External assessment 2023

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

The biological species concept defines *species* as a group of organisms

(A) with a common set of alleles.

(B) descended from a common ancestor.

(C) occupying the same niche or adaptive zone.

(D) that can interbreed to produce fertile offspring.

QUESTION 2

Species classified as K-strategists

(A) often live in unstable habitats.

(B) exhibit an exponential rate of reproduction.

(C) reach sexual maturity later than r-strategists.

(D) are first to colonise a new environment created by a disturbance.

QUESTION 3

The table provides population data for a species of fairy-wren.

Year	Population on 1st January	Births	Deaths	Immigration	Emigration
2022	15 200	7600	4310	790	24

The population growth rate in 2022 was closest to

(A) 17%

(B) 27%

(C) 55%

(D) 73%

QUESTION 4

Populations with reduced genetic diversity face an increased risk of extinction because they

(A) have fewer chromosomes.

(B) have difficulty finding mates for reproduction.

(C) are less likely to adapt to changing environments.

(D) contain a larger proportion of heterozygous individuals.

QUESTION 5

Which statement is true for DNA replication?

(A) Adenine pairs with guanine.

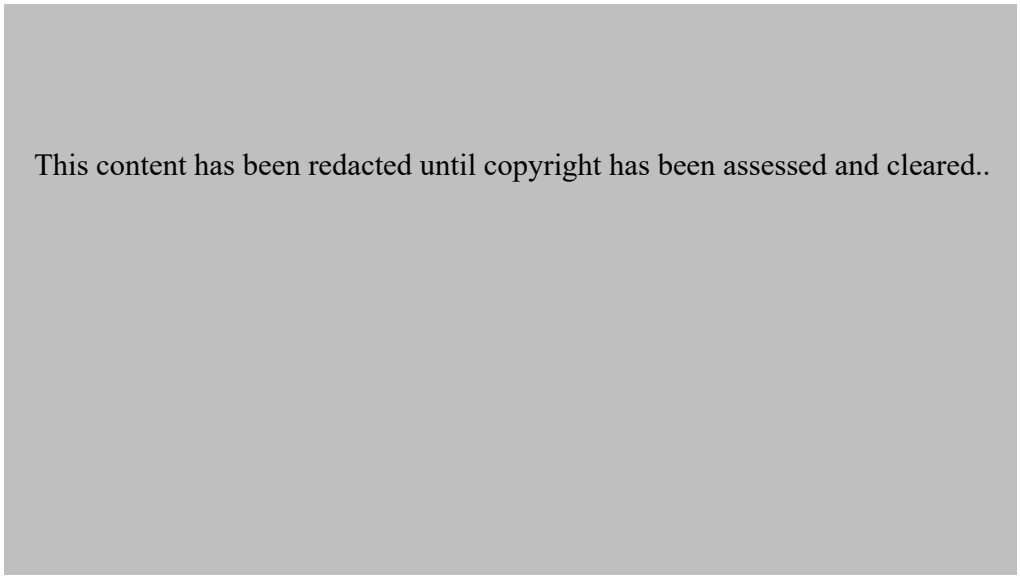
(B) The process occurs during metaphase I.

(C) DNA polymerase unwinds the double helix.

(D) New strands are synthesised in the 5′ to 3′ direction.

QUESTION 6

The phylogenetic tree shows evolutionary relationships between seven species of Himalayan songbird and the elevations they inhabit.



The data shows that

(A) the most closely related species occupy different elevations.

(B) the most closely related species diverged 14 million years ago.

(C) species at low elevation are more closely related than species at high elevation.

(D) species at middle elevation are less closely related than species at other elevations.

QUESTION 7

The distributions of phenotypes before and after a selection pressure acted on a population are shown.

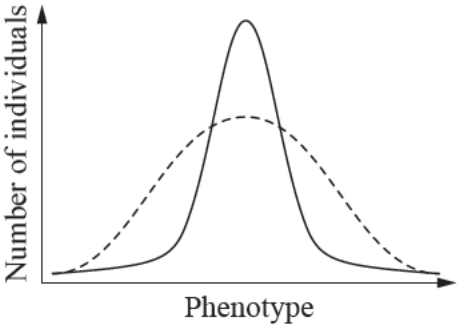
Which graph shows disruptive selection?

Key

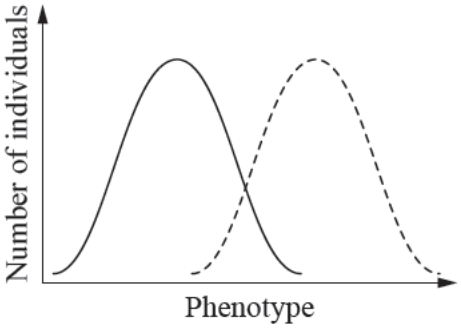
------- Before selection pressure

——— 25 generations later

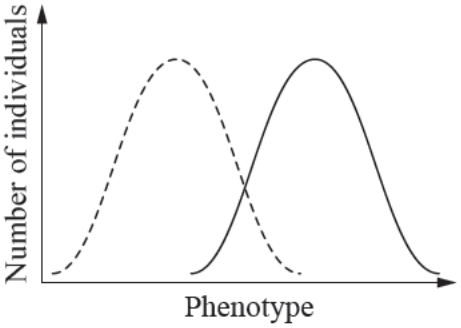
(A)



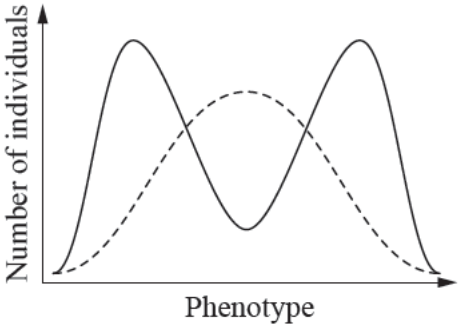
(B)



(C)

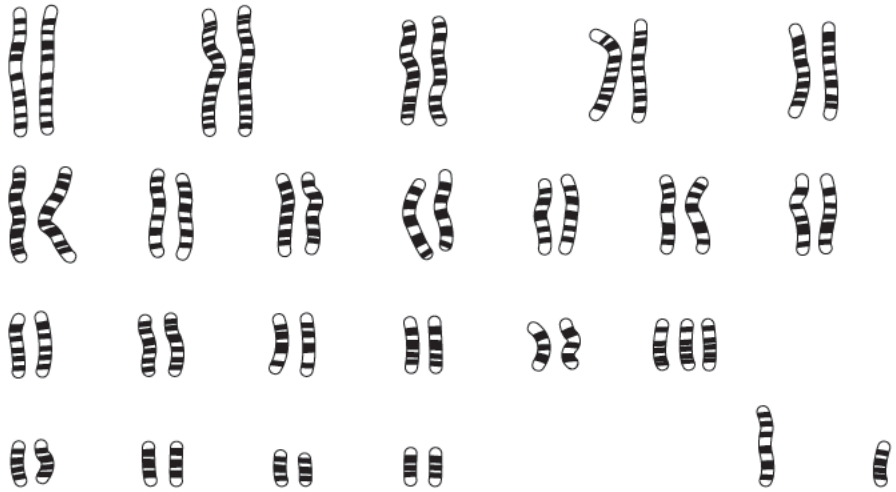


(D)



QUESTION 8

The diagram shows a human karyotype and a list of genetic conditions.



Genetic condition	Common name
Monosomy X	Turner syndrome
Monosomy 5	Cri du chat syndrome
Trisomy 18	Edwards syndrome
Trisomy 21	Down syndrome

Which genetic condition is indicated in the karyotype?

(A) Turner syndrome

(B) Cri du chat syndrome

(C) Edwards syndrome

(D) Down syndrome

QUESTION 9

An *ecological niche* refers to

(A) a group of organisms competing for the same resources.

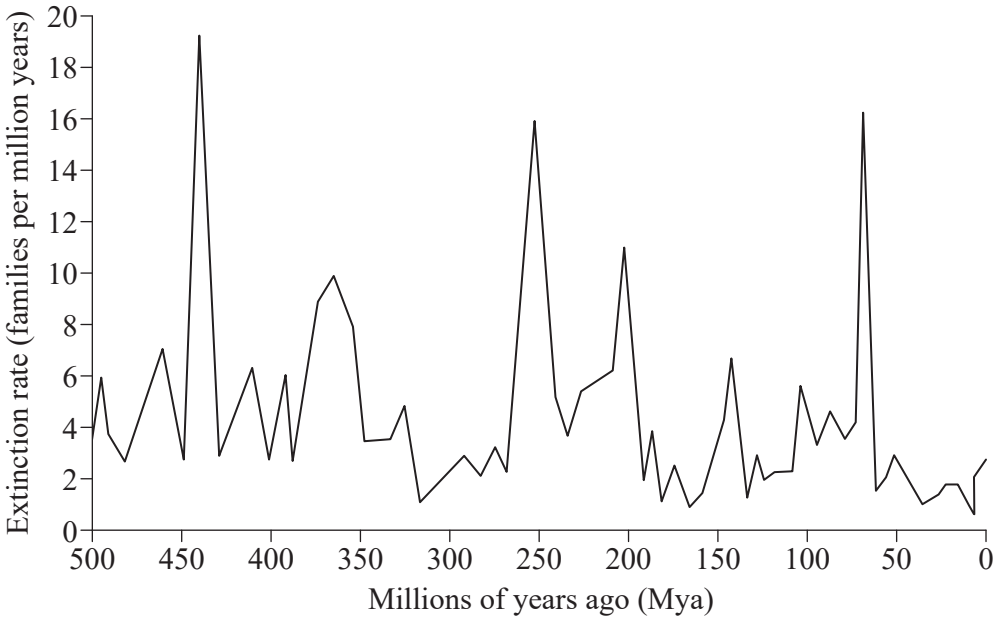
(B) the role and space that an organism fills in an ecosystem.

(C) all organisms occupying a physical space close enough to interact with each other.

(D) the largest population of a particular species that can be supported by an ecosystem.

QUESTION 10

The graph shows extinction rates over time.



How many times in the past 500 million years has the extinction rate exceeded 14 families per million years?

(A) 3

(B) 4

(C) 5

(D) 6

QUESTION 11

Restriction enzymes

(A) join DNA into a single strand.

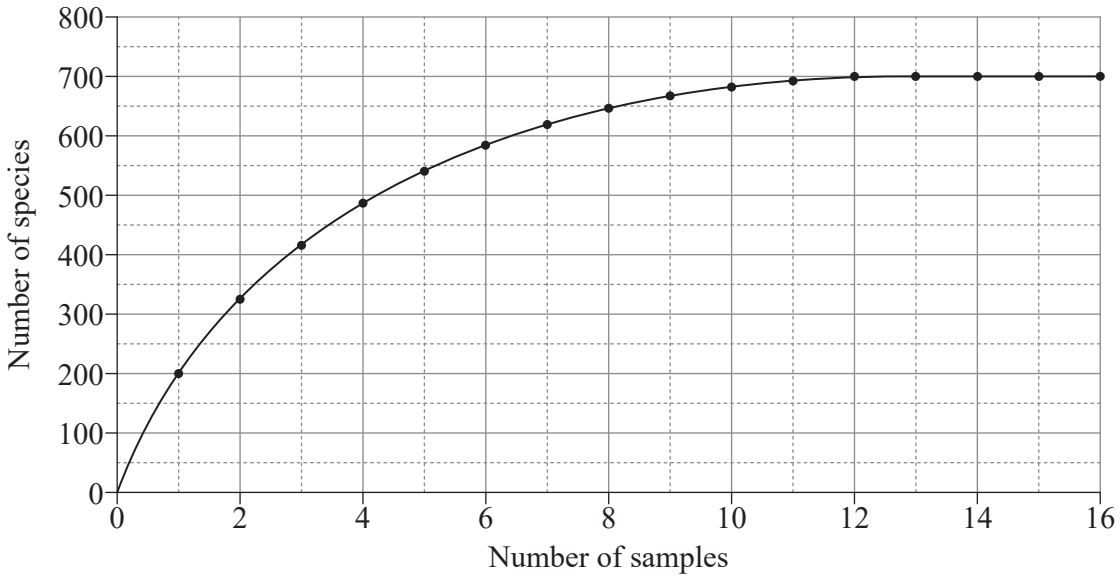
(B) cut DNA at specific locations.

(C) add nucleotides to a growing DNA strand.

(D) assist in the amplification of recombinant DNA.

QUESTION 12

The graph shows the results of a study on the species richness of gut microbes. The data represents the cumulative number of species observed as the number of samples increased.



Based on this data, the minimum number of samples required to obtain valid species richness data is

(A) 2

(B) 6

(C) 12

(D) 16

QUESTION 13

Which option best describes the conditions for parapatric speciation?

(A) Geographical barriers limit gene flow between populations.

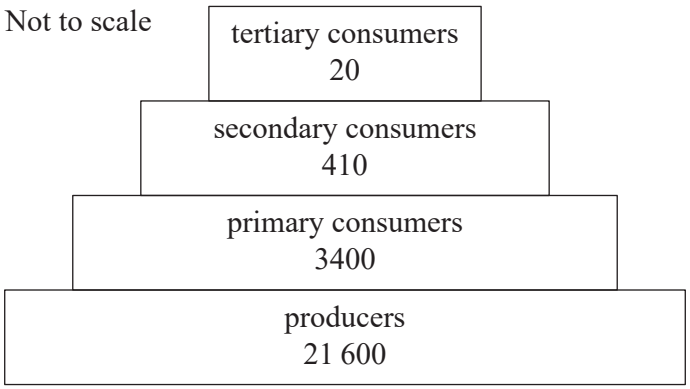
(B) Gene flow is interrupted in populations occupying the same habitat.

(C) A species occupies such a large geographical area that mate selection is influenced by proximity.

(D) A small group of organisms becomes separated from their parent population by physical barriers.

QUESTION 14

An energy pyramid for an aquatic ecosystem is shown (values are in kJ m^{-2} y^{-1}).



Transfer efficiency between producers and primary consumers is closest to

(A) 5%

(B) 10%

(C) 12%

(D) 16%

QUESTION 15

Allele frequencies are most likely to stay constant in

(A) large populations with low levels of migration.

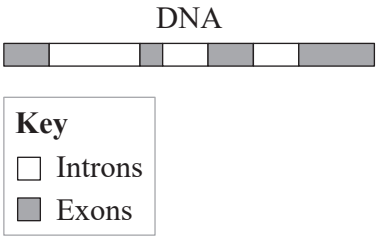
(B) small populations with low levels of migration.

(C) large populations with high levels of migration.

(D) small populations with high levels of migration.

QUESTION 16

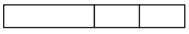
The diagram shows a section of DNA.



Immediately following transcription and RNA splicing, the product would most closely resemble

(A) mRNA:

(B) tRNA: 

(C) mRNA: 

(D) tRNA: 

QUESTION 17

What is the most likely outcome of a homeobox (HOX) gene mutation?

(A) slower growth rate

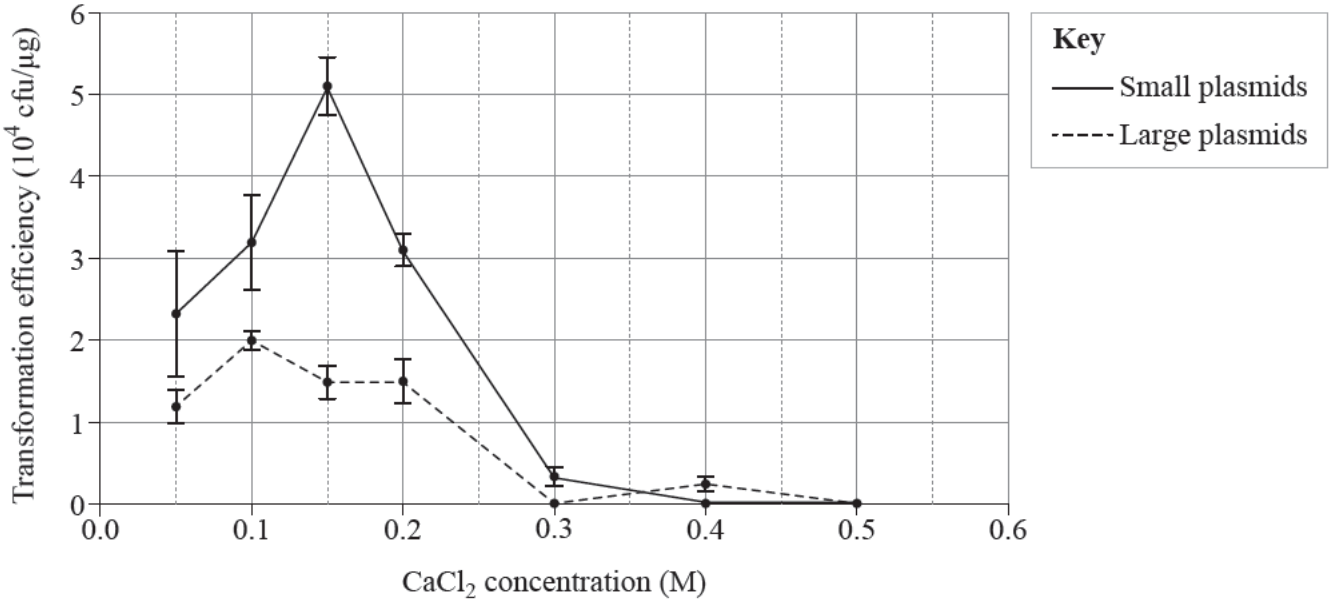
(B) body appendages in the incorrect location

(C) failure of sex characteristics to fully develop

(D) impaired ability of red blood cells to carry oxygen

QUESTION 18

Calcium chloride ($CaCl_2$) is a chemical used in bacterial transformation. An experiment was conducted to determine how the concentration of calcium chloride affects the transformation efficiency of large and small plasmids. Error bars show standard error.



The data suggests that

(A) the optimal concentration for transforming small plasmids is 0.15 M.

(B) transformation efficiency is highest at concentrations greater than 0.1 M.

(C) large plasmids have higher transformation efficiency than small plasmids.

(D) there is less variation in transformation efficiency of small plasmids when concentration is less than 0.2 M.

QUESTION 19

Electrophoresis separates DNA fragments based on

(A) size, with larger fragments travelling further through the gel.

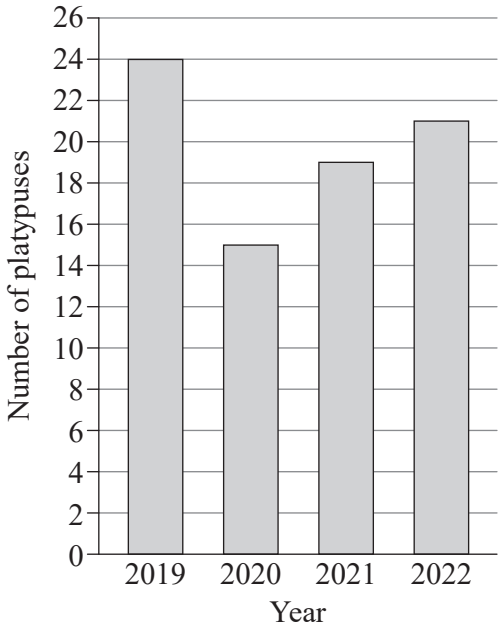
(B) size, with smaller fragments travelling further through the gel.

(C) charge, with more positively charged fragments travelling further through the gel.

(D) charge, with more negatively charged fragments travelling further through the gel.

QUESTION 20

The capture–recapture method and Lincoln index ($N = \frac{M \times n}{m}$) were used to monitor a population of platypuses over a four-year period. Experimental findings are shown.



The table shows data from one year of the study.

Number of individuals captured and marked in first sampling	20
Number of individuals captured in second sampling	18
Number of recaptured individuals marked	17

When was the data in the table collected?

(A) 2019

(B) 2020

(C) 2021

(D) 2022

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References

Question 6

Adapted from Mooers, A 2014, Figure 1: *Himalayan songbird assemblage*, 'Supply and demand', Nature, issue 509, pp. 171-172, https://www.nature.com/articles/nature13332.

Question 10

Adapted from Ritchie, H, Roser, M 2021, '*Big Five*' *Mass Extinctions in Earth's History*, 'Biodiversity', OurWorldinData, https://ourworldindata.org/extinctions

Question 18

Adapted from 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'; J*ournal of Experimental Microbiology and Immunology (JEMI)*, https://jemi.microbiology.ubc.ca/sites/default/files/Lim%20et%20al.pdf

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Book of books used

External assessment 2023

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 (26 marks)

- 7 short response questions

Clear zone — margin trimmed off after completion of assessment

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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 26 marks.

QUESTION 21 (4 marks)

The diagram represents a section of DNA.

Identify the DNA components indicated by labels 1–4.

1. _____

2. _____

3. _____

4. _____

Do not write outside this box.

QUESTION 22 (2 marks)

Describe two ways bacteria assist matter to cycle through ecosystems.

QUESTION 23 (3 marks)

Mistletoe is the common name for plants that have a close and long-term interaction with a host tree. In Australia, mistletoe frequently live on eucalyptus trees, penetrating the bark with their modified root systems to access water and nutrients from the xylem. This can restrict nutrient flow in the host tree and may cause parts of its branches to die.

a) Identify the species interaction demonstrated in this scenario. *[1 mark]*

b) Explain how this relationship differs from predation. *[2 marks]*

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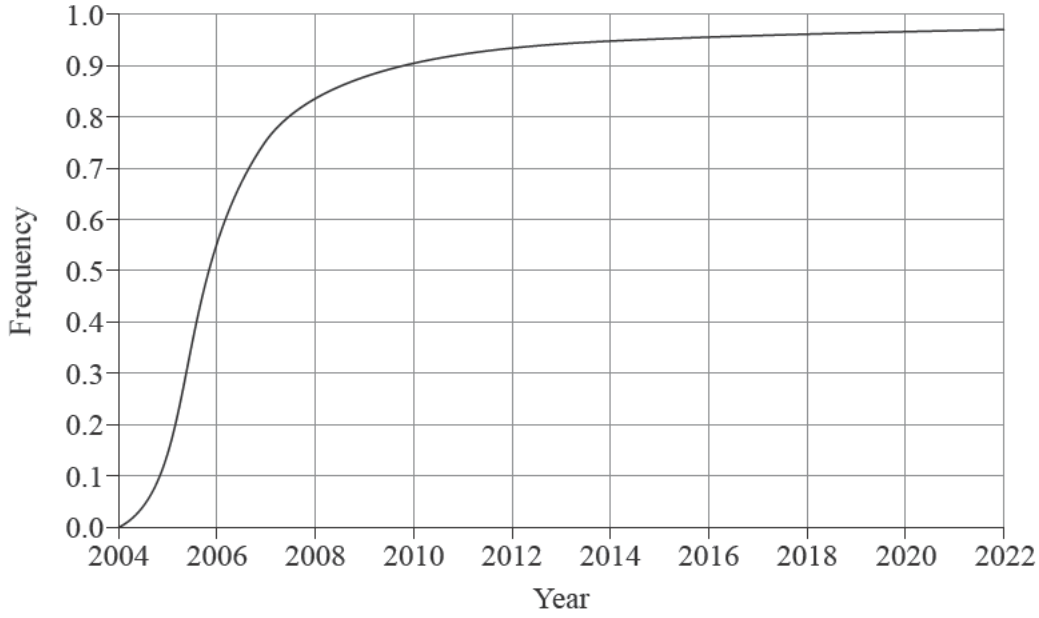
QUESTION 24 (5 marks)

The frequency of a new allele was monitored in a population of insects over an 18-year period.



a) Infer if the new allele is advantageous or detrimental in this environment. Justify your response using evidence from the graph. *[2 marks]*

Do not write outside this box.

b) Explain how mutations can contribute to microevolutionary change in populations that reproduce sexually. *[3 marks]*

Do not write outside this box.

QUESTION 25 (6 marks)

The effect of an invasive species on plant biodiversity was investigated by collecting this data from an ecosystem.

		Percentage cover (invasive species)				
		0–20%	**>20–40%**	**>40–60%**	**>60–80%**	**>80–100%**
Plant biodiversity	**Species richness**	7	7	7	4	2
	Simpson's diversity index	0.83	0.77	0.55	0.49	0.30

a) Contrast species richness in areas of low invasive species cover (0–20%) with areas of high invasive species cover (>80–100%). *[1 mark]*

b) Draw a conclusion about the effect of the invasive species on plant biodiversity in this ecosystem. Justify your response. *[2 marks]*

Do not write outside this box.

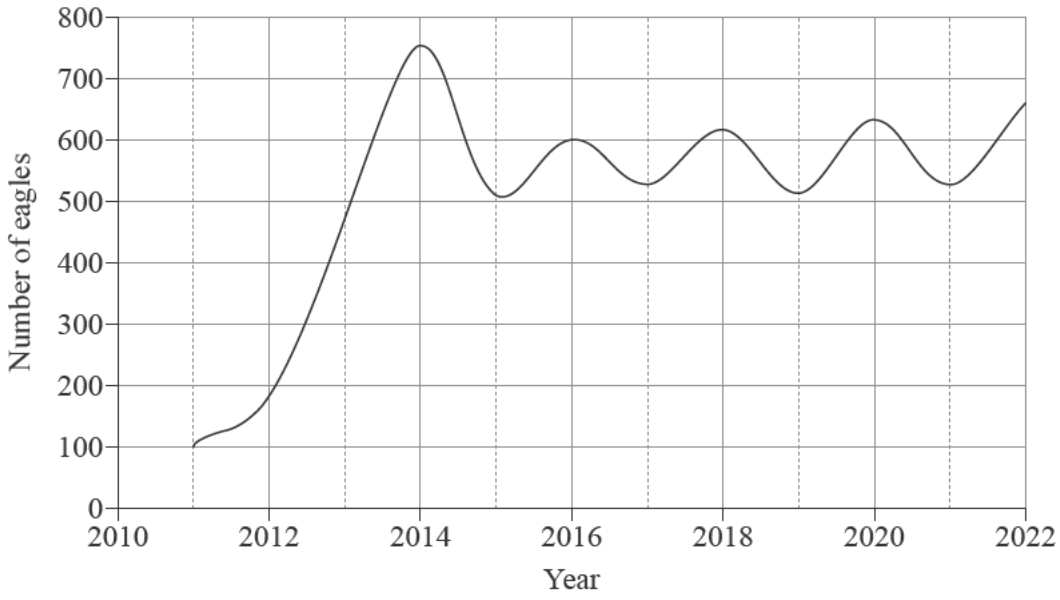
c) Explain why having data on species richness and Simpson's diversity index is more informative than a single measure for the purpose of this investigation. Refer to the table to support your response. *[3 marks]*

Do not write outside this box.

QUESTION 26 (3 marks)

Wedge-tailed eagles are large birds that reside in tall trees, where they build nests for their young. They often feed on ground-dwelling herbivores such as kangaroos and rabbits.

The graph shows the number of wedge-tailed eagles observed in an ecosystem over time.



a) Determine the carrying capacity of wedge-tailed eagles in this ecosystem. *[1 mark]*

b) Explain how a change to one abiotic factor could reduce the carrying capacity. *[2 marks]*

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QUESTION 27 (3 marks)

Clownfish have 24 pairs of chromosomes and reproduce via external fertilisation, with gametes initially created through meiosis. Females lay up to 1500 eggs and then males swim over the eggs and fertilise them.

Explain how the processes of independent assortment and random fertilisation create variation in the genotypes of clownfish offspring.

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ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

Do not write outside this box.

ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

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ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

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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 21

Derived from Clark, MA, Cho, J & Douglas, M 2018, *Biology 2e* (iBooks), OpenStax, Rice University, Houston, https://openstax.org/details/books/biology-2e?Book%20details.

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Book of books used

External assessment 2023

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 (43 marks)

- 9 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.
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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.

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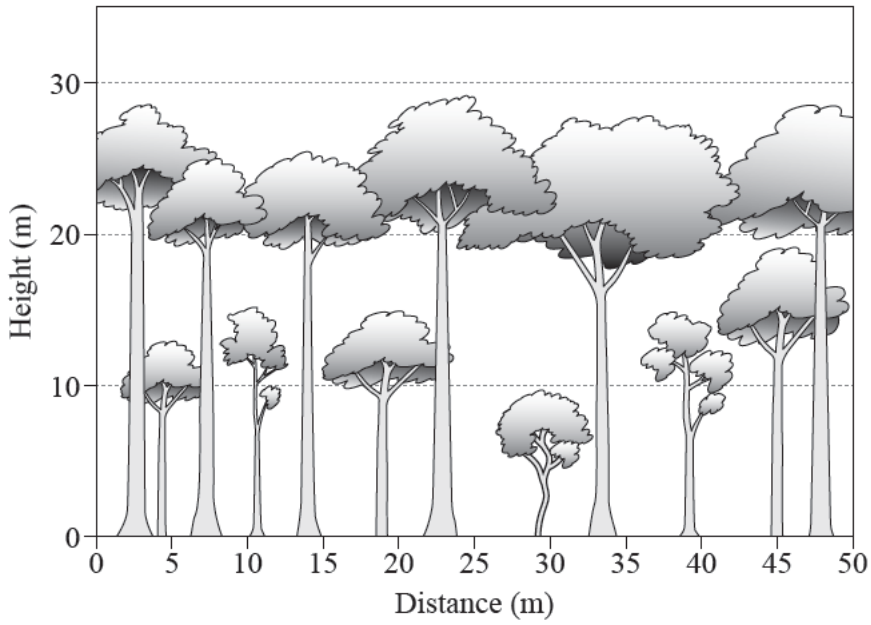
QUESTION 1 (6 marks)

The profile diagram shows a representative section of an ecosystem.



This table can be used to classify ecosystems based on Specht's classification system.

	Foliage cover of tallest plant layer		
Life form and height of tallest stratum	**Dense (70–100%)**	**Mid-dense (30–70%)**	**Sparse (10–30%)**
Trees >30 m	Tall closed-forest	Tall open-forest	Tall woodland
Trees 10–30 m	Closed-forest	Open-forest	Woodland
Trees 5–10 m	Low closed-forest	Low open-forest	Low woodland
Shrubs 2–8 m	Closed-scrub	Open-scrub	Tall shrubland

a) Classify this ecosystem. *[1 mark]*

b) Describe how field data could be collected for the purpose of classifying this ecosystem using Specht's classification system. Include at least one strategy to minimise bias. *[3 marks]*

Do not write outside this box.

c) Explain how Specht's classification system could be used to monitor how the ecosystem recovers after a logging event that removes 80% of trees from the tallest plant layer. *[2 marks]*

Do not write outside this box.

QUESTION 2 (4 marks)

The diagram shows feeding relationships for an Australian ecosystem.

a) Use the data to explain why dingoes are a keystone species. *[2 marks]*

Do not write outside this box.

b) Predict the effect a drastic reduction in the number of dingoes would have on the termite population. Justify your response. *[2 marks]*

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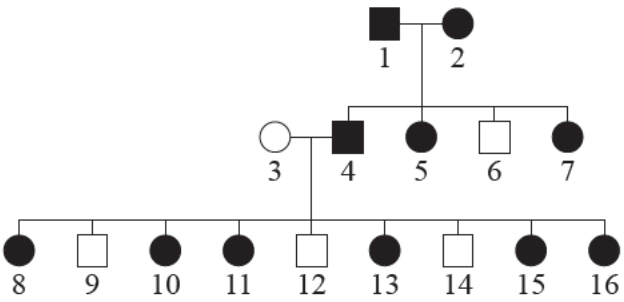
QUESTION 3 (7 marks)

The chart shows the inheritance pattern of a trait, which is thought to be sex-linked dominant.



Key

- Male with the trait
- Female with the trait
- Male without the trait
- Female without the trait

Parents

Offspring

1–16 used to identify each individual

a) Identify how many offspring of individuals 1 and 2 have the trait. *[1 mark]*

Do not write outside this box.

b) Identify evidence to support the conclusion that the trait is sex-linked dominant. Justify your response using a Punnett square. *[4 marks]*

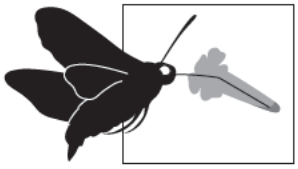
c) Infer the genotype of individual 6. Explain your reasoning. *[2 marks]*

Do not write outside this box.

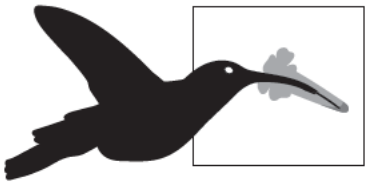
QUESTION 4 (5 marks)

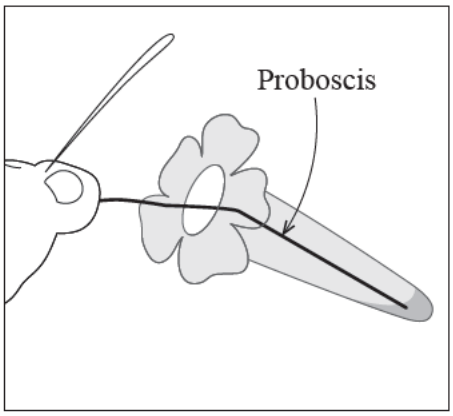
The hummingbird hawkmoth (phylum: *Arthropoda*) is named for its similarity to hummingbirds (phylum: *Chordata*). The two species have independently developed similar feeding structures, which they use to draw nectar from tube-shaped flowers. Both species help plants reproduce by distributing their pollen.

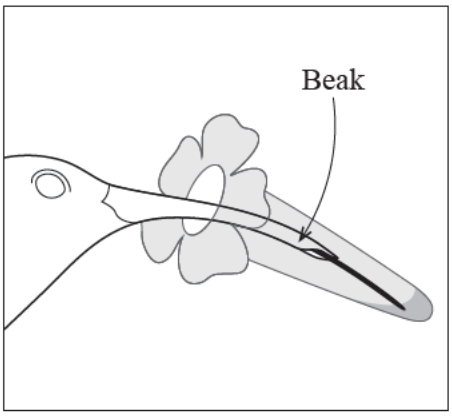
Hummingbird hawkmoth



Hummingbird







a) Identify the diversification pattern demonstrated by the hummingbird and the hummingbird hawkmoth. *[1 mark]*

Do not write outside this box.

b) Use the principles of natural selection to explain the similarities between the two species. *[2 marks]*

c) Explain how coevolution of the hummingbird hawkmoth and tube-shaped flowers may have occurred. *[2 marks]*

Do not write outside this box.

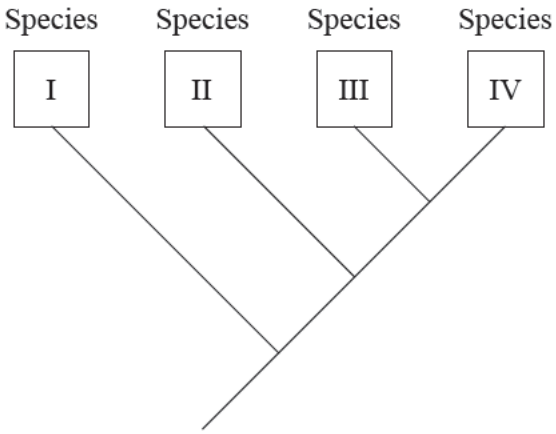
QUESTION 5 (3 marks)

Nucleic acid sequences were used to investigate evolutionary relationships between four species.

Species	Nucleic acid sequence
B. bartonus	G A C C G C A T T T A C G T A
B. deakinii	G A C G T C A T A T C C G T A
B. reidus	G A C C G C A T T T C C G T A
B. watsonii	G A C G G C A T A T C C G T A

a) Explain how data from conserved molecular sequences can be used to estimate time since divergence. *[2 marks]*

b) Use the data to infer species II–IV in the cladogram. *[1 mark]*



I: *B. bartonus*

II: _____

III: _____

IV: _____

Do not write outside this box.

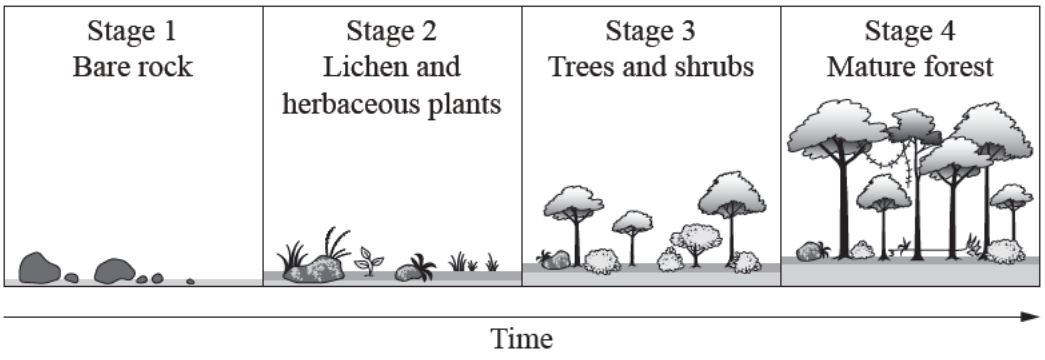
QUESTION 6 (3 marks)

Explain how twin studies can be used to investigate the effect of the environment on gene expression.

Do not write outside this box.

QUESTION 7 (5 marks)

The diagram shows the stages of succession in an ecosystem.



a) Identify the type of ecological succession depicted. Explain your reasoning. *[2 marks]*

b) Infer two features of the species in stage 2 and describe the role of these species in ecological succession. *[3 marks]*

Do not write outside this box.

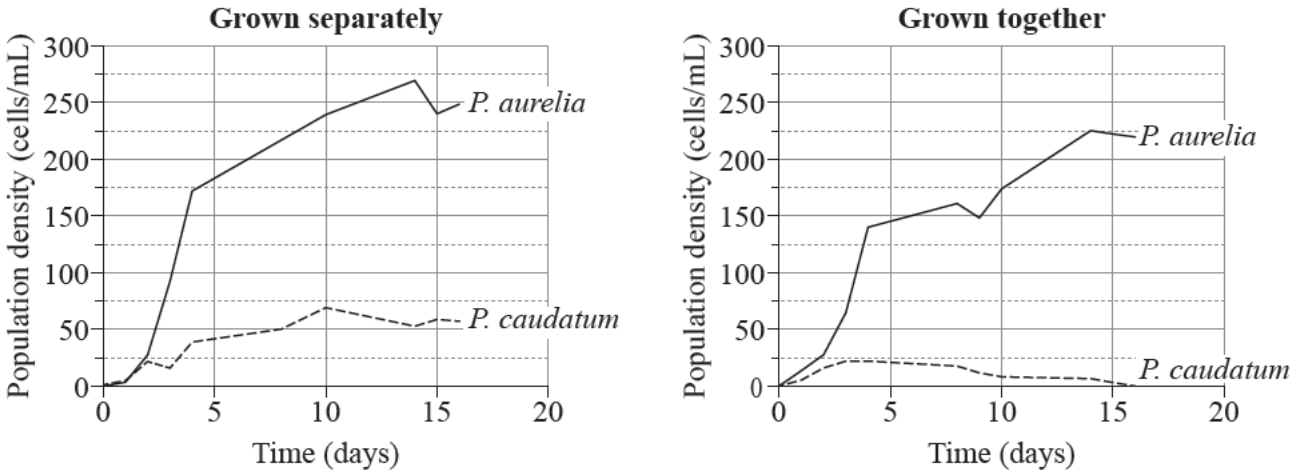
QUESTION 8 (3 marks)

Explain how temporal isolation can lead to speciation.

Do not write outside this box.

QUESTION 9 (7 marks)

The graphs show the findings of an experiment investigating the competitive exclusion principle. Two species of protozoa (*P. aurelia* and *P. caudatum*) were grown separately and together under identical conditions.



a) Identify the population density of *P. caudatum* on day 10 when grown separately. *[1 mark]*

b) Compare the growth of *P. aurelia* in the two graphs. *[3 marks]*

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c) Use the data to explain the competitive exclusion principle. *[3 marks]*

END OF PAPER

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ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

Do not write outside this box.

ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

Do not write outside this box.

References

Question 1

Figure inspired by Lowman, MD 1995, 'Herbivory in Australian forest — a comparison of dry sclerophyll and rain forest canopies', *Proceedings of the Linnean Society of New South Wales*, vol. 115, pp. 77–87, https://canopymeg.com/PDFs/papers/0049.pdf.

Table of Specht's 1970 classification scheme found at Australian National Herbarium 2015, 'A simplified look at Australia's vegetation', www.anbg.gov.au/aust-veg/veg-map.html.

Question 2

Adapted from The Savage Savanna, *Food web of Australian tropical savanna*, https://visitthesavannahtoday.weebly.com/food-web.html.

Question 4

Hummingbird moth: Ahisgett, 'Hummingbird moth 3', *Openverse*, https://search-production.openverse.engineering/image/c0e5f29f-948f-4fb8-9716-c2b4f9be744f.

Hummingbird: Sharp Photography 2010, 'Purple-throated carib hummingbird feeding', *Wikimedia Commons*, https://commons.wikimedia.org/w/index.php?curid=12374160.

Question 7

Image adapted from:

Rcole17 2015, 'Primary succession diagram', *Wikimedia Commons*, https://commons.wikimedia.org/wiki/File:Primary_Succession_Diagram.svg.

LucasMartinFrey 2011, 'Forest succession depicted over time', *Wikimedia Commons*, https://commons.wikimedia.org/wiki/File:Forest_succession_depicted_over_time.png.

Question 9

Adapted from OpenStax 2016, *Biology*, Rice University Publishers. OpenStax is licensed under Creative Commons Attribution License v4.0.