External assessment 2024

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 term describes a group of organisms consisting of a common ancestor and all its lineal descendants?

(A) clade

(B) subgroup

(C) population

(D) community

QUESTION 2

Polymerase chain reaction is a technique used in DNA profiling to

(A) cut DNA at specific sites.

(B) create more copies of DNA.

(C) determine the order of nucleotides.

(D) separate DNA fragments based on size.

QUESTION 3

What is a key difference between spermatogenesis and oogenesis?

(A) Spermatogenesis produces haploid cells, whereas oogenesis produces diploid cells.

(B) Spermatogenesis produces four functional gametes, whereas oogenesis produces one.

(C) Spermatogenesis occurs throughout life, whereas oogenesis only occurs after puberty.

(D) Spermatogenesis begins with haploid cells, whereas oogenesis begins with diploid cells.

QUESTION 4

The table shows data on four plant species. Which is most likely to be a pioneer species?

	Germination rate	Presence of nitrogen-fixing bacteria
(A)	slow	present
(B)	slow	not present
(C)	rapid	present
(D)	rapid	not present

QUESTION 5

A limitation of the biological species concept is that it does not account for species that

(A) reproduce asexually.

(B) are reproductively isolated.

(C) are morphologically indistinguishable.

(D) have a different number of chromosomes.

QUESTION 6

What can introduce new alleles into a population?

(A) point mutations

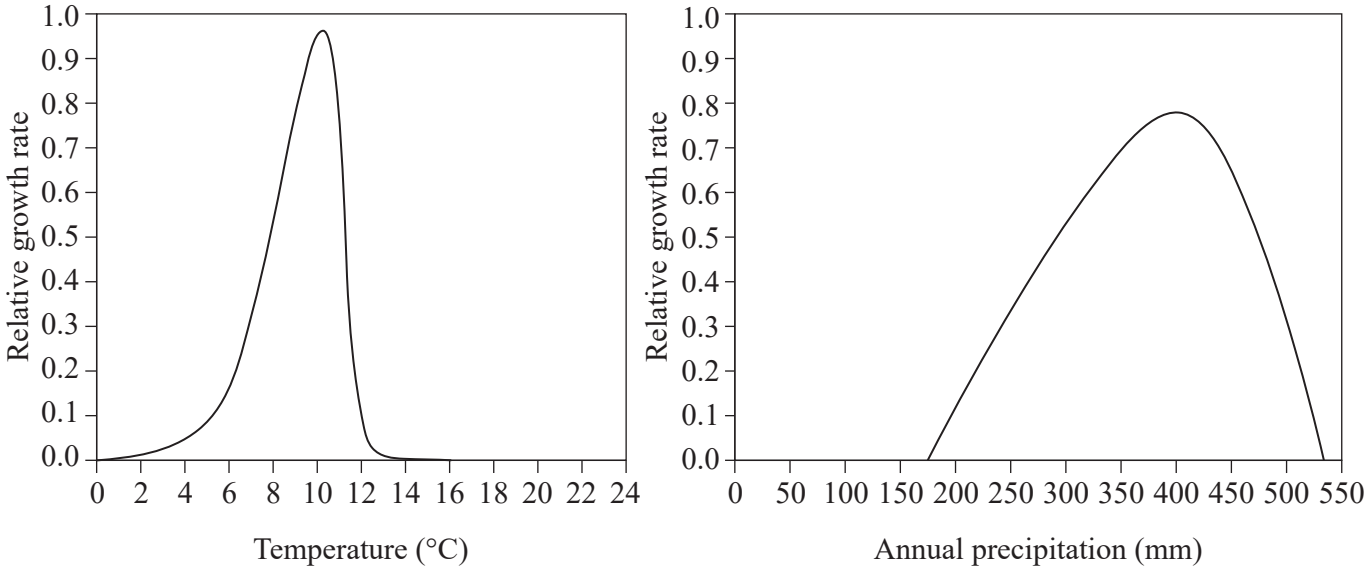
(B) non-disjunction

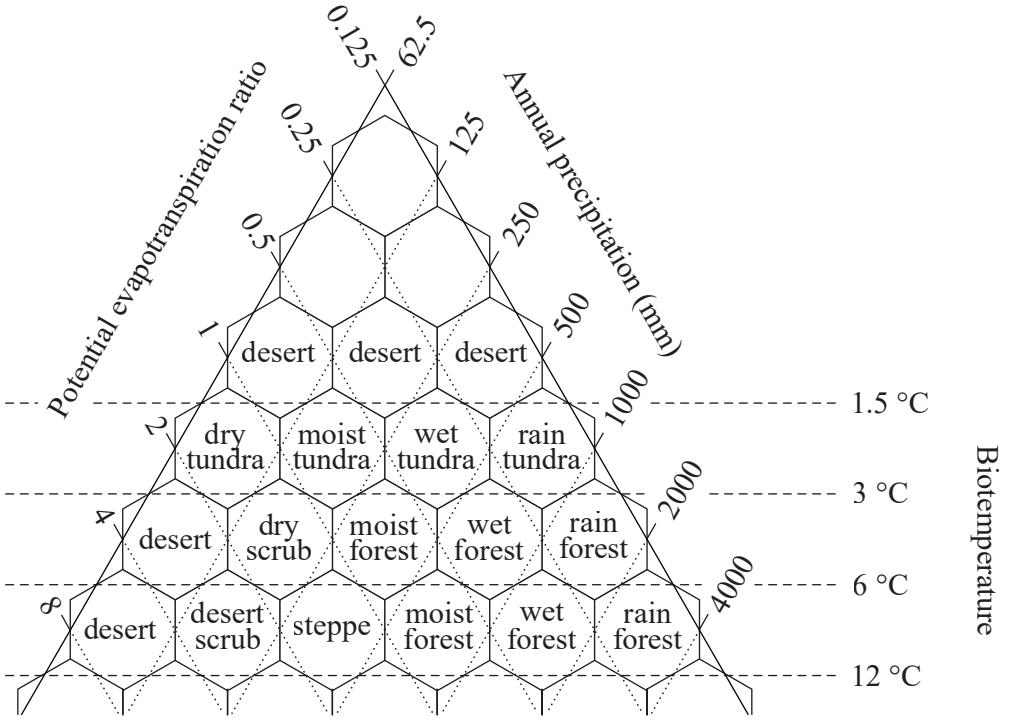
(C) random fertilisation

(D) independent assortment

QUESTION 7

Tolerance ranges for species X and a Holdridge life zone classification chart are shown.





Based on this data, the preferred habitat for species X is

(A) desert.

(B) steppe.

(C) wet tundra.

(D) moist forest.

QUESTION 8

In the Linnaean system of classification, two species of the same class will also belong to the same

(A) order.

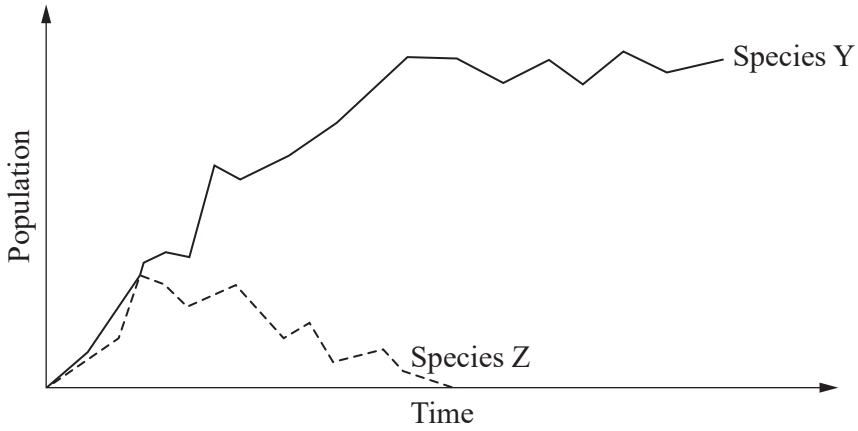
(B) genus.

(C) family.

(D) phylum.

QUESTION 9

The graph shows how populations of two species living in the same area changed over time.



Which species interaction is indicated?

(A) predation, where species Y preyed on species Z

(B) predation, where species Z preyed on species Y

(C) competition, where species Y outcompeted species Z

(D) competition, where species Z outcompeted species Y

QUESTION 10

A key function of histones is to

(A) add nucleotides to a growing DNA strand.

(B) bind to specific sections of DNA to initiate replication.

(C) allow DNA to tightly condense so it fits into the nucleus.

(D) join amino acids to form a polypeptide chain during translation.

QUESTION 11

Which mode of inheritance leads to continuous variation in the phenotypes of a population due to the cumulative effect of multiple genes?

(A) codominance

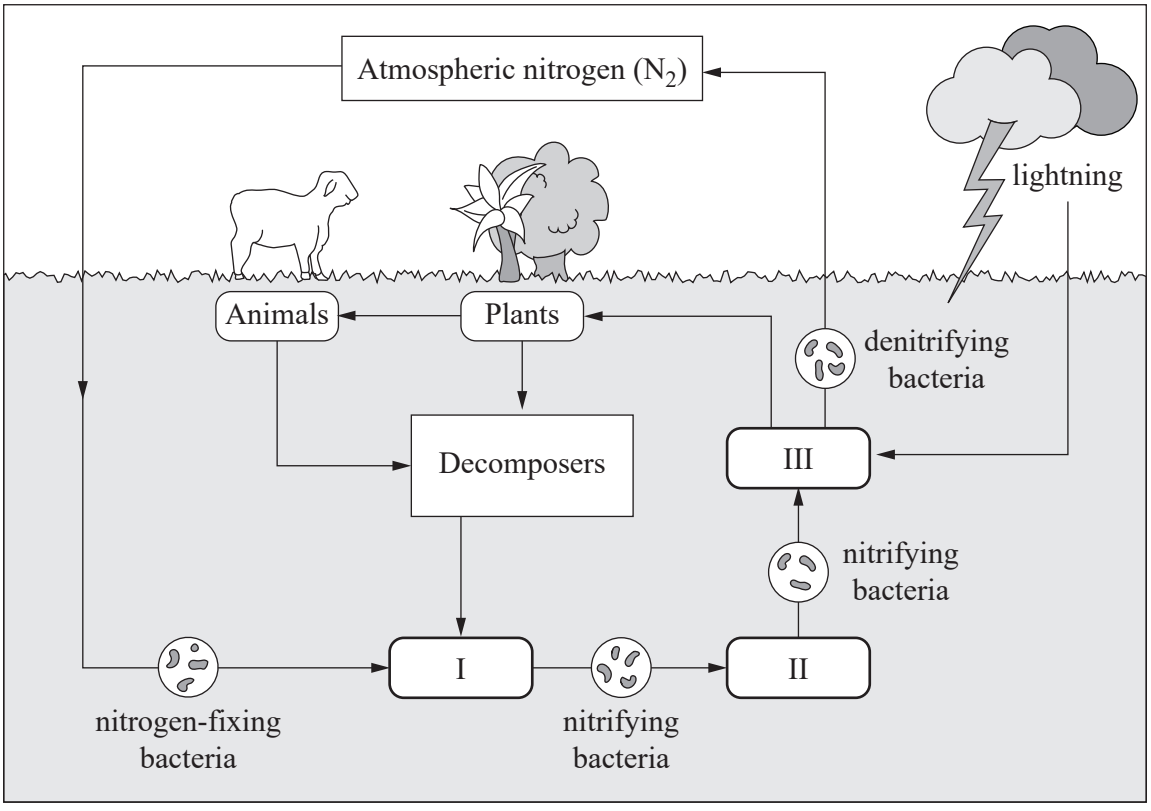
(B) polygenic inheritance

(C) incomplete dominance

(D) multiple allele inheritance

QUESTION 12

The diagram shows key processes in the nitrogen cycle.



Which option correctly identifies I, II and III?

	I	II	III
(A)	nitrites (NO_2^-)	nitrates (NO_3^-)	ammonium (NH_4^+)
(B)	nitrates (NO_3^-)	ammonium (NH_4^+)	nitrites (NO_2^-)
(C)	nitrites (NO_2^-)	ammonium (NH_4^+)	nitrates (NO_3^-)
(D)	ammonium (NH_4^+)	nitrites (NO_2^-)	nitrates (NO_3^-)

QUESTION 13

The role and space that an organism fills in an ecosystem is referred to as its

(A) niche.

(B) ecoregion.

(C) environment.

(D) microhabitat.

QUESTION 14

Compared to K-strategists, species classified as r-strategists tend to

(A) have more offspring.

(B) have longer lifespans.

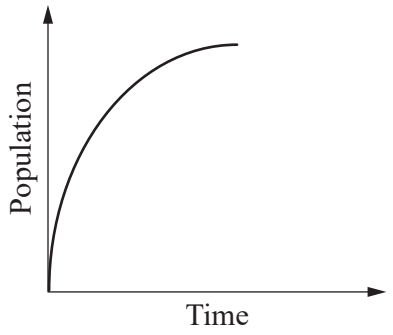
(C) reach sexual maturity later.

(D) live in more stable habitats.

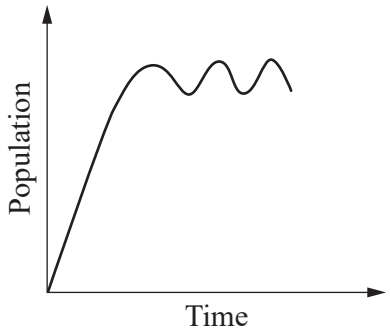
QUESTION 15

Which graph best illustrates exponential growth?

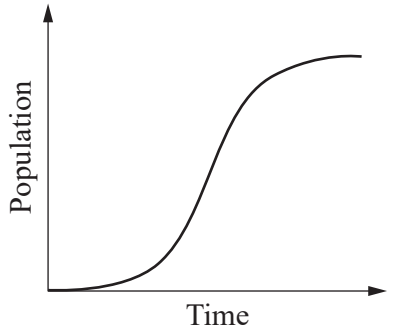
(A)



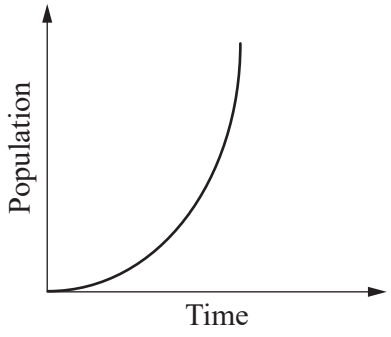
(B)



(C)

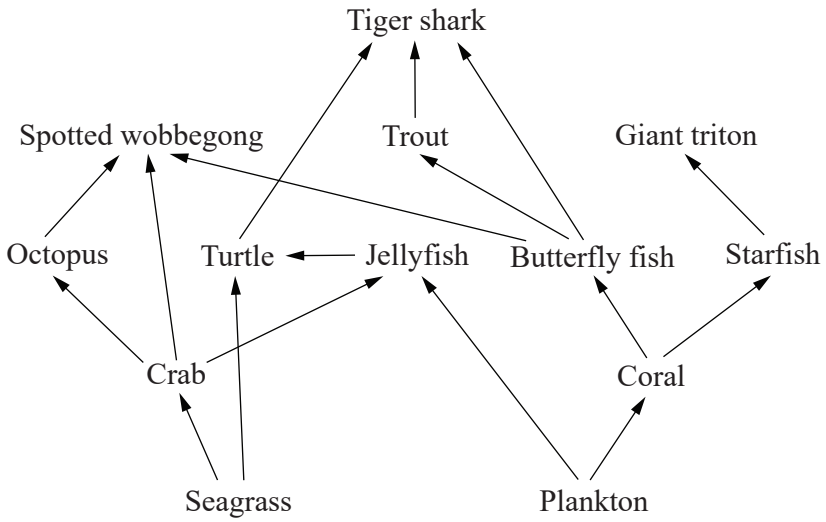


(D)



QUESTION 16

The diagram shows feeding relationships for an ecosystem where tiger sharks are a keystone species.



Which species is most likely to experience an increase in predation if tiger sharks are removed?

(A) trout

(B) starfish

(C) jellyfish

(D) spotted wobbegong

QUESTION 17

Which genetic tool is **not** required to make recombinant DNA?

(A) DNA ligase

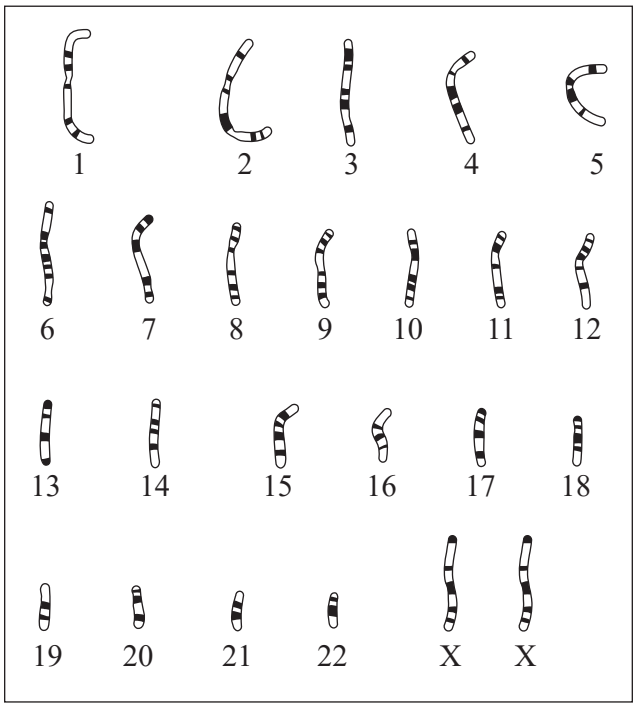
(B) plasmid vectors

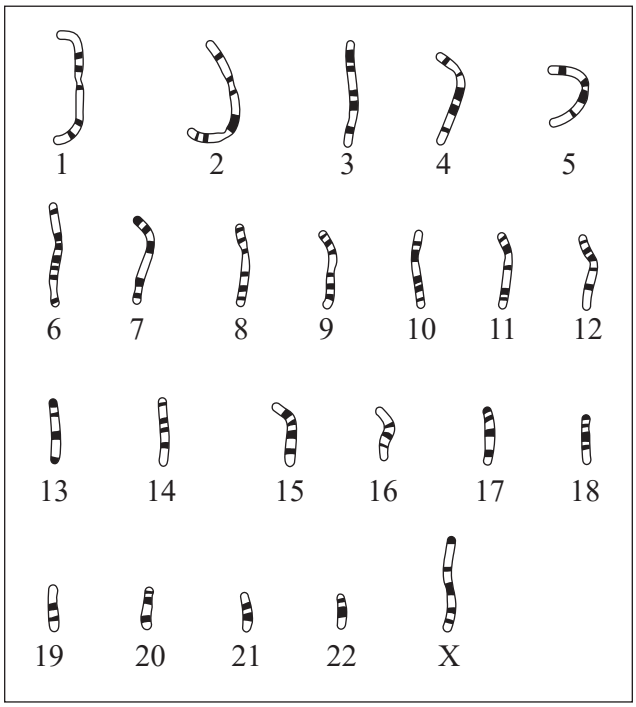
(C) restriction enzymes

(D) transcription factors

QUESTION 18

Karyotypes for two human gametes are shown.





If the two gametes produced a zygote, the resulting embryo would be

(A) male, with trisomy.

(B) female, with trisomy.

(C) male, with monosomy.

(D) female, with monosomy.

QUESTION 19

Which diversification pattern involves the independent development of similar structures in two species with no recent common ancestor?

(A) coevolution

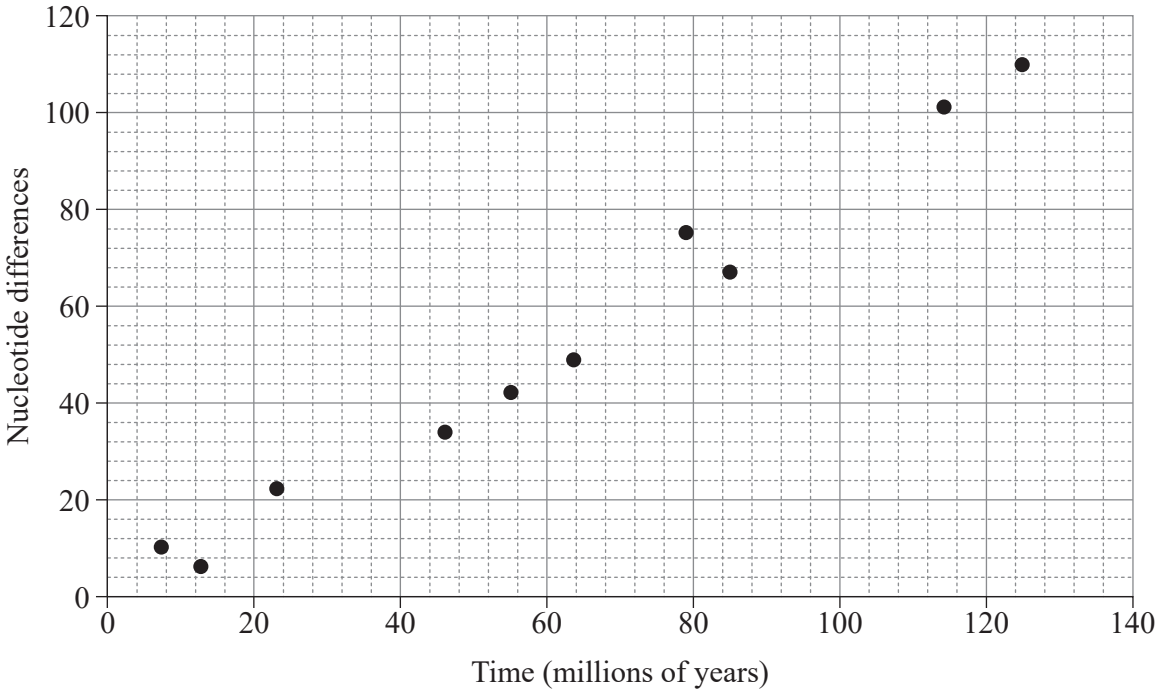
(B) parallel evolution

(C) divergent evolution

(D) convergent evolution

QUESTION 20

The graph shows the number of nucleotide differences observed in the cytochrome c gene of 10 species and their time since divergence.



Cytochrome c genes from two new species were compared and found to have 60 nucleotide differences.

Based on this information, the two species diverged approximately

(A) 48 million years ago.

(B) 60 million years ago.

(C) 72 million years ago.

(D) 120 million years ago.

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References

Question 7

Adapted from Halasz, P 2007, *Holdridge life zones*, https://en.wikipedia.org/wiki/File:Lifezones_Pengo.svg. Licensed CC BY-SA

Question 9

Thwink.org 2014, *Competitive exclusion principle*, www.thwink.org/sustain/glossary/CompetitiveExclusionPrinciple.htm

Question 12

Modified from *Nitrogen Cycle*,Wikimedia Commons 2019, Dreo, J, https://commons.wikimedia.org/wiki/File:Nitrogen_Cycle_2.svg. CC BY-SA 3.0

Question 16

Queensland Museum 2023*, Marine food web*, www.museum.qld.gov.au/learning-resources/learnings/marine-food-web

Question 20

Langley, CH, Fitch, WM 1974, 'An examination of the constancy of the rate of molecular evolution', *Journal of Molecular Evolution*, 3, 161–177, https://doi.org/10.1007/BF01797451

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Attach your barcode ID label here

Book of books used

External assessment 2024

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 (27 marks)

- 7 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 seven questions and is worth 27 marks.

QUESTION 21 (7 marks)

In 2014, a group of scientists surveyed a plant community and determined Simpson's diversity index (SDI) to be 0.84. They returned to the same site in 2024 and collected this data.

Species	Number of individuals
A	133
B	96
C	256

a) Calculate SDI in 2024 using the formula $SDI = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$. Show your working. *[2 marks]*

Do not write outside this box.

b) The scientists noted that species richness was the same in 2024 and 2014.
Infer how species evenness changed over the 10-year period. Justify your response. *[2 marks]*

c) Describe how sampling could be used to collect data for this investigation.
Include at least two strategies to minimise bias. *[3 marks]*

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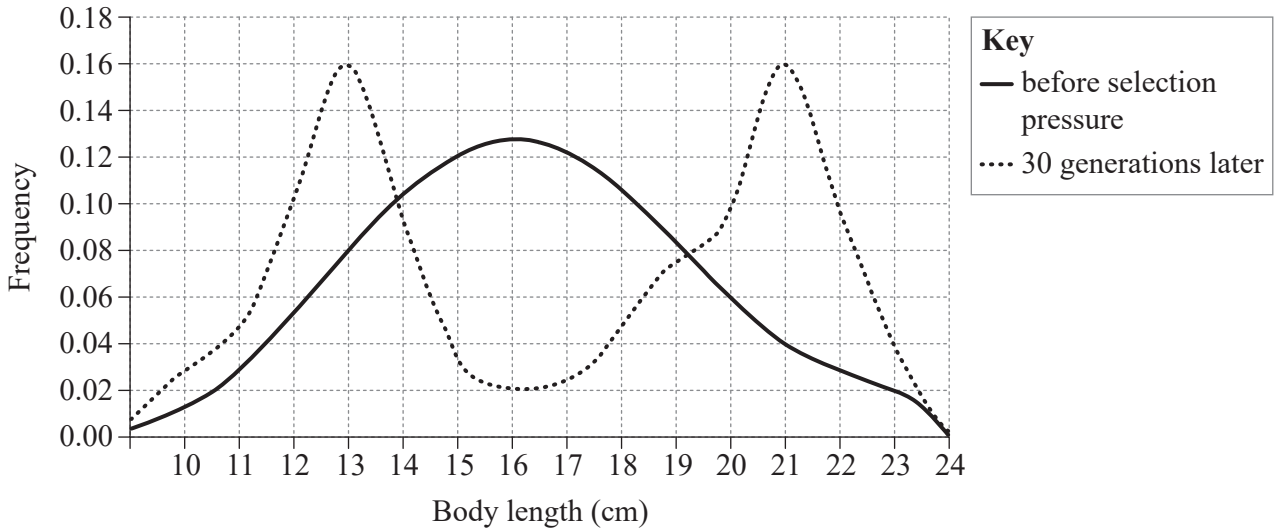
QUESTION 22 (4 marks)

The graph shows the effect of a selection pressure on the body length of a fish population.



a) Determine which type of phenotypic selection has occurred. *[1 mark]*

b) Use the principles of natural selection to explain the observed trends. *[3 marks]*

Do not write outside this box.

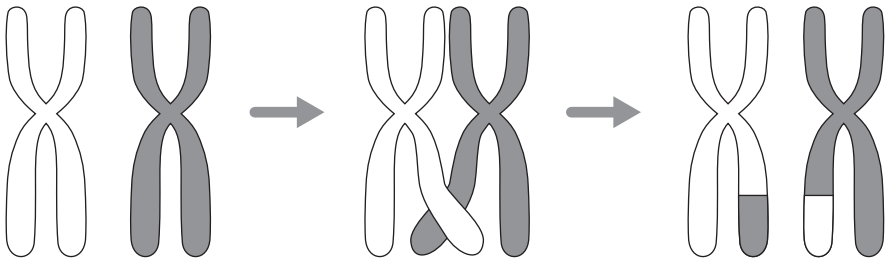
QUESTION 23 (3 marks)

In rabbits, black fur is dominant to white fur. A male that is heterozygous for black fur is crossed with a female with white fur, producing 12 offspring.

Predict the number of offspring with white fur. Justify your response using a Punnett square.

QUESTION 24 (3 marks)

The diagram shows a process that occurs during meiosis.



a) Identify the process. *[1 mark]*

b) Explain how this process contributes to genetic variation in the genotypes of offspring. *[2 marks]*

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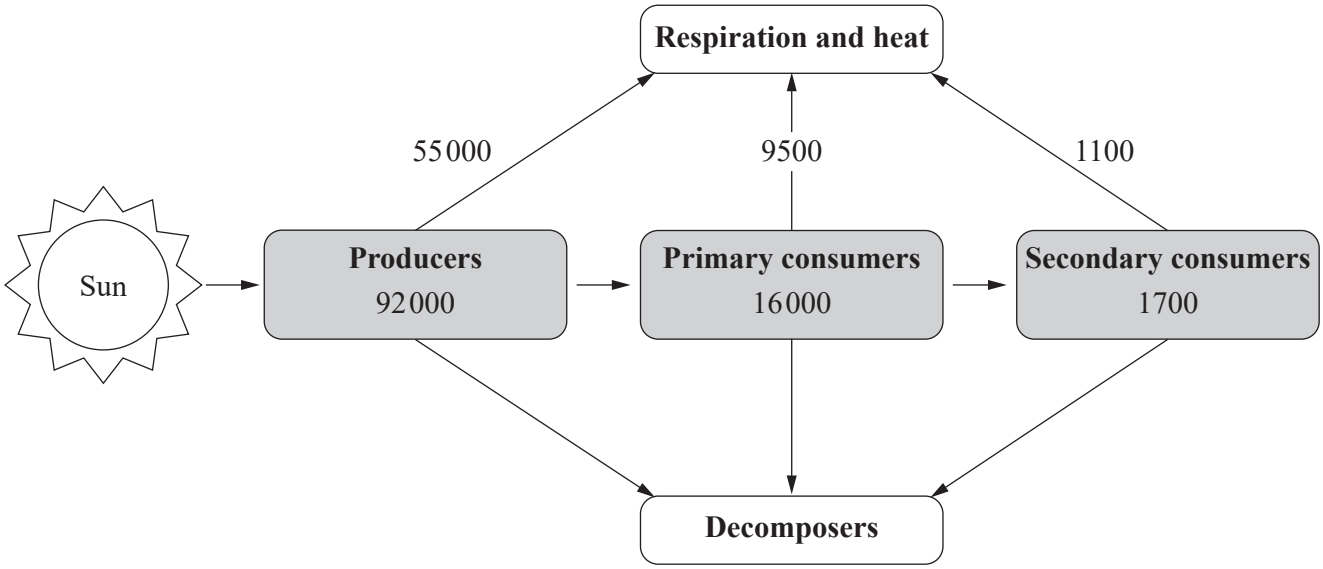
QUESTION 25 (2 marks)

Describe what is meant by an *interspecific hybrid*, using an example.

QUESTION 26 (6 marks)

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



a) Calculate the efficiency of energy transfer between primary and secondary consumers. Show your working. *[2 marks]*

Do not write outside this box.

b) Determine the amount of energy lost to decomposers at the producer level.
Show your working. *[2 marks]*

c) Describe two ways energy is transformed in this ecosystem. *[2 marks]*

Do not write outside this box.

QUESTION 27 (2 marks)

To determine the reliability of the capture–recapture technique and the Lincoln index $N = \frac{M \times n}{m}$, two researchers collected data on a mouse population from the same site at the same time.

Researcher	Number of mice in first capture	Number of mice in second capture	Number of marked mice in second capture
I	160	140	80
II	100	60	?

If the reliability of the technique is high, how many marked mice would be expected in the second capture for researcher II? Show your working.

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Write the question number you are responding to.

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References

Question 24

BioNinja 2023, *Forming Recombinant Chromosomes via Crossing Over*, https://old-ib.bioninja.com.au/higher-level/topic-10-genetics-and-evolu/101-meiosis/crossing-over.html

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School name

Given name/s

Family name

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Book of books used

External assessment 2024

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 (50 marks)

- 11 short response questions

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Section 1

Instructions

- 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.

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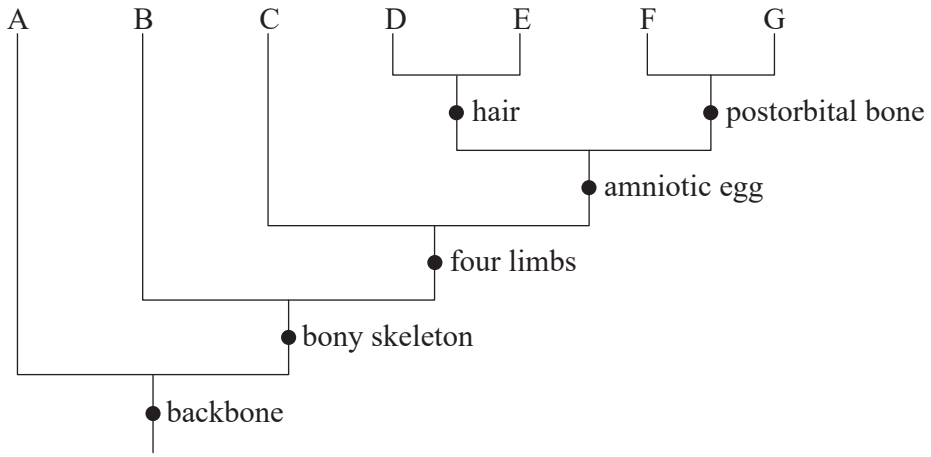
QUESTION 1 (3 marks)

This cladogram shows the development of key features in species A to G.



a) Identify the most distant relative of species C. *[1 mark]*

b) List all the features you would expect to observe in the most recent common ancestor of species C and F. *[1 mark]*

c) Identify the features that could be used to distinguish between species C and D. *[1 mark]*

Do not write outside this box.

QUESTION 2 (3 marks)

a) Define *carrying capacity*. *[1 mark]*

b) Identify two factors that affect the carrying capacity of plant species in an ecosystem. *[2 marks]*

QUESTION 3 (2 marks)

The table shows data for a population in 2023.

Starting population	Births	Deaths	Immigration	Emigration
4000	835	324	34	65

Calculate the population growth rate. Show your working.

Do not write outside this box.

QUESTION 4 (6 marks)

a) Describe the roles of helicase and DNA polymerase in DNA replication. *[2 marks]*

b) Explain two ways the structure of DNA allows helicase and DNA polymerase to carry out their roles. *[2 marks]*

c) Explain how errors during DNA replication can lead to point and frameshift mutations. *[2 marks]*

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QUESTION 5 (3 marks)

a) Describe a *population bottleneck.* *[1 mark]*

b) Explain why populations affected by bottlenecks face increased risk of extinction. *[2 marks]*

Do not write outside this box.

QUESTION 6 (4 marks)

Sickle-cell anaemia is an autosomal recessive condition that reduces the ability of red blood cells to carry oxygen. This is usually considered detrimental; however, individuals who are heterozygous for the trait may be less prone to the infectious disease malaria.

These maps show the distribution of malaria and frequency of the sickle-cell anaemia allele in Africa.

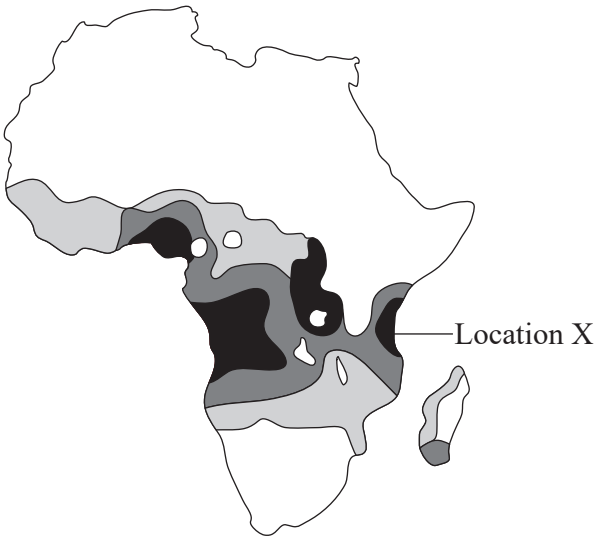
Not to scale

Malaria distribution

Key

Malaria present Malaria not present

Frequency of sickle-cell anaemia allele



Key

>20% >10–20% 1–10% <1%

This table shows the genotypes of individuals living at location X.

Genotype	Number of individuals
AA	830
Aa	540
aa	23

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a) Calculate the frequency of the recessive allele, a, in the population at location X. Show your working. *[2 marks]*

b) Identify evidence for the sickle-cell anaemia allele being advantageous for individuals living where malaria is prevalent. Explain your reasoning. *[2 marks]*

Do not write outside this box.

QUESTION 7 (4 marks)

a) Explain how habitat fragmentation can lead to speciation. *[3 marks]*

b) Identify the type of speciation that occurs due to habitat fragmentation. *[1 mark]*

Do not write outside this box.

QUESTION 8 (6 marks)

The table shows data from a transect study along a sand dune.

	Zone			
	A	**B**	**C**	**D**
Distance from sea (m)	0–100	>100–150	>150–250	>250–300
Age of dune (years)	0–50	>50–100	>100–125	>125–150
pH of soil	8.4	7.4	6.9	6.0
Organic matter in soil (%)	1	2.5	5	30
Number of grass species	2	4	6	2
Number of tree species	0	1	3	8

a) Contrast species richness in zones A and D. Refer to data in your response. *[2 marks]*

b) Infer how organic matter affects the pH of soil. Justify your response. *[2 marks]*

c) Predict which zone would have the highest proportion of K-selected species. Explain your reasoning. *[2 marks]*

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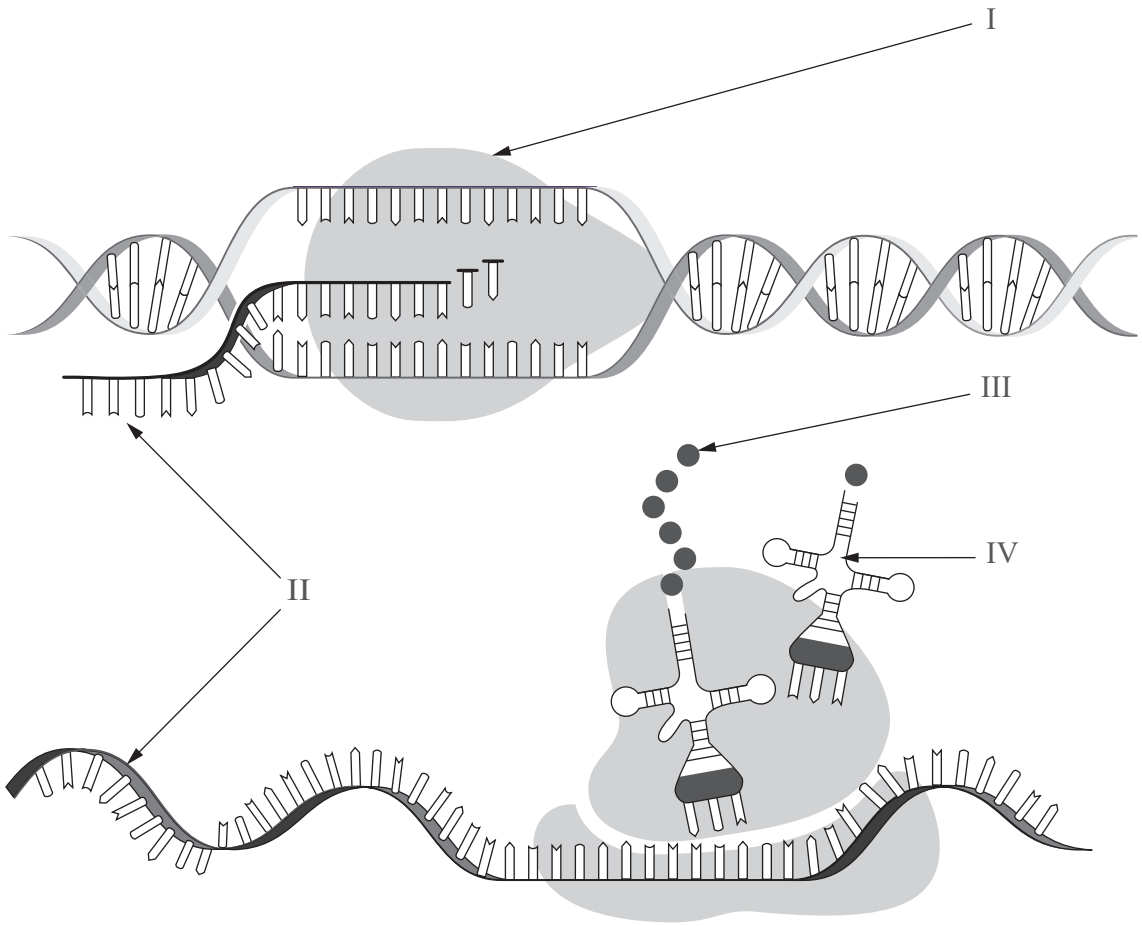
QUESTION 9 (10 marks)

The diagram shows key stages of gene expression.



a) Identify structures I, II and III. *[3 marks]*

I: _____

II: _____

III: _____

b) Describe the role of structure IV and explain how it carries out this function. *[3 marks]*

_____

_____

_____

_____

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c) Describe two ways gene expression is regulated. *[2 marks]*

d) Explain two reasons why genetic mutations do not always affect the phenotype of an individual. *[2 marks]*

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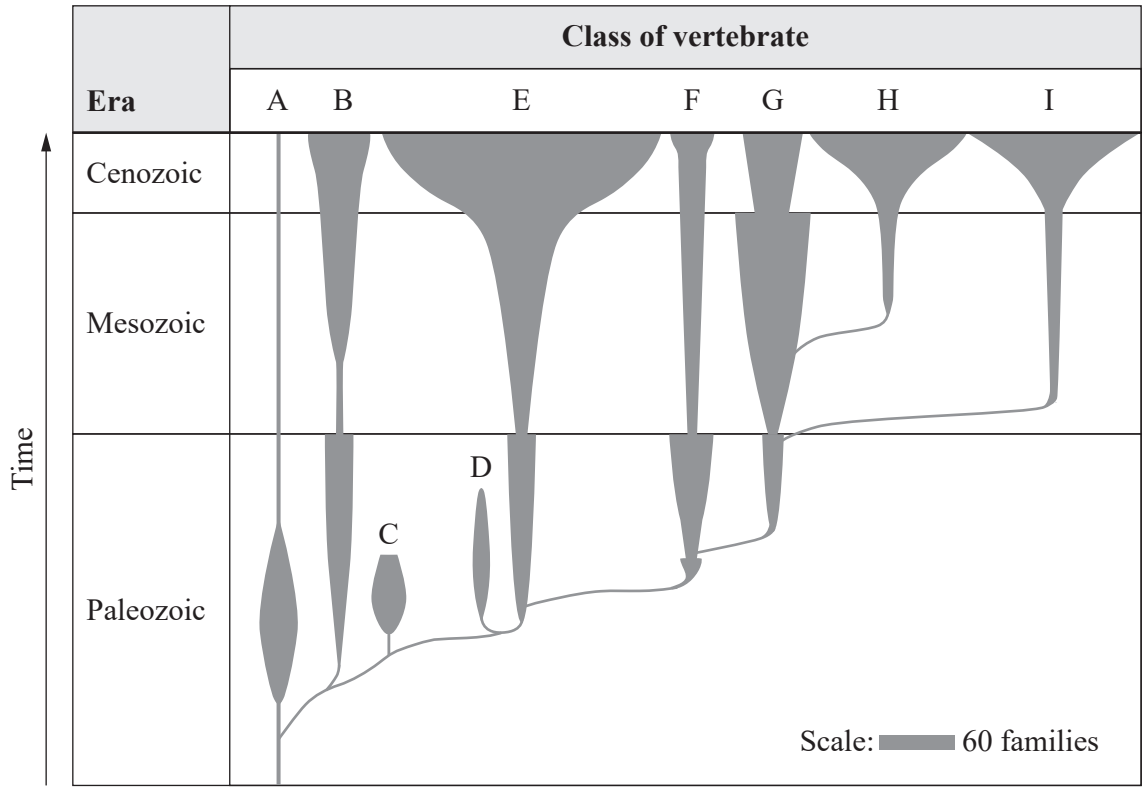
QUESTION 10 (5 marks)

The chart shows the number of families in nine classes of vertebrate (A to I) over geological time.



a) Identify a trend in vertebrate biodiversity over time. Refer to data to support your response. *[2 marks]*

Do not write outside this box.

b) Identify which classes became extinct during this time and the era/s in which the extinctions occurred. *[2 marks]*

c) Which class had family extinctions at the boundary of the Mesozoic and Cenozoic eras? *[1 mark]*

QUESTION 11 (4 marks)

a) Describe the process of ecological succession. *[3 marks]*

b) Distinguish between primary and secondary succession. *[1 mark]*

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References

Question 1

Modified from StackExchange 2017, 'Example of impossibility in the nested heirarchy?', *Biology*, https://biology.stackexchange.com/questions/65364/example-of-impossibility-in-the-nested-hierarchy. CC BY-SA 3.0

Question 6

Adapted from Allison, A 2009, *Malaria_versus_sickle-cell_trait_distributions*, https://en.m.wikipedia.org/wiki/File:Malaria_versus_sickle-cell_trait_distributions.png. Public Domain

Question 8

Adapted from JAGS Geography South Wales 2013, *Idealised sand dune*, https://jagssouthwales2013.files.wordpress.com/2013/03/idealised-sand-dune.png

Question 9

Adapted from National Human Genome Research Institute 2022, *MRNA-interaction*, Wikimedia Commons, available at https://commons.wikimedia.org/wiki/File:MRNA-interaction.svg#globalusage. Public Domain

Question 10

Adapted from Bøckman, P 2011, *Spindle Diagram*, https://commons.wikimedia.org/wiki/File:Spindle_diagram.jpg. Public Domain