External assessment 2025

Multiple choice question book

Biology

Paper 1

General instruction

- Work in this book will not be marked.

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Section 1

Instruction

- Respond to these questions in the question and response book.

QUESTION 1

Which base pairs with adenine during DNA replication?

(A) uracil

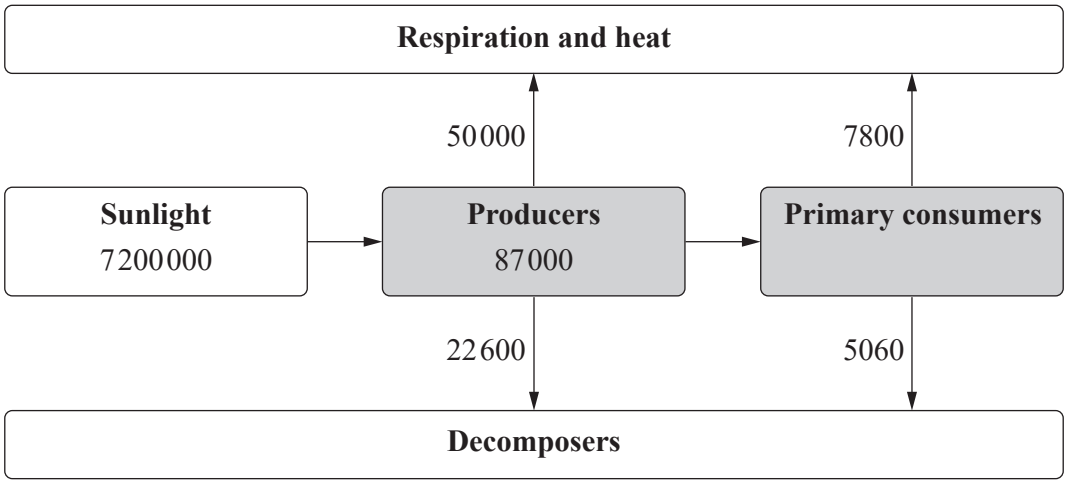
(B) guanine

(C) thymine

(D) cytosine

QUESTION 2

The diagram shows energy flow through an ecosystem in kJ m^{-2} $year^{-1}$. Shaded boxes represent gross productivity.



Calculate the percentage of solar energy available to primary consumers.

(A) 0.1%

(B) 0.2%

(C) 0.4%

(D) 0.5%

QUESTION 3

As a population approaches its carrying capacity, the population growth rate will

(A) increase due to intraspecific competition.

(B) increase due to interspecific competition.

(C) decrease due to intraspecific competition.

(D) decrease due to interspecific competition.

QUESTION 4

What is the role of tRNA in protein synthesis?

(A) acting as a template strand for mRNA

(B) matching amino acids to mRNA codons

(C) transporting mRNA from the nucleus to the ribosome

(D) providing a copy of genetic instructions for the ribosome

QUESTION 5

Which option describes the contents of a human cell at metaphase I of meiosis?

	Number of chromosomes	Number of copies of each gene
(A)	23	1
(B)	23	2
(C)	46	2
(D)	46	4

QUESTION 6

A student investigating the impact of a selection pressure on a population collected the data shown.

Genotype	BB	Bb	bb
Number of individuals	128	220	85

Calculate the frequency of the recessive allele in the population.

(A) 10%

(B) 20%

(C) 32%

(D) 45%

QUESTION 7

Which process is involved in both carbon and water cycling?

(A) respiration

(B) evaporation

(C) transpiration

(D) precipitation

QUESTION 8

Speciation is more likely to occur between two populations when

(A) gene flow is low and selection pressures are similar.

(B) gene flow is high and selection pressures are similar.

(C) gene flow is low and selection pressures are different.

(D) gene flow is high and selection pressures are different.

QUESTION 9

Which term describes large, geographically distinct areas of Earth's surface with common climates, geology, landforms and communities?

(A) niches

(B) ecoregions

(C) environments

(D) microhabitats

QUESTION 10

In humans, sex-linked recessive traits are more common in

(A) males, because they have a Y chromosome.

(B) females, because they have two X chromosomes.

(C) males, because they have only one X chromosome.

(D) females, because they do not have a Y chromosome.

QUESTION 11

A student surveying a forest community collected the data shown.

Species	Number of individuals
W	220
X	123
Y	62
Z	145

Calculate the relative abundance of species W.

(A) 0.22

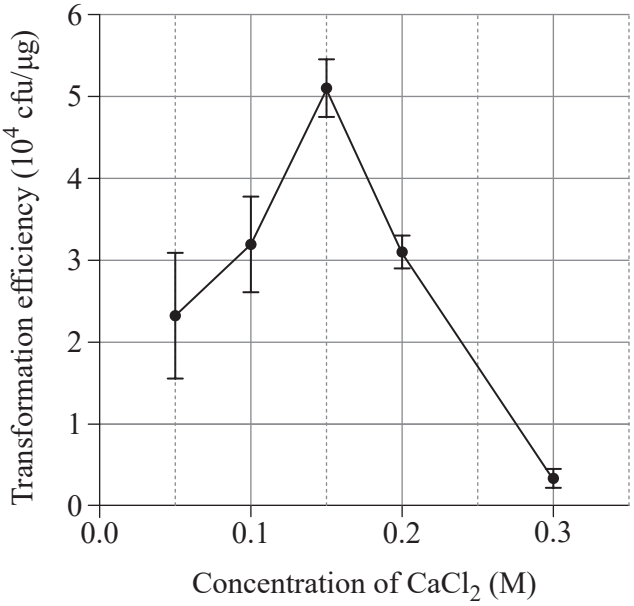
(B) 0.25

(C) 0.40

(D) 0.67

QUESTION 12

An experiment was conducted to determine how the concentration of calcium chloride ($CaCl_2$) affects the transformation efficiency of plasmids. Error bars show standard error.



Which concentration had the greatest variation in transformation efficiency?

(A) 0.05 M

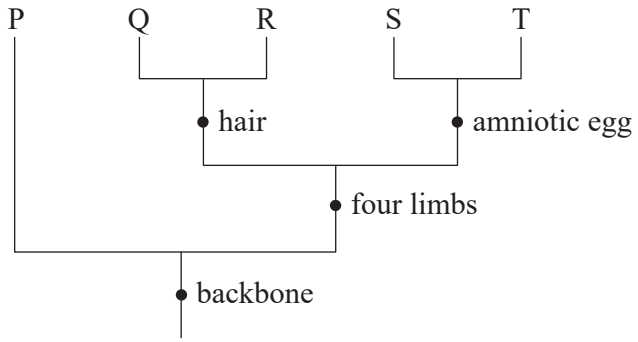
(B) 0.15 M

(C) 0.20 M

(D) 0.30 M

QUESTION 13

The cladogram shows relationships for species P, Q, R, S and T.



What inference can be drawn?

(A) Species Q, R and S form a clade.

(B) Species P and R are more closely related than species P and T.

(C) The most recent common ancestor of species R and T had four limbs.

(D) Species Q and R have a more recent common ancestor than species S and T.

QUESTION 14

Which species concept is based on common ancestry?

(A) biological

(B) ecological

(C) phylogenetic

(D) morphological

QUESTION 15

Which technique identifies the order of bases in DNA?

(A) DNA profiling

(B) DNA sequencing

(C) gel electrophoresis

(D) polymerase chain reaction

QUESTION 16

The table shows haploid (n) and diploid ($2n$) chromosome numbers for different matings.

Mating	Female	Male
I	$n = 32$	$2n = 62$
II	$2n = 62$	$n = 31$
III	$n = 31$	$2n = 62$
IV	$2n = 64$	$n = 32$

Predict which mating would produce an interspecific hybrid.

(A) I

(B) II

(C) III

(D) IV

QUESTION 17

Which mode of evolution involves the development of complementary characteristics in two species experiencing a close and long-term interaction?

(A) coevolution

(B) parallel evolution

(C) divergent evolution

(D) convergent evolution

QUESTION 18

Which mutation is likely to have the greatest effect on the viability of an embryo?

(A) a point mutation in a HOX gene

(B) a point mutation in the SRY gene

(C) a frameshift mutation in a HOX gene

(D) a frameshift mutation in the SRY gene

QUESTION 19

Which process involves the random alignment and separation of homologous chromosomes to form unique combinations of maternal and paternal chromosomes in gametes?

(A) cytokinesis

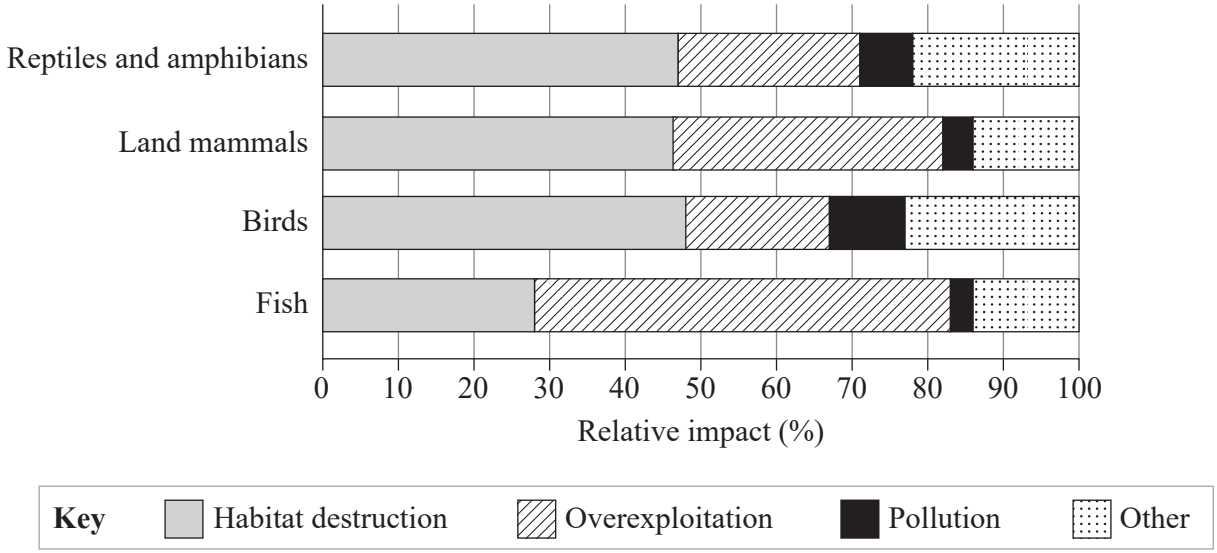
(B) crossing over

(C) recombination

(D) independent assortment

QUESTION 20

The graph shows the relative impact of habitat destruction, overexploitation, pollution and other human activities on four taxonomic groups.



Which activity has the greatest impact on terrestrial ecosystems?

(A) habitat destruction

(B) overexploitation

(C) pollution

(D) other

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References

Question 12

Lim, G; Lum, D; Ng, B & Sam, C 2015, 'Differential transformation efficiencies observed for pUC19 and pBR322 in e. coli may be related to calcium chloride concentration', Journal of Experimental Microbiology and Immunology (JEMI), vol. 19, https://jemi.microbiology.ubc.ca/sites/default/files/Lim%20et%20al.pdf

Question 13

StackExchange 2017, 'Example of impossibility in the nested heirarchy?', Biology, https://biology.stackexchange.com/questions/65364/example-of-impossibility-in-the-nested-hierarchy

Question 20

WWF. 2018. Living Planet Report - 2018: Aiming Higher. Grooten, M. and Almond, R.E.A.(Eds). WWF, Gland, Switzerland. https://c402277.ssl.cf1.rackcdn.com/publications/1187/files/original/LPR2018_Full_Report_Spreads.pdf

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Book of books used

External assessment 2025

Question and response book

Biology

Paper 1

Time allowed

- Perusal time — 10 minutes
- Working time — 90 minutes

General instructions

- Answer all questions in this question and response book.
- QCAA-approved calculator permitted.
- Planning paper will not be marked.

Section 1 (20 marks)

- 20 multiple choice questions

Section 2 (29 marks)

- 6 short response questions

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Section 1

Instructions

- This section has 20 questions and is worth 20 marks.
- Use a 2B pencil to fill in the A, B, C or D answer bubble completely.
- Choose the best answer for Questions 1–20.
- If you change your mind or make a mistake, use an eraser to remove your response and fill in the new answer bubble completely.

	A	B	C	D
Example:	●	○	○	○

	A	B	C	D
1.	○	○	○	○
2.	○	○	○	○
3.	○	○	○	○
4.	○	○	○	○
5.	○	○	○	○
6.	○	○	○	○
7.	○	○	○	○
8.	○	○	○	○
9.	○	○	○	○
10.	○	○	○	○
11.	○	○	○	○
12.	○	○	○	○
13.	○	○	○	○
14.	○	○	○	○
15.	○	○	○	○
16.	○	○	○	○
17.	○	○	○	○
18.	○	○	○	○
19.	○	○	○	○
20.	○	○	○	○

Ensure you have filled an answer bubble for each question.

Do not write outside this box.

Section 2

Instructions

- Write using black or blue pen.
- If you need more space for a response, use the additional pages at the back of this book.
  - On the additional pages, write the question number you are responding to.
  - Cancel any incorrect response by ruling a single diagonal line through your work.
  - Write the page number of your alternative/additional response, i.e. See page …
  - If you do not do this, your original response will be marked.
- This section has six questions and is worth 29 marks.

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QUESTION 21 (4 marks)

a) Describe two key features of the Linnaean system of biological classification. *[2 marks]*

b) Explain, using an example, how the Linnaean system allows researchers to infer similarities between species. *[2 marks]*

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QUESTION 22 (5 marks)

a) Compare the role of pioneer species in primary and secondary succession. *[3 marks]*

Similarity: _____

Difference: _____

Significance: _____

b) Describe two ways climax communities differ from pioneer communities. *[2 marks]*

Do not write outside this box.

QUESTION 23 (6 marks)

a) Identify two enzymes involved in DNA replication and describe their functions. *[4 marks]*

Enzyme 1: _____

Function: _____

_____

Enzyme 2: _____

Function: _____

_____

b) Explain how synthesis of the leading strand is different from the lagging strand. *[2 marks]*

_____

_____

_____

QUESTION 24 (2 marks)

Describe the structure of plasmids and their role in making recombinant DNA.

_____

_____

_____

_____

_____

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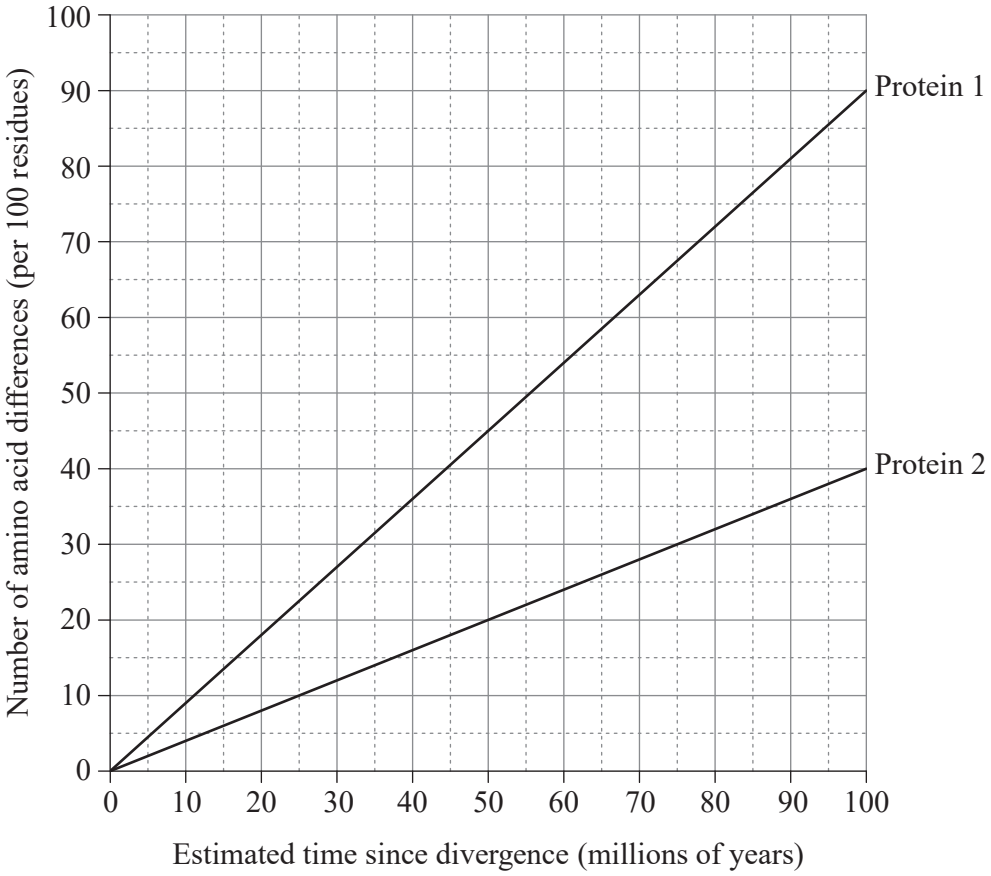
QUESTION 25 (5 marks)

Molecular sequence data from two proteins was used to determine the relatedness of giant pandas, red pandas, polar bears and ferrets.

The graph shows the mutation rate of the two proteins used in the investigation.



The table shows the average number of amino acid differences observed (per 100 residues) in protein 1.

	Giant panda	**Red panda**	**Polar bear**	**Ferret**
Giant panda		44	18	43
Red panda			45	36
Polar bear				44
Ferret				

a) Infer which species is most closely related to the ferret. *[1 mark]*

Do not write outside this box.

b) Predict the number of amino acid differences (per 100 residues) between polar bears and red pandas for protein 2. Justify your response. *[2 marks]*

c) Use your knowledge of convergent and divergent evolution to explain why molecular sequence data is often more accurate than anatomical data for determining the relatedness of different species. *[2 marks]*

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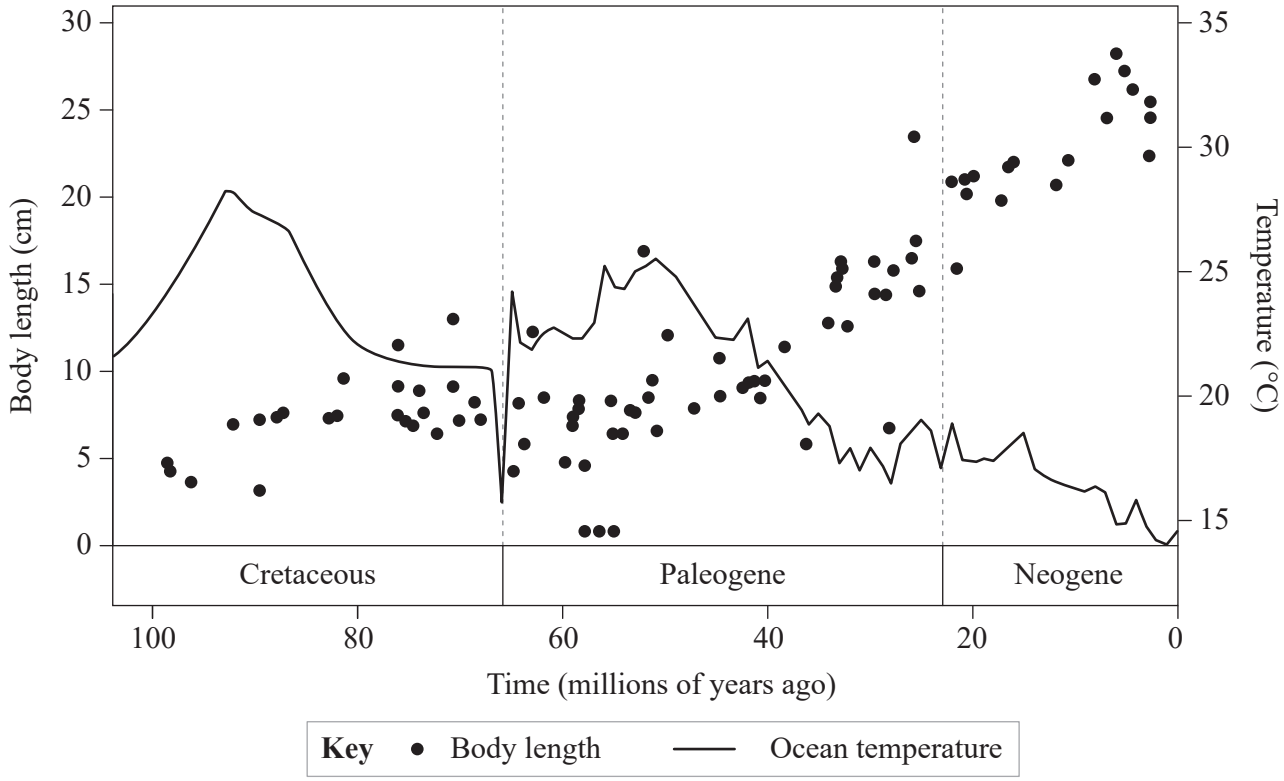
QUESTION 26 (7 marks)

Scientists investigating the impact of ocean temperature on the evolution of marine organisms compiled the data shown.



a) Identify the abiotic changes that occurred at the boundary of the Cretaceous and Paleogene periods. Refer to the data in your response. *[2 marks]*

Do not write outside this box.

b) Identify a relationship between ocean temperature and body length. *[1 mark]*

c) Use the principles of natural selection to provide a possible explanation for the trend in body length over geological time. *[3 marks]*

d) Identify the type of phenotypic selection that has occurred. *[1 mark]*

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ADDITIONAL PAGE FOR STUDENT RESPONSES

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ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

Do not write outside this box.

References

Question 25

Data from Yi, SV 2021, 'Molecular Evolution: A Brief Introduction', in Ho, SYW (eds), The Molecular Evolutionary Clock, Springer, Cham, pp. 25–34, https://doi.org/10.1007/978-3-030-60181-2_2

Question 26

Troyer, EM et al. 2022, 'The Impact of Paleoclimatic Changes on Body Size Evolution in Marine Fishes', Proceedings of the National Academy of Sciences of the United States of America, vol. 119, no. 29, https://doi.org/10.1073/pnas.2122486119

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School name

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Book of books used

External assessment 2025

Question and response book

Biology

Paper 2

Time allowed

- Perusal time — 10 minutes
- Working time — 90 minutes

General instructions

- Answer all questions in this question and response book.
- Write using black or blue pen.
- QCAA-approved calculator permitted.
- Planning paper will not be marked.

Section 1 (52 marks)

- 11 short response questions

Clear zone — margin trimmed off after completion of assessment

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Section 1

Instructions

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  - Write the page number of your alternative/additional response, i.e. See page …
  - If you do not do this, your original response will be marked.

QUESTION 1 (3 marks)

a) Define *genetic drift*. *[1 mark]*

b) Explain why genetic drift is usually high in populations affected by bottlenecks. *[2 marks]*

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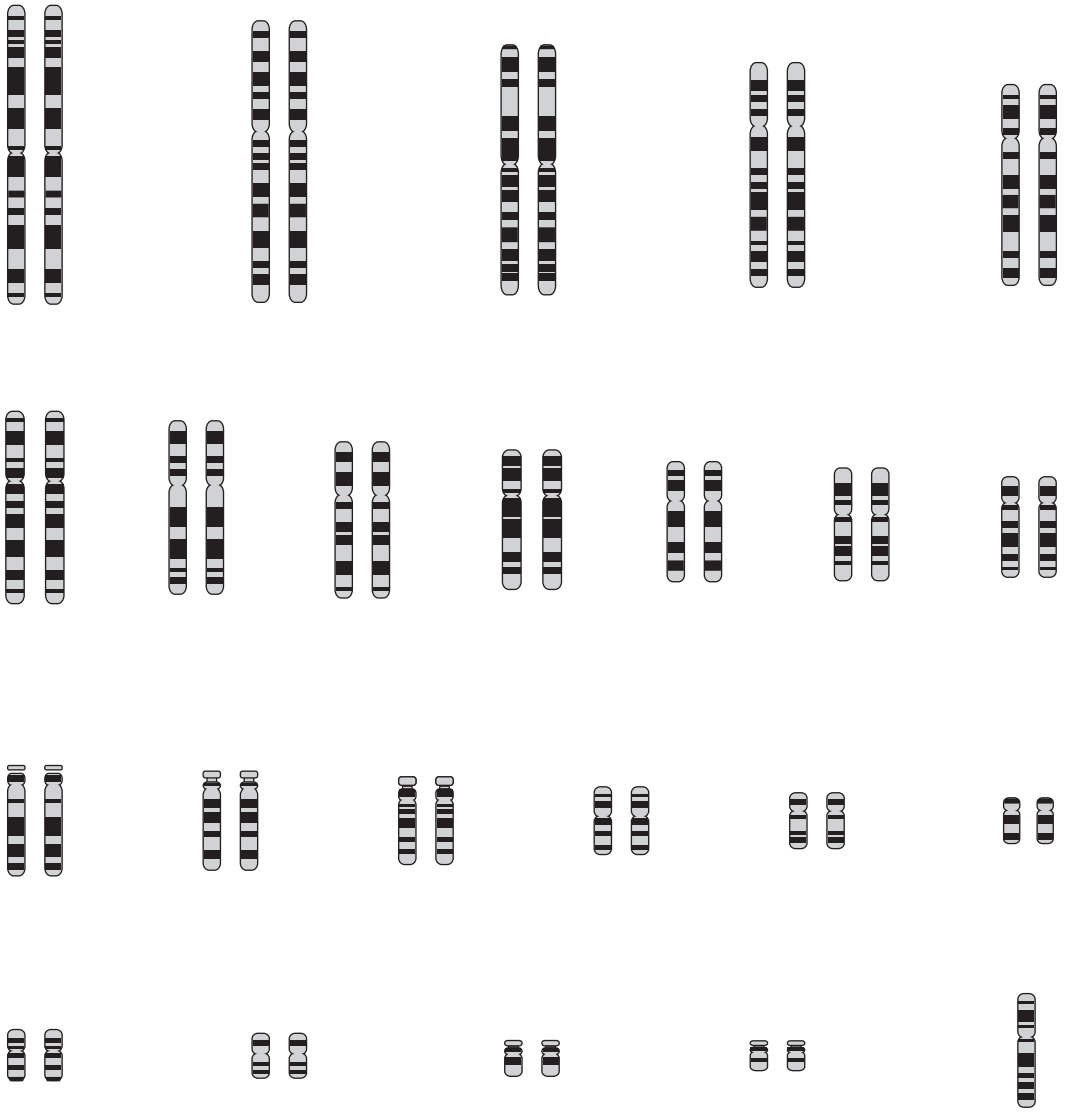
QUESTION 2 (6 marks)

A human karyotype and list of genetic conditions are shown.



Genetic condition	Common name
Monosomy 5	Cri du chat syndrome
Monosomy X	Turner syndrome
Trisomy 13	Patau syndrome
Trisomy 21	Down syndrome
Trisomy X	Triple X syndrome

Do not write outside this box.

a) Which genetic condition is indicated by the karyotype? *[1 mark]*

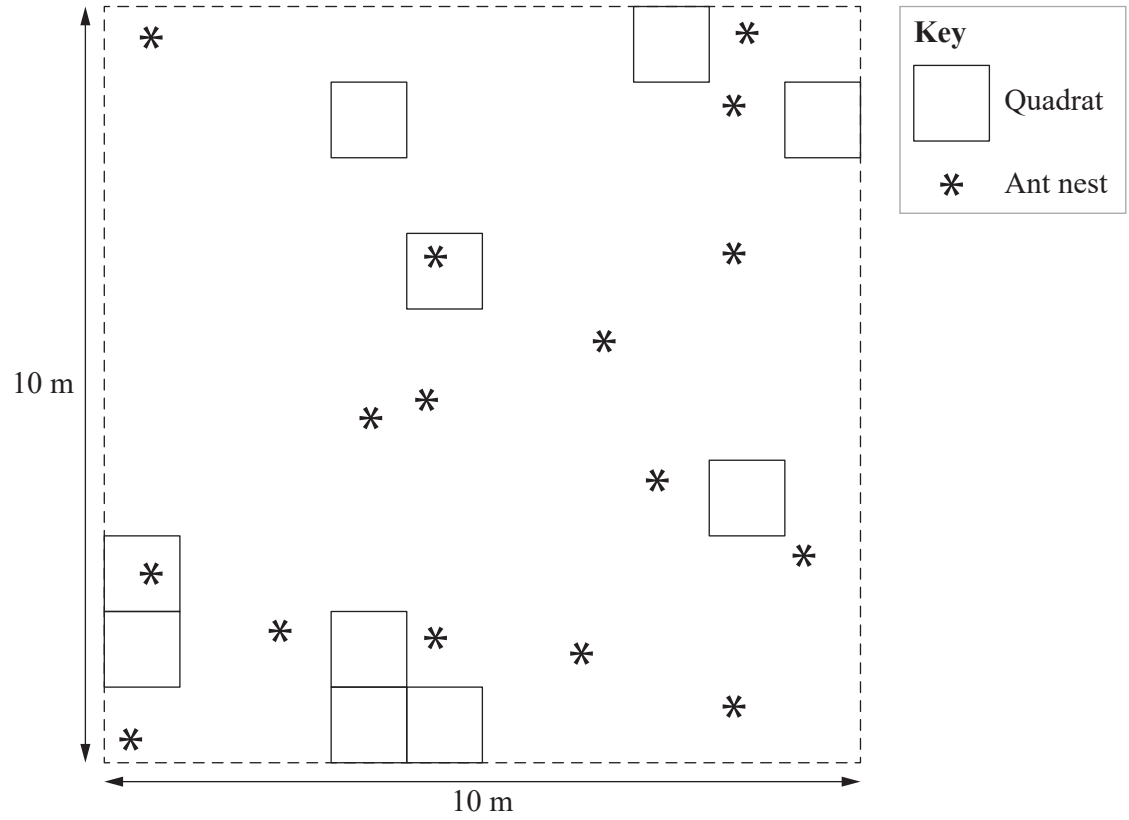
b) Explain how errors in meiosis may have led to this condition. *[3 marks]*

c) Describe how the karyotype would be different for a male with Down syndrome. *[2 marks]*

Do not write outside this box.

QUESTION 3 (6 marks)

Students used 10 quadrats, each 1 m^2 in size, to investigate the number of ant nests in a 100 m^2 section of their school oval. A random number generator was used to determine the location of each quadrat. Results are shown.



a) Use the quadrat data to predict the number of ant nests in the 100 m^2 section of the oval. Show your working. *[2 marks]*

Do not write outside this box.

b) Contrast the actual number of ant nests with that predicted by the quadrat data. *[2 marks]*

c) Explain why the students did not use stratified sampling for this investigation. *[2 marks]*

QUESTION 4 (3 marks)

Explain how transcription factors allow for cell differentiation, using an example.

Do not write outside this box.

QUESTION 5 (9 marks)

A student investigating the health of two freshwater ecosystems collected the data shown.

Abiotic indicator	Healthy range
Dissolved oxygen (% saturation)	90–110
Turbidity (NTU)	1–20
pH	6.5–8.0

		Ecosystem 1	Ecosystem 2
Abiotic data	Dissolved oxygen (% saturation)	95	105
	Turbidity (NTU)	20	5
	pH	6.2	7.5
Biotic data	Species richness	13	12
	Simpson's diversity index (SDI)	0.38	0.82

a) Infer which ecosystem has the greatest species evenness. Explain your reasoning. *[2 marks]*

Do not write outside this box.

b) Use the abiotic data to compare the health of the two ecosystems. *[3 marks]*

Similarity: _____

_____

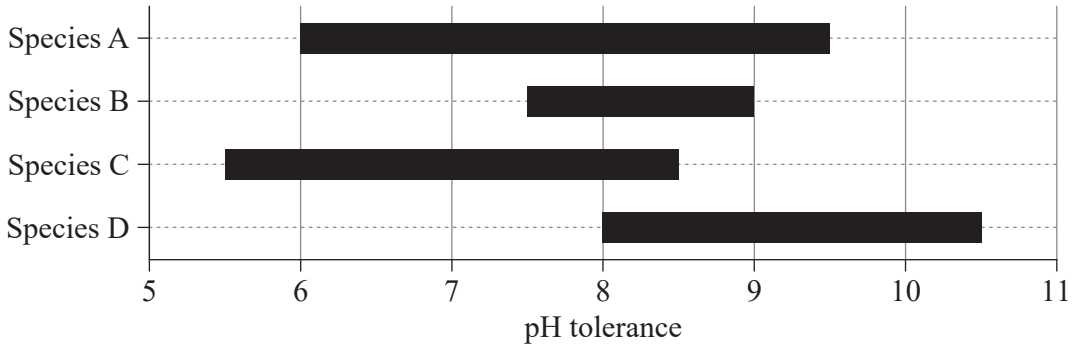
Difference: _____

_____

Significance: _____

_____

The chart shows pH tolerance ranges for phytoplankton species observed in the investigation.



c) Identify the species with the greatest pH tolerance range and state the tolerance range. *[2 marks]*

_____

d) Determine which two species were most likely observed in ecosystem 1. *[1 mark]*

_____

e) Determine the probability that two randomly caught individuals from ecosystem 2 were from the same species. *[1 mark]*

_____

_____

_____

Do not write outside this box.

QUESTION 6 (4 marks)

a) Explain how energy enters the biotic components of an ecosystem. *[2 marks]*

b) Distinguish between gross primary productivity and net primary productivity. *[2 marks]*

Do not write outside this box.

QUESTION 7 (3 marks)

The sex of chickens is determined by Z and W chromosomes. Chickens that inherit two Z chromosomes (ZZ) are male, while chickens with one Z chromosome and one W chromosome (ZW) are female. A barred feather pattern is a sex-linked dominant trait inherited on the Z chromosome.

A male chicken that was heterozygous for the barred feather pattern was bred with a female chicken that did not have the trait. They produced eight offspring.

Predict the number of offspring with the barred feather pattern. Justify your response using a Punnett square.

Do not write outside this box.

QUESTION 8 (2 marks)

Distinguish between exons and introns.

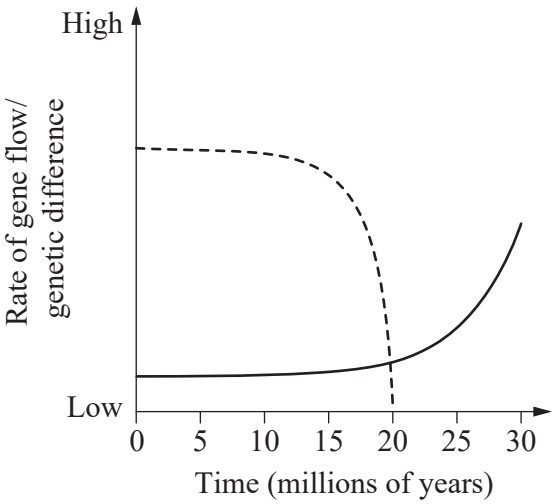
Do not write outside this box.

QUESTION 9 (2 marks)

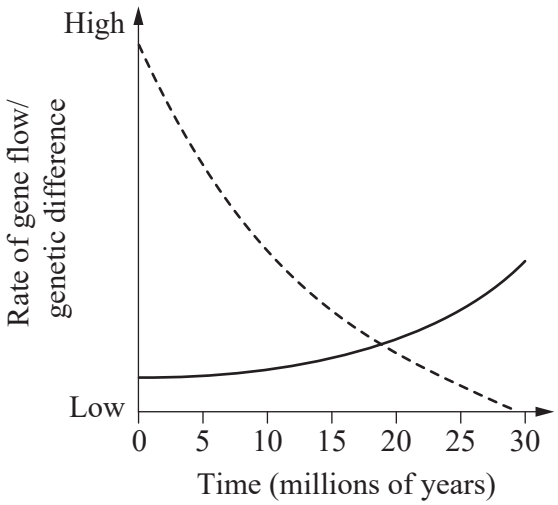
Scientists analysed data on three populations (A, B and C) in a region affected by habitat fragmentation.

The graphs show how the rate of gene flow and genetic differences between the populations changed over time.

Populations A and B



Populations A and C



Key

---- rate of gene flow

—— genetic difference

Infer which populations underwent allopatric speciation. Justify your response.

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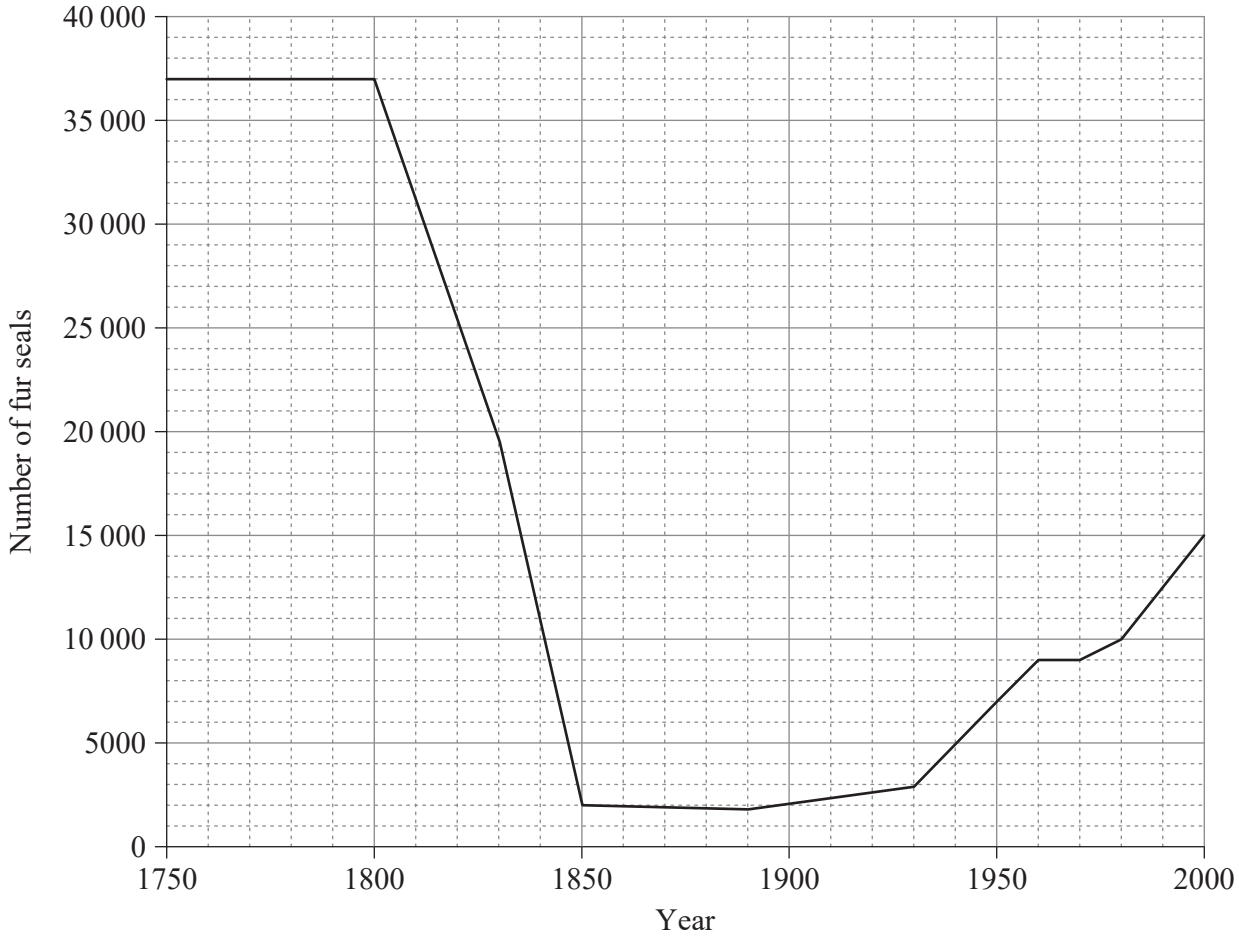
QUESTION 10 (10 marks)

Australian fur seals live in the Southern Ocean and feed on krill. In the 1800s, their population experienced a significant decline due to overharvesting. To monitor their recovery, scientists collected the data shown.



Fur seal population data (1850–2000)	
Deaths	1 217 900
Immigration	1500
Emigration	600

a) Identify the number of fur seals in 1800. *[1 mark]*

Do not write outside this box.

b) Determine the number of fur seal births between 1850 and 2000. Show your working. *[2 marks]*

c) Infer whether the fur seal population had reached carrying capacity in 2000.
Justify your response using evidence from the graph. *[2 marks]*

Some researchers believe that the Southern Ocean krill population will decrease by 40% by 2050.

d) Predict how this would affect the carrying capacity of fur seals in the ecosystem.
Explain your reasoning. *[2 marks]*

Do not write outside this box.

In 2025, a follow-up study used the capture–recapture technique and the Lincoln index $N = \frac{M \times n}{m}$ to estimate the number of fur seals. Results are shown.

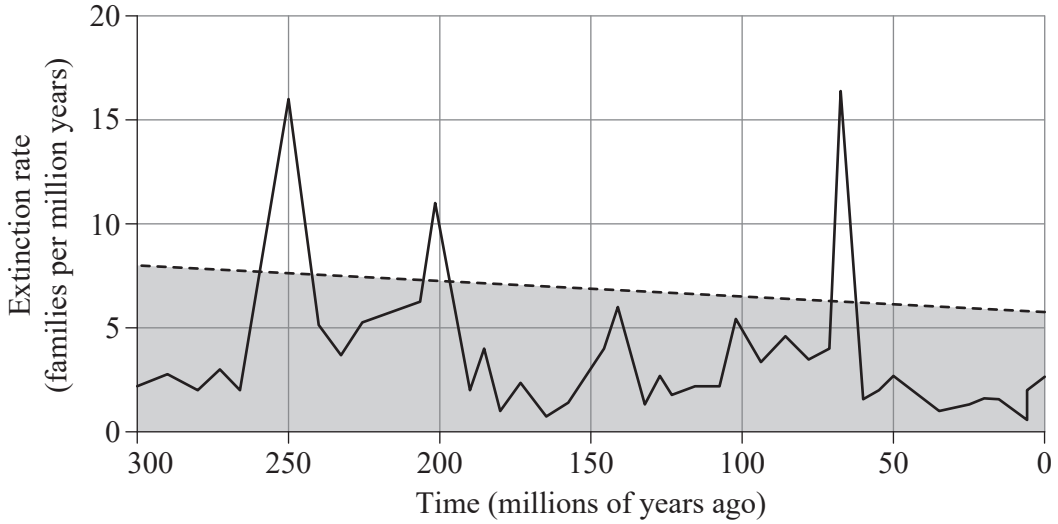
Number of fur seals in first capture	230
Number of fur seals in second capture	250
Number of marked fur seals in second capture	2

e) Use the data in the table and the graph on page 12 to determine the average annual population growth rate (%) between 2000 and 2025. *[3 marks]*

Do not write outside this box.

QUESTION 11 (4 marks)

Mass extinctions occur when the extinction rate of a taxonomic group exceeds the background extinction rate. Mass extinctions are an important part of macroevolution and are often followed by episodes of evolutionary radiation. The graph shows the extinction rate for marine animals alongside the background extinction rate.



Key ---- Background extinction rate
—— Extinction rate for marine animals

a) Identify a trend in the background extinction rate. *[1 mark]*

b) Determine how many mass extinctions occurred in the period shown on the graph. *[1 mark]*

c) Use the competitive exclusion principle to explain why mass extinctions are often followed by episodes of evolutionary radiation. *[2 marks]*

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ADDITIONAL PAGE FOR STUDENT RESPONSES

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ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

Do not write outside this box.

References

Question 10

Graph modified from McIntosh RR, Sorrell KJ, Thalmann S, Mitchell A, Gray R, Schinagl H, et al. (2022) Sustained reduction in numbers of Australian fur seal pups: Implications for future population monitoring. PLoS ONE 17(3): e0265610. https:// doi.org/10.1371/journal.pone.0265610 Licensed CC BY.

Question 11

Graph adapted from Ritchie H, 2022, 'There have been five mass extinctions in Earth's history', Our World in Data, https://ourworldindata.org/mass-extinctions. Licensed CC BY.

Graph data from:

Barnosky, AD et al. 2011, 'Has the Earth's sixth mass extinction already arrived?', Nature, vol. 471, https://doi.org/10.1038/nature09678.

McCallum, ML 2015, 'Vertebrate biodiversity losses point to a sixth mass extinction', Biodiversity and Conservation, vol. 24, no. 10, https://doi.org/10.1007/s10531-015-0940-6 Howard Hughes Medical Institute.

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