SCIENCE TEACHERS ASSOCIATION VICTORIA 2022

TRIAL EXAMINATION

QUESTION AND ANSWER BOOK

Total writing time:
2 hours 30 minutes

BIOLOGY
UNITS 3 & 4

Student name	

Student ID									**Letter**	

Structure of book

Section	Number of questions	Number of marks
A	40	40
B	7	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 calculators are allowed in this examination.

Materials supplied

- Question and answer book of 28 pages, with a detachable answer sheet for multiple-choice questions inside the front cover.

Instructions

- Detach the answer sheet for multiple-choice questions during reading time.
- Write your name and student ID in the space provided above on this page and on the answer sheet for multiple-choice questions.
- Unless otherwise indicated, the diagrams in this book are not drawn to scale.
- All written responses should be in English.

At the end of the examination

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

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BIOLOGY
Units 3 & 4 Trial Examination
MULTIPLE CHOICE ANSWER SHEET

STUDENT NAME:	

INSTRUCTIONS: **USE PENCIL ONLY**

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries.
- If you make a mistake, **ERASE** it – **DO NOT** cross it out.
- Marks will **NOT** be deducted for incorrect answers.
- **NO MARK** will be given if more than **ONE** answer is completed for any question.
- Mark your answer by **SHADING** the letter of your choice.

	ONE ANSWER PER LINE					ONE ANSWER PER LINE					ONE ANSWER PER LINE				
1	A	B	C	D	15	A	B	C	D	28	A	B	C	D
2	A	B	C	D	16	A	B	C	D	29	A	B	C	D
3	A	B	C	D	17	A	B	C	D	30	A	B	C	D
4	A	B	C	D	18	A	B	C	D	31	A	B	C	D
5	A	B	C	D	19	A	B	C	D	32	A	B	C	D
6	A	B	C	D	20	A	B	C	D	33	A	B	C	D
7	A	B	C	D	21	A	B	C	D	34	A	B	C	D
8	A	B	C	D	22	A	B	C	D	35	A	B	C	D
9	A	B	C	D	23	A	B	C	D	36	A	B	C	D
10	A	B	C	D	24	A	B	C	D	37	A	B	C	D
11	A	B	C	D	25	A	B	C	D	38	A	B	C	D
12	A	B	C	D	26	A	B	C	D	39	A	B	C	D
13	A	B	C	D	27	A	B	C	D	40	A	B	C	D
14	A	B	C	D										

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions 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 table to answer Questions 1 and 2.

The amino acid table for mRNA codons

1st letter	Second Letter: U	Second Letter: C	Second Letter: A	Second Letter: G	3rd letter
U	UUU Phe UUC UUA Leu UUG	UCU UCC UCA UCG Ser	UAU Tyr UAC UAA Stop UAG Stop	UGU Cys UGC UGA Stop UGG Trp	U C A G
C	CUU CUC CUA CUG Leu	CCU CCC CCA CCG Pro	CAU His CAC CAA CAG Gln	CGU CGC CGA CGG Arg	U C A G
A	AUU AUC AUA Ile AUG Met	ACU ACC ACA ACG Thr	AAU Asn AAC AAA AAG Lys	AGU Ser AGC AGA AGG Arg	U C A G
G	GUU GUC GUA GUG Val	GCU GCC GCA GCG Ala	GAU Asp GAC GAA GAG Glu	GGU GGC GGA GGG Gly	U C A G

Question 1

The DNA triplet TTA is the code for which one of the following amino acids?

A. Asn

B. Pro

C. Gly

D. Arg

Question 2

A single mutation in which one of the following codons could result in a stop amino acid?

A. Val

B. His

C. Tyr

D. Phe

Question 3

The ability of a multiple RNA codons to code for a single amino acid is referred to as

A. mutagenicity

B. the ability to transcribe

C. the universal genetic code

D. the degeneracy of the genetic code

Question 4

One of the functions of a ribosome is to

A. connect an anticodon to a codon.

B. connect a codon to an amino acid.

C. connect a nucleotide to an anticodon.

D. connect an amino acid to another amino acid.

Question 5

The process in which the introns are removed from the pre-messenger RNA is referred to as

A. splicing

B. capping

C. transcription

D. translation

Question 6

The role of the promotor region in the regulation of gene expression is to

A. bind to RNA polymerase and transcription factors.

B. allow for alternative splicing and recombination of DNA.

C. bind regulatory proteins that inhibit gene expression.

D. modify gene expression by binding transcription factors.

Question 7

The primary sequence of amino acids are bonded together by

A. hydrogen bonds

B. ionic bonds

C. glycosidic bonds

D. peptide bonds

Question 8

Haemoglobin is a protein consisting of four peptide subunits.

The haemoglobin molecule

The protein structure can be described as a

A. primary structure

B. secondary structure

C. tertiary structure

D. quaternary structure

Question 9

The active site of an enzyme is different to the antibody-antigen binding side because the enzyme active site

A. contains modified amino acids.

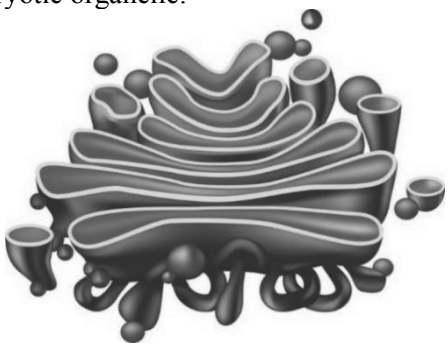
B. is complimentary to the product.

C. catalyses a chemical reaction.

D. contains amino acids without a R group.

Question 10

The diagram below shows a eukaryotic organelle.



The correct function of the organelle shown in the diagram above is

A. to process and package proteins and lipids.

B. protein synthesis and lipid metabolism.

C. aerobic cellular respiration.

D. the production of glucose in photosynthesis.

Question 11

Plasma cells release large amounts of antibodies. These cells would contain a large amount of

A. rough endoplasmic reticulum.

B. smooth endoplasmic reticulum.

C. vacuoles.

D. genetic material.

Question 12

Endonucleases are enzymes capable of

A. cutting a DNA molecule at a specific recognition sequence.

B. adding a nucleotide at the 3' end.

C. restricting protein synthesis at a ribosome.

D. joining DNA molecules together.

Question 13

Identify the effect on a PCR reaction if there were no polymerase in the reaction.

A. PCR would proceed normally.

B. The reaction would stop after a few cycles.

C. The PCR would not complete a full cycle.

D. The PCR would copy random strands of DNA.

Question 14

In gel electrophoresis, the DNA migrates through the gel because

A. the DNA is negatively charged.

B. of the movement of the buffer.

C. it diffuses through the agarose gel.

D. the short DNA segments are travelling faster.

Question 15

The insulin produced by recombinant DNA technology is

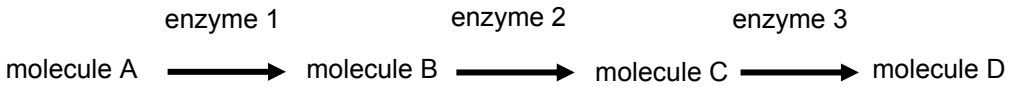
A. a combination of *E.coli* and human insulin.

B. produced from human insulin mRNA.

C. produced by a cloned human insulin gene.

D. engineered to be more effective than human insulin.

Use the following enzyme pathway to answer Questions 16 and 17.



Question 16

Identify what would happen to the rate of production of molecule D if enzyme 1 was not present.

A. it would increase

B. it would decrease

C. it would stop

D. it would be unchanged

Question 17

Identify how the rate of production of molecule D would be affected if the concentration of enzyme 1 was increased but the concentration of enzymes 2 and 3 remained unchanged.

A. it would increase

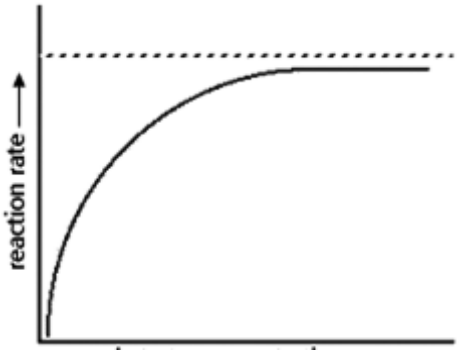
B. it would decrease

C. it would stop

D. it would be unchanged

Question 18

The graph below shows the effect of altering a factor on the rate of an enzyme-controlled reaction.



Identify the factor shown on the horizontal axis of the graph.

A. temperature

B. enzyme concentration

C. pH

D. product concentration

Question 19

The final electron acceptor during the electron transport chain is

A. oxygen

B. water

C. carbon dioxide

D. ATP

Question 20

Identify the process where the greatest number of ATP are produced in aerobic cellular respiration.

A. the Krebs cycle

B. the electron transport chain

C. glycolysis

D. fermentation

Question 21

The Krebs cycle occurs in the

A. mitochondrial cristae

B. nucleus

C. cytoplasm

D. mitochondrial matrix

Question 22

Thirty minutes after ^{18}O is provided to photosynthesising plants in water molecules, it will be found as

A. glucose

B. carbon dioxide

C. gaseous oxygen

D. starch

Question 23

Identify which one of the following will increase the rate of photosynthesis.

A. increasing water

B. decreasing temperature

C. decreasing oxygen

D. increasing light

Question 24

Identify what will happen if carbon dioxide is removed from a plant's environment.

A. The rate of the light independent reaction will decrease.

B. The amount of water used in the light independent reaction will decrease.

C. The amount of NADH produced will decrease.

D. The amount of $FADH_2$ will increase.

Question 25

Identify the location where anaerobic fermentation occurs in a yeast cell.

A. mitochondria

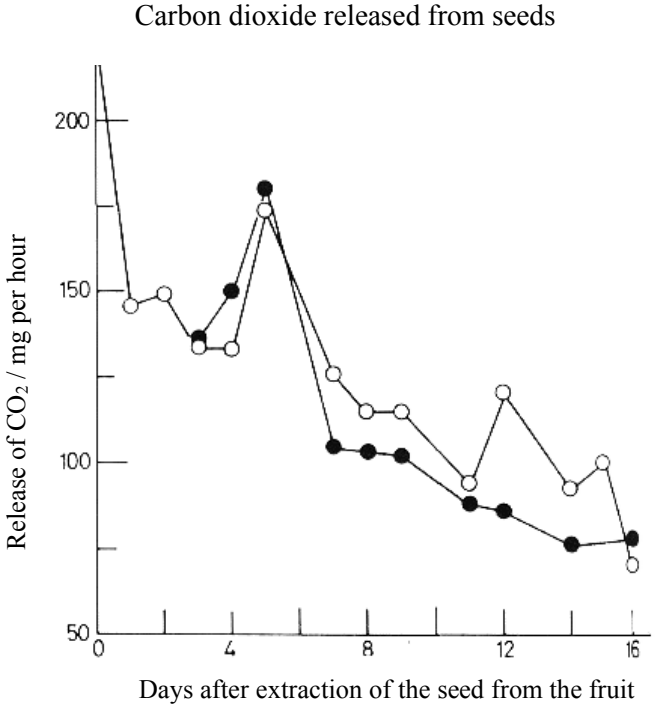
B. ribosomes

C. cytoplasm

D. vacuole

Question 26

Botanists measured the rate of carbon dioxide produced by two avocado seeds for 16 days after being removed from the fruit.



Identify which one of the following statements is most correct.

A. Both seeds have a constant rate of cellular respiration.

B. The experiment is unreliable because the rate of carbon dioxide released varies.

C. Both seeds had an overall decrease in cellular respiration over the 16 days.

D. Both seeds increased their rate of respiration at day 4 and day 11.

Question 27

When completing strenuous exercise, the circulatory system in mammals can struggle to provide enough oxygen to the muscle cells. This will slow which one of the following processes first?

A. anaerobic fermentation

B. glycolysis

C. the Krebs cycle

D. the electron transport chain

Question 28

Identify which one of the following is correct for the second line of defence in the immune system.

A. Complement proteins are antigen specific.

B. Mast cells produce antihistamine.

C. Interferon is produced in response to viral infections.

D. Eosinophils are not antigen-presenting cells .

Question 29

Identify which one of the following are involved in an allergic response to pollen.

A. cytotoxic T cells

B. eosinophils

C. self-antigens

D. interferons

Question 30

The greatest source of genetic variation in viral infections is from

A. mutation

B. sexual reproduction

C. natural selection

D. genetic drift

Question 31

A small group of people living in Oregon, USA, developed ‘blue skin’ as a result of a change in the structure of the protein haemoglobin. All of the ‘blue-skinned’ residents of this area can trace their ancestry to a single pair of original settlers in the area. This unusually high allele frequency of ‘blue skin’ is most likely an example of

A. mutation

B. genetic drift

C. natural selection

D. speciation

Question 32

Gene flow describe the movement of alleles between

A. chromosomes

B. species

C. individuals

D. populations

Question 33

Identify which one of the following will lead to the greatest genetic diversity.

A. genetic drift

B. natural selection

C. the bottleneck effect

D. antigenic shift

Question 34

Influenza is a virus that can reinfect the same host a number of times over 10 years. The main cause of this ability to become unrecognisable by the host's immune system is

A. antigenic drift

B. natural selection

C. herd immunity

D. the primary defence system

Question 35

Determining the order of fossil age by examining the position of rocks in a sequence is called

A. relative dating

B. radiometric dating

C. radiocarbon dating

D. absolute dating

Question 36

Vestigial structures are

A. structures that have a common function and suggests a common ancestry.

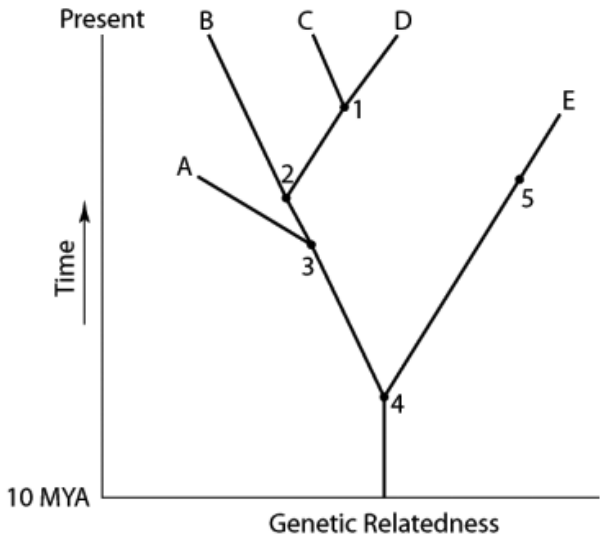
B. genetically determined structures that have lost most or all of their ancestral function.

C. traits of organisms that result from sharing a common ancestor.

D. traits that have similar embryological origins.

Use the following diagram to answer Questions 37 and 38.

A phylogenetic tree



Question 37

The common ancestor for both species A and D could be found at position number

A. 1

B. 2

C. 3

D. 4

Question 38

The most distantly related species to species B would be

A. A

B. C

C. D

D. E

Question 39

A student suspected that their friends had difficulty concentrating in class because they consumed energy drinks during recess. An experiment to test this should include

A. the whole class drinking energy drinks and no water at recess.

B. the whole class drinking water and no energy drinks at recess.

C. the friends drinking both water and energy drinks at recess.

D. half the class drinking water and the other half drinking energy drinks at recess.

Question 40

One way to improve the accuracy of an experiment is to

A. increase the sample size.

B. repeat the experiment.

C. calibrate the equipment.

D. control the variables.

END OF SECTION A

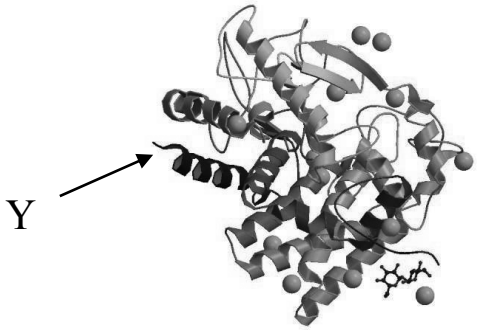
SECTION B

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 (13 marks)

The production of beer involves a process of fermentation of hops by yeast (*Saccharomyces cerevisiae*). The temperature of the hops solution can have an impact on the process. One of the key enzymes used by the yeast, beta glucanase, (shown below) is involved in breaking down the beta-glucans in the cell wall of the hops flowers.



beta glucanase

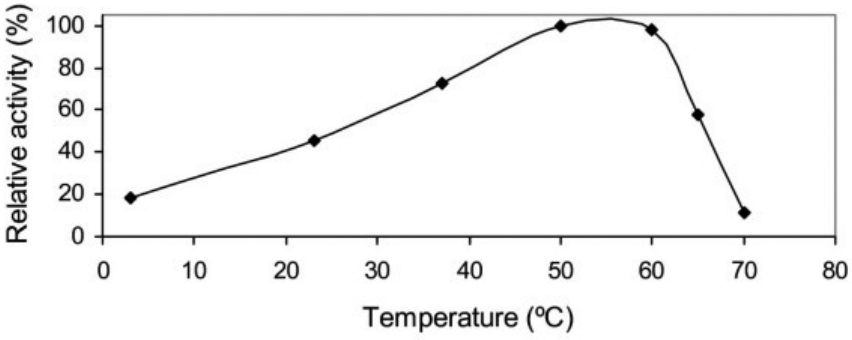
a Identify the structure labelled Y in the diagram above.

_____

1 mark

To ensure that the enzyme is able to work effectively, it is important that the temperature of *Saccharomyces cerevisiae* is kept at a constant level.

The effect of temperature on beta glucanase activity



b Use the graph above to identify the optimum temperature for *Saccharomyces cerevisiae* in the brewing process.

_____

1 mark

c Explain why a temperature of 10°C is **not** used in the brewing process.

_____

_____

_____

2 marks

At the end of fermentation, portions of the yeast can be removed from the solution for the next brew. The top part of the solution will contain younger yeast, while the lower part of the solution contains 'aged' yeast. Brewers claim that aged yeast cultures produce a 'better' beer with an increased ability to use the sugars to produce a high yield of ethanol and other flavours, as well as an increased flocculation potential (frothing when poured).

d Identify the inputs and outputs of the fermentation process.

inputs	**outputs**

2 marks

e Identify a coenzyme that is part of the process of fermentation.

_____

1 mark

A brewer wanted to test in an experiment if the age of the yeast affected the quality of the beer produced.

f Identify the independent variable for the experiment.

_____

1 mark

g Identify the dependent variable that could be measured to determine the quality of the beer.

_____

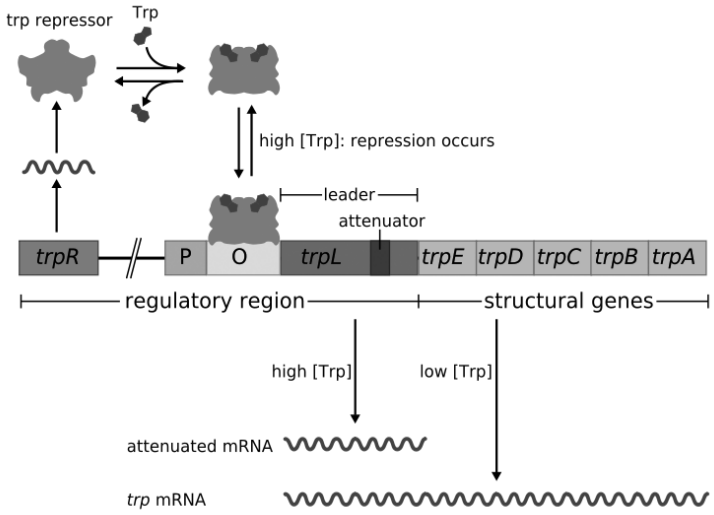
1 mark

h Design an experiment that could test the brewer's hypothesis.

4 marks

Question 2 (6 marks)

The diagram below shows the *trp* operon.



Source: <https://en.wikipedia.org/wiki/File:Trpoperon.svg>

In *E.coli* there are two mechanisms that repress the genes E, D, C, B and A in the *trp* operon.

a Explain how **one** of these mechanisms prevent the formation of tryptophan in a high tryptophan environment.

_____

_____

_____

_____

_____

_____

3 marks

If the level of tryptophan is low, the *E.coli* will transcribe and translate the operon. Three forms of RNA are involved in these processes.

b Describe the role of each type of RNA.

mRNA _____

_____

tRNA _____

_____

rRNA _____

_____

3 marks

Question 3 (7 marks)

Cowpea, cassava soybean and rice are examples of C_3 plants because the molecule Rubisco is used to fix carbon dioxide at the first stage of photosynthesis.

Rubisco is a quaternary structured protein.

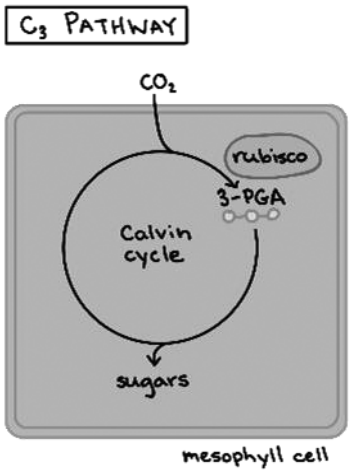
a Describe what is meant by a 'quaternary structure'.

_____

_____

1 mark

The diagram below shows the C_3 pathway for carbon dioxide binding rubisco during the light independent stage of photosynthesis.



b Describe one difference between C_3 plants and each of the following plant groups:

i CAM plants: _____

_____

_____

_____

1 mark

ii C_4 plants: _____

_____

_____

_____

1 mark

The single celled organism *Chlamydomonas* is often used as a model to study the role of genes in photosynthesis. The CRISPR / Cas9 system is used to selectively disable genes so that their function can be determined. The CRISPR sequence requires a short section of DNA called spacers in order to function.

c Describe the role of a spacer sequence.

_____

_____

_____

_____

1 mark

The spacer sequence binds to a nuclease called Cas 9. The Cas 9 enzyme will only cut the viral DNA if it is adjacent to a PAM sequence.

d Describe the role of the PAM sequence.

_____

_____

_____

_____

1 mark

CRISPR-Cas9 has been used to disrupt the KRN2 gene in maize. When this gene is activated, the number of kernel rows in a cob of corn decreases.

e Describe how the disruption of the KNR2 gene could increase crop productivity.

_____

_____

_____

_____

2 marks

Question 4 (24 marks)

Monkeypox is a virus that is related to the smallpox virus. Its genome is a single linear double stranded DNA molecule.

a Complete the following table to compare **two** differences between viruses and bacteria.

	viruses	**bacteria**
difference 1:		
difference 2:		

2 marks

Monkeypox is able to transcribe many of its own genes without the use of the host cell's mechanisms. It can be contracted by skin-to-skin contact.

b Describe the process of transcription.

_____

_____

_____

_____

3 marks

c Explain how the monkeypox virus is able to replicate in humans.

_____

_____

_____

_____

3 marks

When a person is first infected with monkey pox, their lymph nodes will become swollen.

d Describe the process that will cause the lymph nodes to swell in an infection.

_____

_____

_____

_____

_____

_____

_____

_____

_____

4 marks

The vaccine used to eradicate smallpox is a modified live *vaccinia* virus.

e Identify the type of immunity provided by vaccination.

_____

1 mark

People at risk for HIV / AIDS are not recommended to be vaccinated with the smallpox vaccine due to the virus's ability to infect T-Helper cells.

f Explain why the smallpox vaccine is not recommended for people at risk of HIV / AIDS.

_____

_

_____

_

_____

_

_____

_ 3 marks

Smallpox is a relative of both cowpox and monkeypox.

g Explain how monkeypox could have emerged into the human population.

3 marks

h Describe **two** strategies that could be used to control the spread of the monkeypox virus in the human population.

2 marks

The eradication of smallpox was achieved through herd immunity.

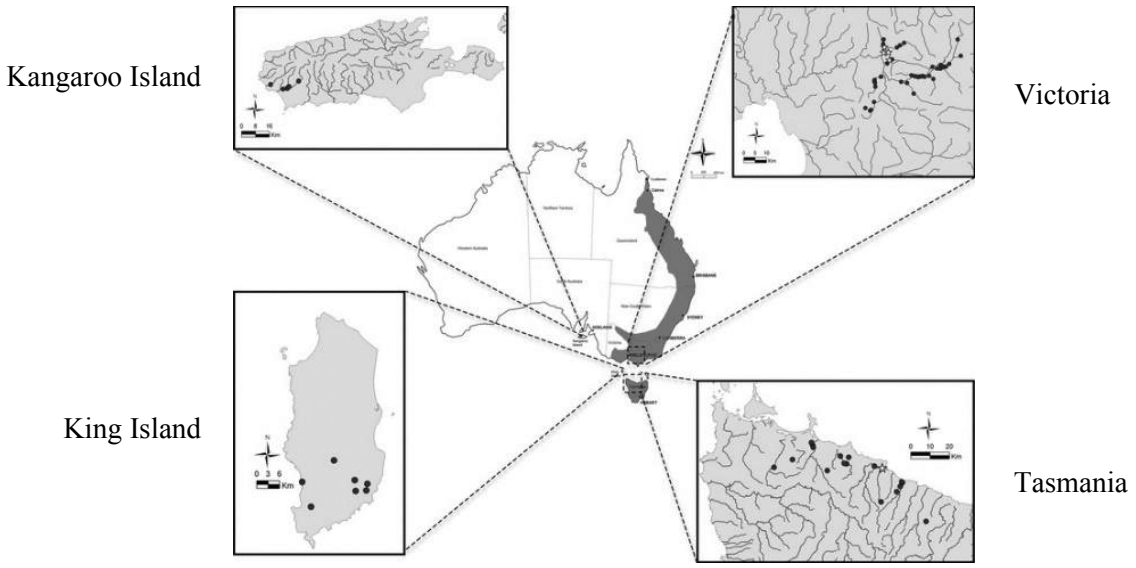
i Explain how herd immunity can eradicate a disease in a population.

3 marks

Question 5 (14 marks)

The platypus (*Ornithorhynchus anatinus*) is found in populations across eastern Australia and South Australia. Genetic samples from four populations (Victoria, King Island, Kangaroo Island and Tasmania) were tested. King Island was isolated from mainland Australia approximately 12 000 years ago and from Tasmania approximately 10 000 years ago. The population on King Island in Bass Strait is naturally occurring. In contrast, the population on Kangaroo Island was established in 1928 with one male platypus and one female platypus from Tasmania. This population was increased in 1944 and 1946 with additional animals from Healesville in Victoria.

The location of platypus populations in Australia.



Source: <https://www ncbi nlm.nih.gov/pmc/articles/PMC3399204/>

a Identify which of the four populations you would expect to have greatest genetic diversity.

_____

1 mark

b Justify your answer to part **a**.

_____

_____

_____

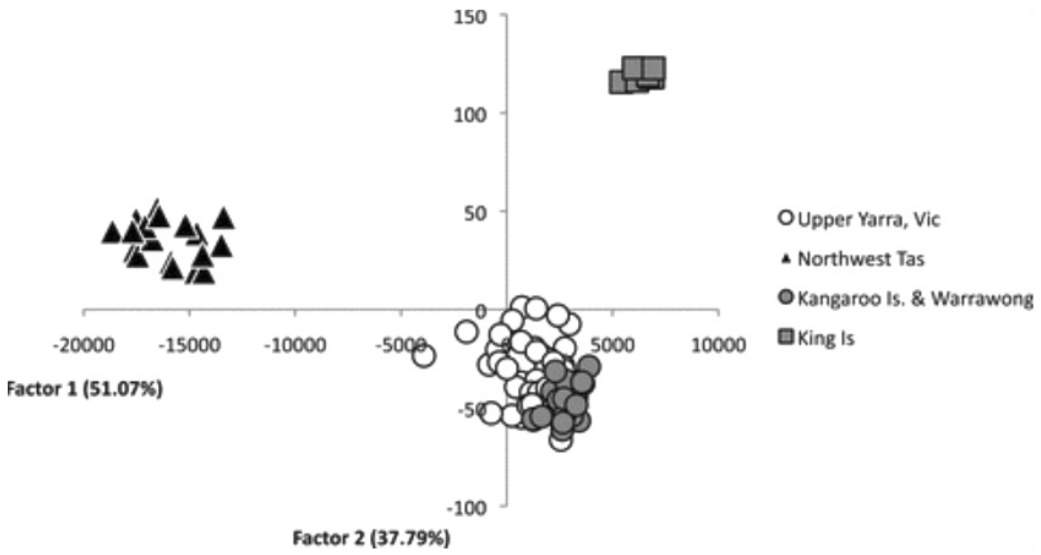
_____

_____

_____

3 marks

The diagram below identifies the results of genetic analysis of the four platypus populations.



c Explain why the platypus population on King Island is genetically distinct from the other populations.

_____

_____

_____

_____

_____

3 marks

d Explain why the limited genetic diversity of the platypus population on King Island puts them at risk of extinction.

_____

_____

_____

2 marks

e Explain why the four platypus populations are not considered an example of allopatric speciation.

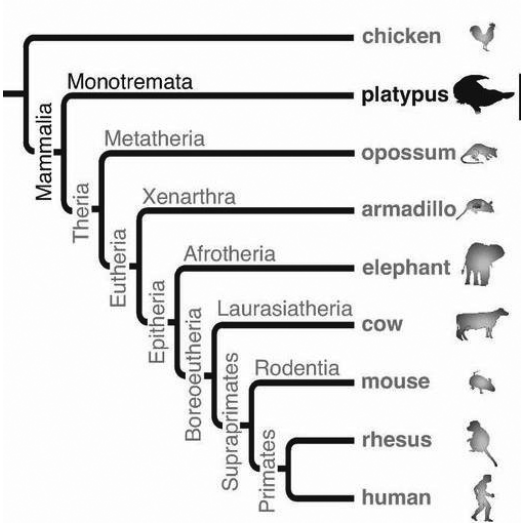
_____

_____

_____

2 marks

The diagram below indicates the genetic similarity of different mammals.



Source: <https://www.researchgate.net/figure/Conservation-and-plasticity-of-platypus-snoRNAs-Phylogenetic-tree-of-mammals-modified_fig4_5388940>

f Identify the most common ancestor of the platypus.

_____

1 mark

g Describe **two** common characteristics of mammals.

_____

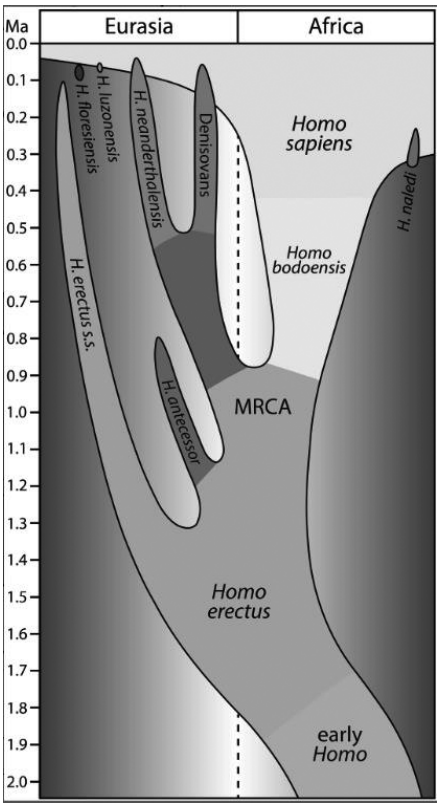
_____

2 marks

Question 6 (7 marks)

The classification of fossil remains of Hominins is often complicated by the damage caused by the fossilisation process. In 2021, a group of scientists suggested that a new taxon *Homo bodoensis* be used to describe many of the fossils found across Africa and into the eastern Mediterranean.

The diagram below shows the relationship between different hominins.



Source: <https://onlinelibrary.wiley.com/doi/10.1002/evan.21929>

a Use the diagram above to describe the proposed relationship between *Homo bodoensis* and *Homo neanderthalensis*.

_____

_____

_____

1 mark

The scientists proposed that the skulls of *Homo bodoensis* shared some characteristics with each of *Homo erectus* and *Homo sapiens* (shown below).

A model of the evolution of the genus *Homo*

Homo erectus *Homo sapiens*

b Identify which species (*Homo erectus or Homo sapiens*) shared each of the following characteristics with *Homo bodoensis*:

i projected jawline _____

1 mark

ii reduced brow ridge _____

1 mark

The first *Homo sapiens* are thought to have left Africa 73 000 years ago. This population are considered to be the ancestors of the Aboriginal and Torres Strait Islander Peoples that reached Australia 40 000 to 60 000 years ago.

c Identify one form of evidence that would support the arrival of the ancestors of Aboriginal and Torres Strait Islander Peoples 40 – 60 000 years ago.

_____

_____

_____

1 mark

Like many parts of the world, stone tools have been discovered in coastal regions of Australia. Occasionally other artifacts made from animal bone have also been discovered. One of these is a bone tool discovered on Ngarrindjeri Country in South Australia. It was dated to between 5300 and 3800 years old.

A bone artifact found in South Australia

Source: <https://www.abc net.au/news/2021-03-17/rare-bone-find-uncovers-ancient-aboriginal-technology/13252236>

d Describe how the absolute age of this artifact could have been determined.

_____

_____

_____

2 marks

e Explain why the discovery of bone artifacts is rare.

_____

_____

_____

1 mark

Question 7 (9 marks)

Biotech firm says it can resurrect extinct woolly mammoth

A technology entrepreneur and a geneticist launched a new biotech firm which they say will bring the extinct woolly mammoth back to life. Calling itself Colossal, the biosciences company claims CRISPR genetic technology can be used to bring back the animal, which went extinct over 11,000 years ago.

"Never before has humanity been able to harness the power of this technology to rebuild ecosystems, heal our Earth and preserve its future through the repopulation of extinct animals," technology entrepreneur and Colossal co-founder Ben Lamm said in a statement.

Scientists have managed to find mammoth tusks, bones and other material to try to sequence the animal's DNA. This DNA would then be inserted into the genome of the Asian elephant to form an "elephant-mammoth hybrid," according to the company.

Advocates of "de-extinction" say the process could help humans gain new knowledge regarding biology, evolution and technology. The resurrection of extinct species could also repair damaged ecosystems. In the case of the woolly mammoth, Colossal believes the animal could revitalize the Arctic grasslands, whose properties can mitigate global warming.

The idea of de-extinction could have its drawbacks, however. A March 2017 study published in the Nature Ecology & Evolution journal found that de-extinction programs would be incredibly expensive. Other downsides include resurrected animals carrying new pathogens that could possibly infect humans, along with how they will impact the environment.

The United Nations said in a 2019 report that 1 million animals, plant and fungi species face extinction in the coming decades.

Source: <https://learngerman.dw.com/en/biotech-firm-says-it-can-resurrect-extinct-woolly-mammoth/a-59171358#>

a With reference to evidence from the article, what ethical approach has been used?

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2 marks

b Suggest a way in which the company proposing the de-extinction of the woolly mammoth could demonstrate the ethical principle of integrity.

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1 mark

c Identify **one** potential political issue and **one** potential economical issue associated with the de-extinction of the woolly mammoth.

political: _____

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_____

1 mark

economical: _____

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_____

1 mark

d The scientists have sequenced the woolly mammoth's DNA. When creating the hybrid, explain if it would be more effective to use the DNA or the amino acid sequence of the woolly mammoth.

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1 mark

e What characteristic of CRISPR-Cas9 makes it an effective tool in modifying the Asian elephant genome when compared to traditional endonucleases?

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2 marks

f Suggest a strategy that could be implemented to minimise the potential transfer of a novel disease that the woolly mammoth hybrid may carry to humans.

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1 mark

END OF TRIAL EXAMINATION