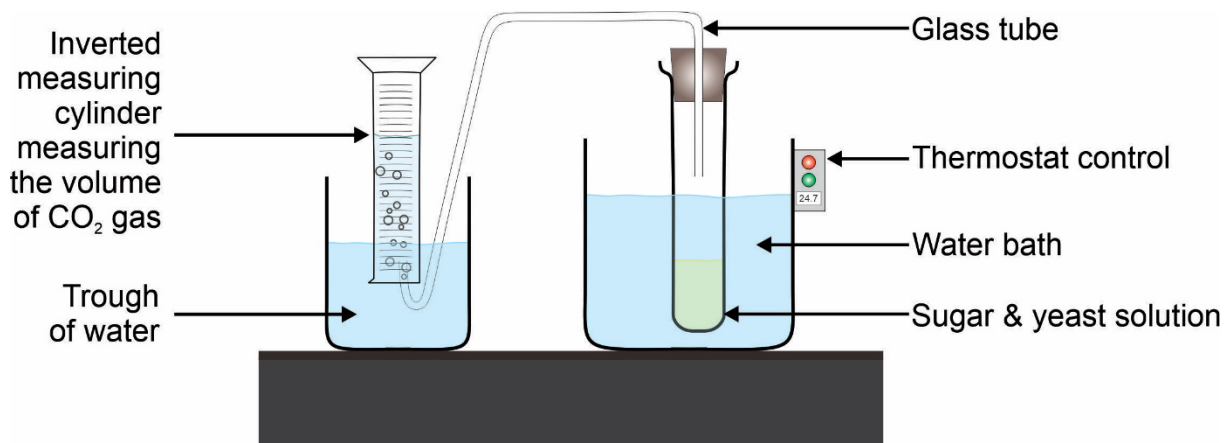


Figure 17: Measuring the carbon dioxide production (mmol) in yeast cells

Temperature (degrees Celsius)	Carbon dioxide production (mmol)
10	0.1
20	0.3
30	0.6
40	0.8
50	0.7
60	0.5
70	0.2

Table 2

- a. State a possible hypothesis the students were testing.

1 mark

- b.** Identify the independent and dependent variables in this experiment. 2 marks

- c.** Provide a biological explanation for the results the students collected. 4 marks

- d.** Apart from temperature, provide another variable that should be controlled throughout the experiment. 1 mark

- e.** Explain whether the data collected by the students are valid. 1 mark

- f.** The experiment was measuring carbon dioxide production in yeast. State another output produced in anaerobic fermentation that could be used to indicate anaerobic fermentation was occurring. 1 mark
