Apex Exam Guidebook

Biology

Year 12 QCE

Queensland Curriculum

2026 Edition

Jordan Lau

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Apex Exam Guidebook
Biology
Year 12 QCE

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Note	• Some question material has not been released by QCAA due to copyright restrictions and are not able to be included in this exam guide. This has been flagged in the relevant questions in the exam guide. Teachers may still be able to locate many of these sources and provide these to students by following the links at the end of the original QCAA exams on the QCAA website.

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Unit 3 – Biodiversity and the interconnectedness of life

Unit 3 - Topic 1: Describing biodiversity

Paper 1 Section 1

2024 Paper 1 Section 1 Question 1 Describing biodiversity	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

2024 Paper 1 Section 1 Question 5 Describing biodiversity	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

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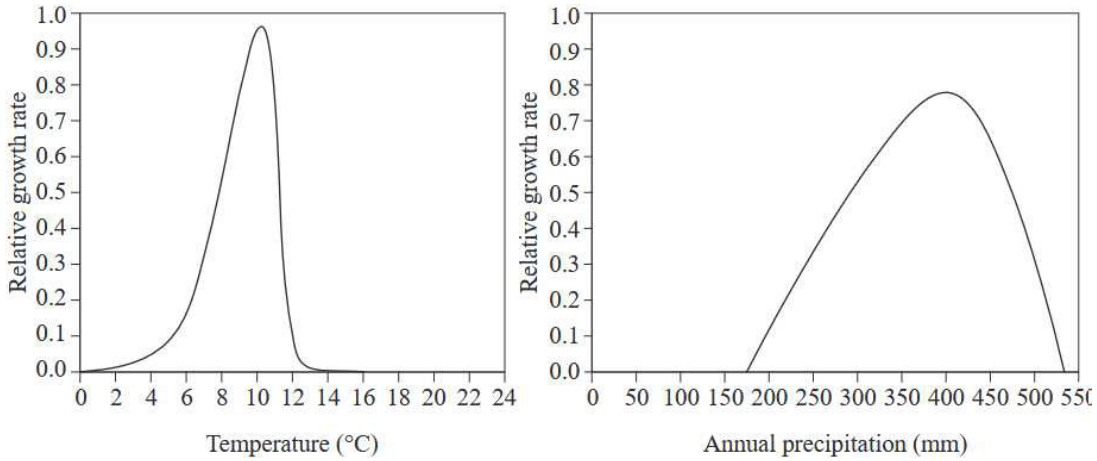
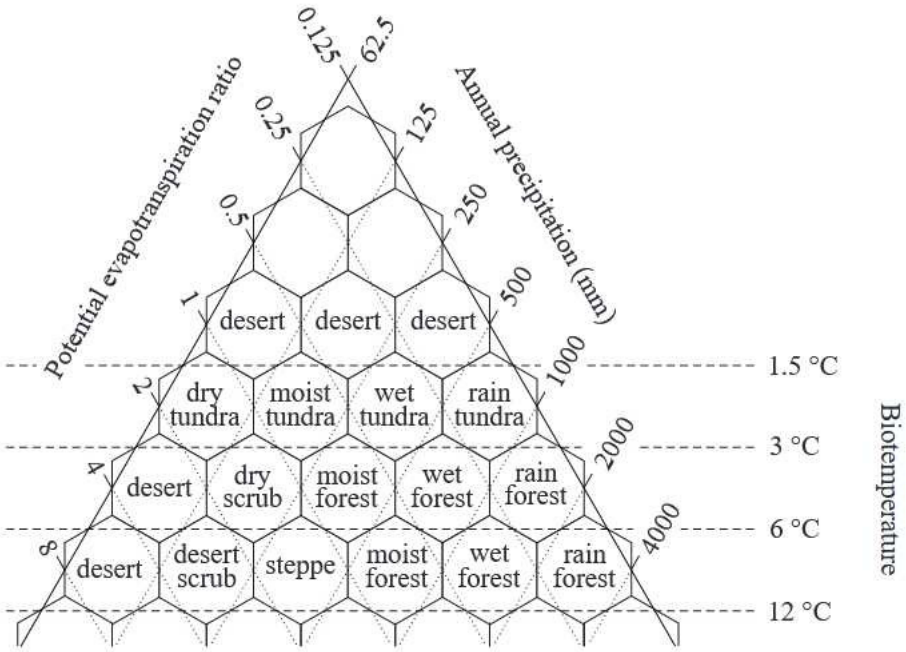
2024 **Paper 1** **Section 1** **Question 7** **Describing biodiversity**	Tolerance ranges for species X and a Holdridge life zone classification chart are shown.   Based on this data, the preferred habitat for species X is (A) desert. (B) steppe. (C) wet tundra. (D) moist forest.

2024 **Paper 1** **Section 1** **Question 8** **Describing biodiversity**	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.

2023 **Paper 1** **Section 1** **Question 1** **Describing biodiversity**	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.

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2023 Paper 1 Section 1 Question 2

Describing biodiversity

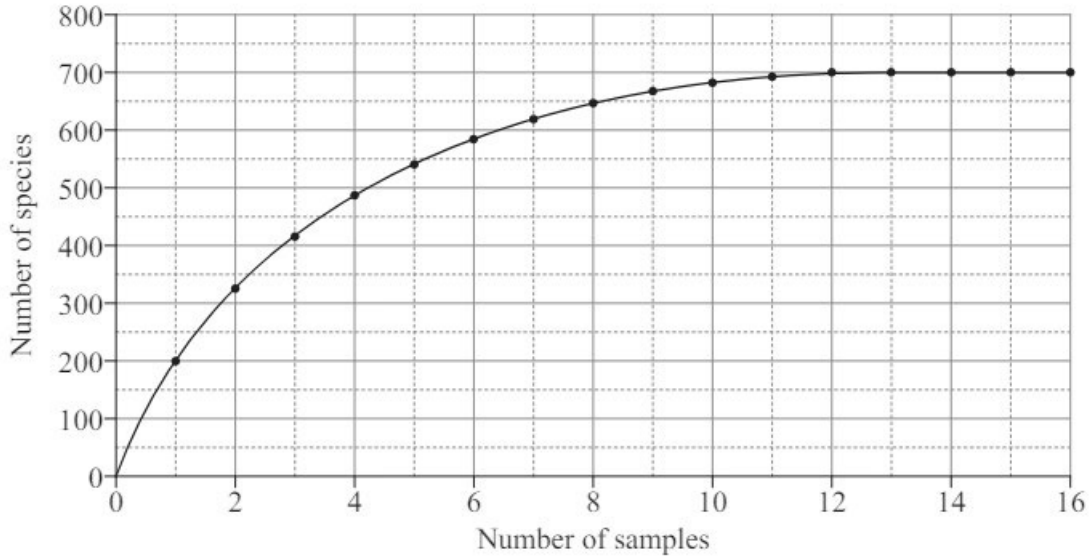
Species classified as K-strategists

(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.

2023 Paper 1 Section 1 Question 12

Describing biodiversity

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

2022 Paper 1 Section 1 Question 3

Describing biodiversity

A survey of grasshopper species was conducted across four eucalypt communities. Counts were conducted and the average abundance per 400 m^2 recorded.

	Grasshopper species (A–F)						
Community	**A**	**B**	**C**	**D**	**E**	**F**	**Total**
I	32	18	1	3	0	46	100
II	3	2	0	1	3	12	21
III	3	2	28	3	18	51	105
IV	18	13	12	14	16	15	88

Which community has both the highest species richness and highest evenness for grasshoppers?

(A) I
(B) II
(C) III
(D) IV

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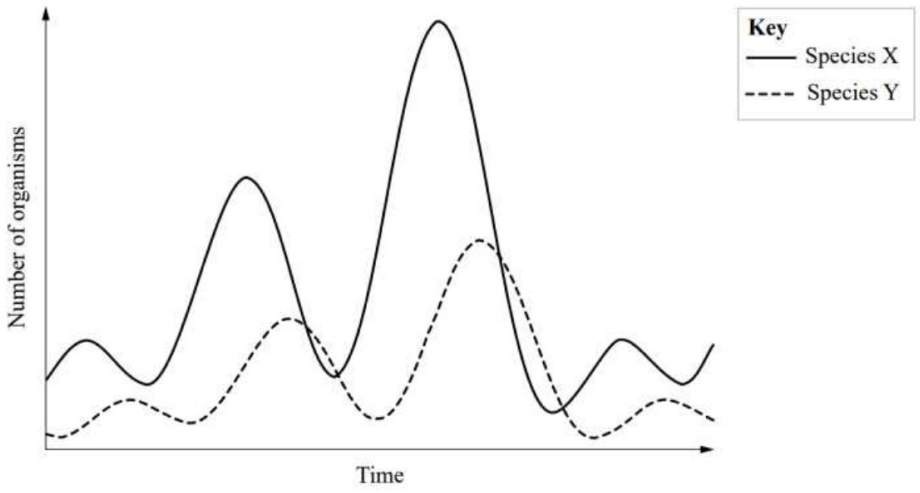
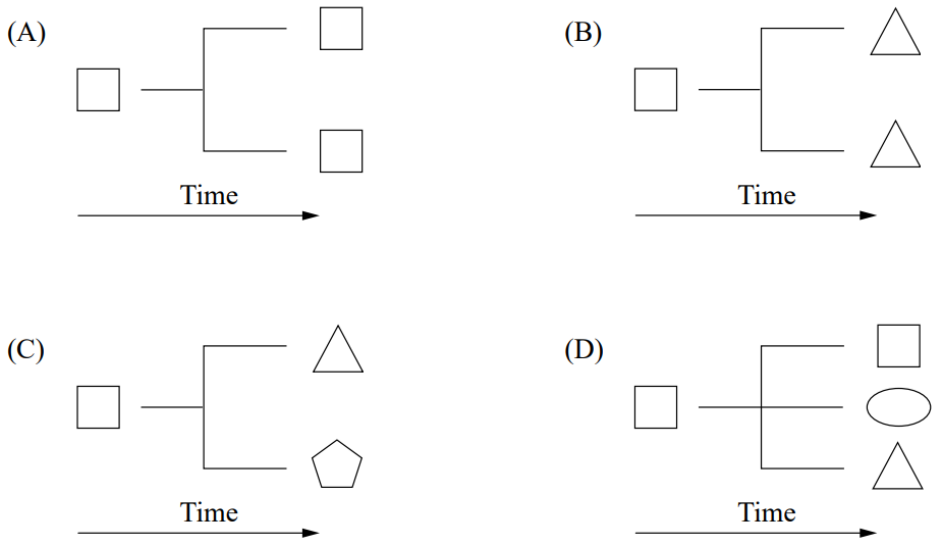
2022 Paper 1 Section 1 Question 8 Describing biodiversity	The graph shows how the populations of two species in an ecosystem change over time.  Which species interaction is represented? (A) predation, where species X preys on species Y (B) predation, where species Y preys on species X (C) competition, where species X outcompetes species Y (D) competition, where species Y outcompetes species X

2022 Paper 1 Section 1 Question 16 Describing biodiversity	If each shape represents a different species, which diagram shows the common assumptions of cladistics? 

2022 Paper 1 Section 1 Question 17 Describing biodiversity	Students used quadrats to investigate biodiversity in a grassland community with scattered distribution of plant species. The students agreed on a counting criteria for each quadrat to (A) reduce the time taken to count the different species. (B) minimise statistical uncertainty. (C) ensure all strata were sampled. (D) minimise bias.

2021 Paper 1 Section 1 Question 8 Describing biodiversity	The place where an organism lives is called its (A) niche. (B) habitat. (C) community. (D) environment.

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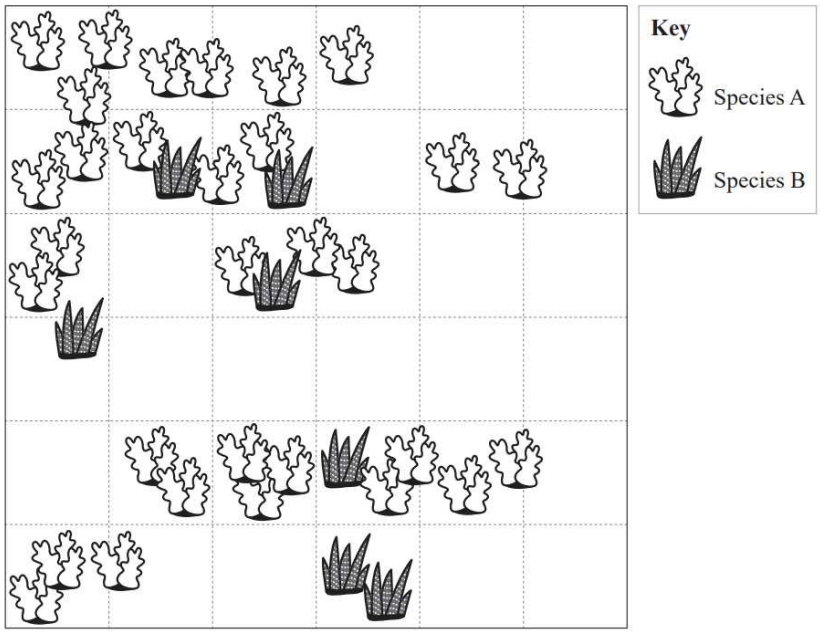
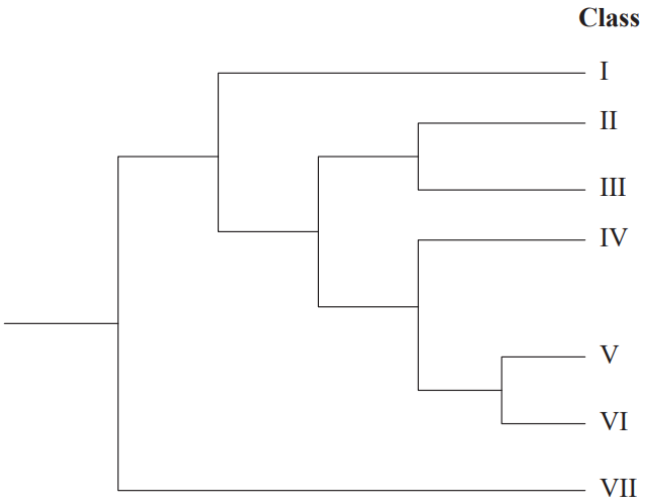
2021 Paper 1 Section 1 Question 9 Describing biodiversity	The image represents a gridded quadrat of 20 cm×20 cm squares used in a plant survey. To calculate cover for a species, the surveyor identified each plant species and then counted the number of squares in which the species appeared.  Not to scale What is the approximate percentage cover of Species A? (A) 22% (B) 44% (C) 53% (D) 58%

2021 Paper 1 Section 1 Question 17 Describing biodiversity	This is a cladogram for seven different classes of organisms (I–VII).  Which two classes of organisms are most closely related? (A) I and VII (B) IV and VI (C) I and II (D) III and IV

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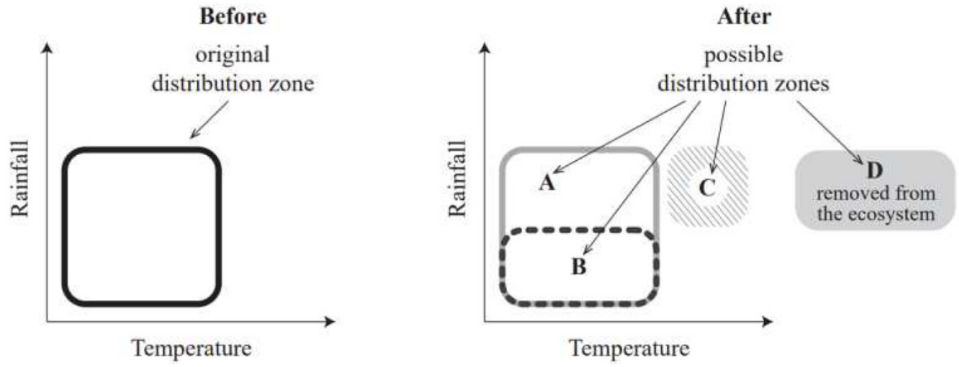
2020 Paper 1 Section 1 Question 11 Describing biodiversity	The Linnaean system originally used which type of evidence for classifying organisms? (A) physical features (B) common ancestry (C) molecular phylogeny (D) reproduction methods

2020 Paper 1 Section 1 Question 14 Describing biodiversity	One of the common assumptions in cladistics is that (A) not all organisms are related by descent. (B) the characteristics of organisms in a population stay the same over time. (C) new kinds of organisms may arise when existing populations divide into two groups. (D) the more shared characteristics two organisms have, the more closely related they are.

2020 Paper 1 Section 1 Question 16 Describing biodiversity	The figures show the original distribution zone of Species I and some possible distribution zones of Species I after the introduction of Species II.  Species II has a competitive advantage over Species I; however, it does not tolerate areas of lower rainfall. Which of the following would be an accurate prediction of the new distribution zone for Species I? (A) Zone A, i.e. no change to the distribution (B) Zone B, i.e. reduced distribution within the original zone (C) Zone C, i.e. new distribution outside the original zone (D) Zone D, i.e. complete removal of the species from the ecosystem

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2024 Paper 1 Section 2 Question 21

Describing biodiversity

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]*

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]

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	c) Describe how sampling could be used to collect data for this investigation. Include at least two strategies to minimise bias. [3 marks]
2024 Paper 1 Section 2 Question 25 Describing biodiversity	Describe what is meant by an interspecific hybrid, using an example. [2 marks]
2023 Paper 1 Section 2 Question 23 Describing biodiversity	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 it branches to die. a) Identify the species interaction demonstrated in this scenario. [1 mark] b) Explain how this relationship differs from predation. [1 mark]

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2023 Paper 1 Section 2 Question 25

Describing biodiversity

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%).

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

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

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2022 **Paper 1** **Section 2** **Question 22** **Describing biodiversity**	Explain how two abiotic factors affect the distribution of species in an ecosystem. [2 marks] Ecosystem: Abiotic factor 1: Abiotic factor 2:

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2022 Paper 1 Section 2 Question 24 Describing biodiversity	Explain two ways that classifying ecosystems allows for effective management of old-growth forests. [2 marks]

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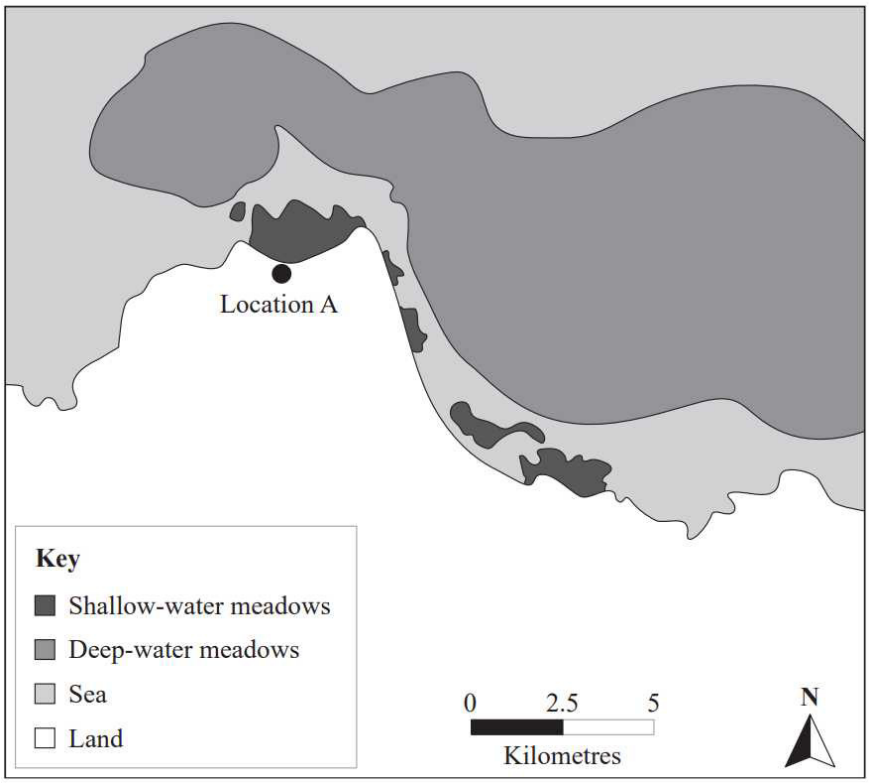
2022
Paper 1
Section 2
Question 25

Describing biodiversity

Severe weather events have caused widespread loss of seagrass in meadows off Location A.

Seagrasses have the capacity to recover from weather-associated disturbances and return to pre-impact levels within 4 to 60 months. Deep-water meadows have a higher rate of recovery than shallow-water meadows.



Describe how stratified sampling could be used to study how seagrass meadows off Location A recover after a severe weather event. Identify a surveying technique and purpose for the study in your response. [4 marks]

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2021 Paper 1 Section 2 Question 21 Describing biodiversity	In the Linnaean system of classification, the features used to classify living things change according to taxonomic levels. Describe, using relevant examples, how these features change. [4 marks]

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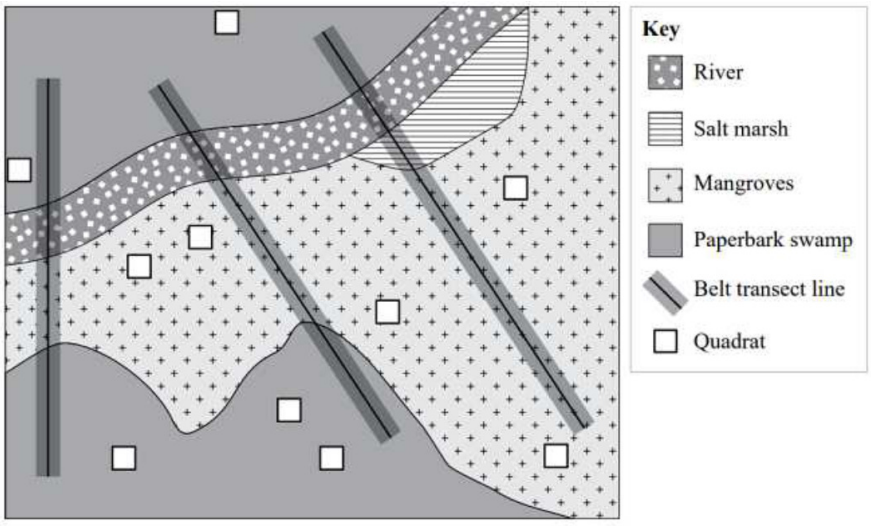
2021
Paper 1
Section 2
Question 23

Describing biodiversity

To determine the species diversity and species richness of a wetland ecosystem, ecologists surveyed communities adjacent to a river, using two methods for each community:
1. random species sampling with predetermined grid numbers, with 10 quadrats of 4 m2 each used for these grids.
2. three belt transect lines (50 m×2 m) across predetermined sampling locations based on strata variation.

The map shows the locations of quadrats and transect lines. The table shows survey results.



Not to scale

	Survey method	
	Quadrat	**Belt transect**
Species diversity (Simpson's diversity index)	0.6	0.8
Species richness (number of species)	16	22

a) Identify three differences between the survey methods used to determine species diversity and species richness in the ecosystem. [3 marks]

b) Draw a conclusion about the most suitable method for estimating species diversity and species richness of the communities in this wetland ecosystem. Give a reason to support your conclusion. [2 marks]

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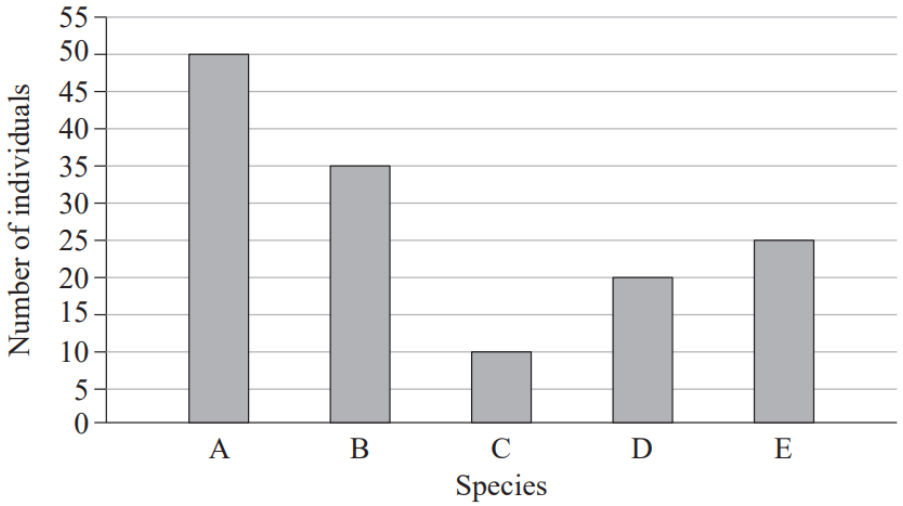
2020
Paper 1
Section 2
Question 21

Describing biodiversity

A count was conducted to determine the number of individuals for five different bird species in a woodland.



Calculate the relative percentage abundance of species B. Show your working. [2 marks]

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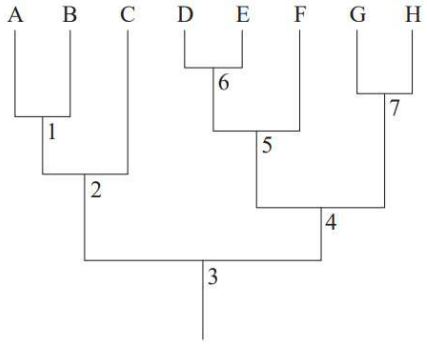
2020 Paper 1 Section 2 Question 22 Describing biodiversity	The following cladogram proposes the evolutionary history of several fish phyla (A–H).  a) Define the term clade. Circle an example of a clade on the cladogram. [2 marks] Note: If you make a mistake on the cladogram, cancel it by ruling a single diagonal line through your work and use the additional cladogram on page 13 of this question and response book. b) Which node (1–7) represents the most recent common ancestor for species E and G? [1 mark] c) Which two species shared the most recent common ancestor? [1 mark]

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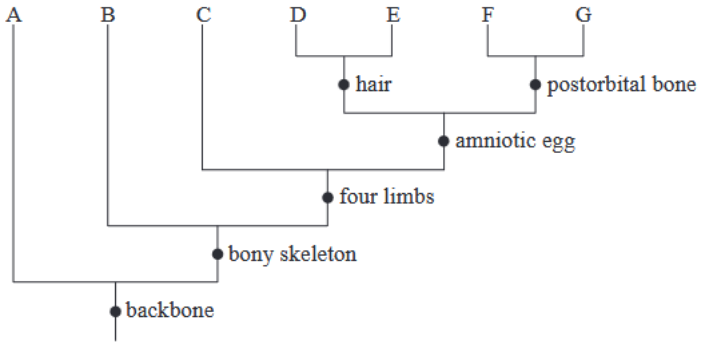
2024 Paper 2 Section 1 Question 1

Describing biodiversity

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]

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2024 Paper 2 Section 1 Question 8

Describing biodiversity

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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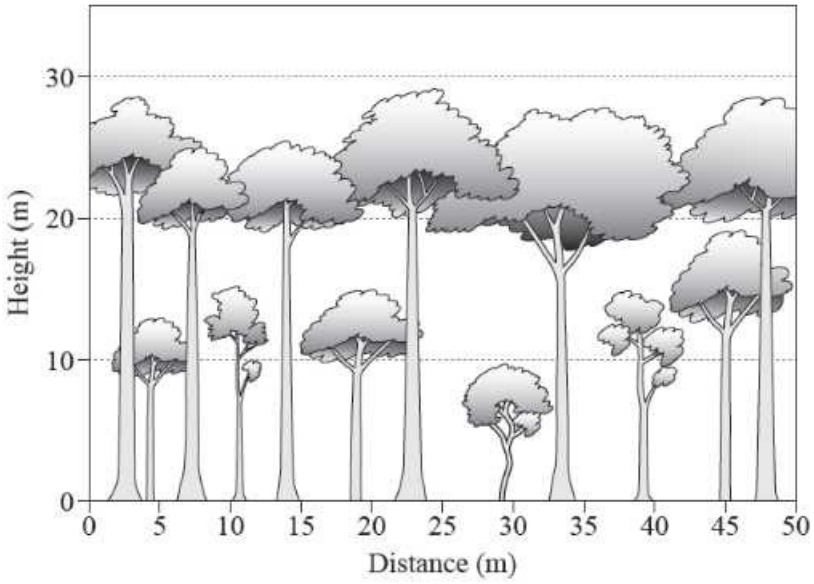
2023 Paper 2 Section 1 Question 1

Describing biodiversity

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]

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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]

2023 Paper 2 Section 1 Question 5

Describing biodiversity

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]

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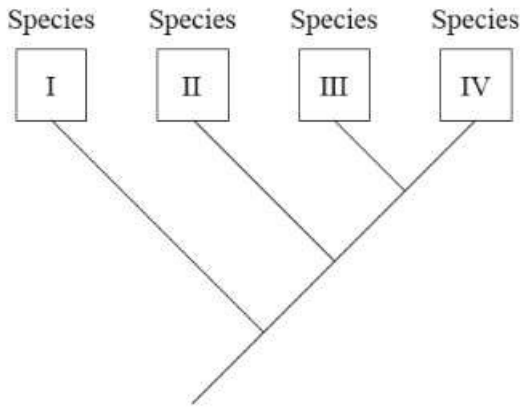
b) Use the data to infer species II-IV in the cladogram. [1 mark]



I: B. bartonus

II: _____

III: _____

IV: _____

2022 Paper 2 Section 1 Question 9

Describing biodiversity

The biological species concept defines species as a group of organisms that can interbreed to produce fertile offspring.

a) Identify another method for defining a species. [1 mark]

_____

b) Describe one limitation of the biological species concept and one limitation of the method identified in Question 9a). [2 marks]

_____

_____

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2021 Paper 2 Section 1 Question 6

Describing biodiversity

The term *species* could be defined as 'one group of individuals that actually or potentially interbreed in nature'.

Identify two limitations of this definition. [2 marks]

2021 Paper 2 Section 1 Question 12

Describing biodiversity

An investigation compared mangrove species diversity for two areas of different size in the same catchment. The table shows species population counts for each area.

		Area 1	Area 2
Total species count	Grey mangrove	37	7
	Red mangrove	32	3
	Yellow mangrove	25	88
	SDI	0.67	?

a) Calculate Simpson's diversity index for Area 2. Show your working. [2 marks]

$$SDI = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

SDI = _____ (correct to two decimal places)

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	b) Using your answer for Question 12a), compare the diversity of the two areas. [3 marks]

2020 Paper 2 Section 1 Question 1 **Describing biodiversity**	a) Explain how a species interaction may be classified as symbiotic. [2 marks] b) Using an example, describe the symbiotic relationship of mutualism. [2 marks]

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2020 Paper 2 Section 1 Question 4

Describing biodiversity

An ecologist investigated the species composition of mangrove trees in a natural mangrove forest and an adjacent 30-year-old planted mangrove forest.

Three 10 m-wide belt transects were sampled from inland to the sea for each of the forests, each covering 100 m on average and placed to cover various strata.

The species diversity of Forest A was determined using the Simpson's Diversity Index (SDI):

$$SDI = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

	Population count	
Species	**Forest A (natural)**	**Forest B (planted)**
Grey mangrove	91	77
Red mangrove	23	14
River mangrove	11	8
Orange mangrove	3	0
Diversity	0.46	?

a) Use the SDI formula to calculate the diversity index for Forest B. Round your answer to two decimal places. [2 marks]

b) Identify three reasons why the ecologist used a belt transect rather than line transects or randomly placed quadrats for collecting data to compare these two forests. [3 marks]

c) Identify one way in which the ecologist minimised bias in the sampling. [1 mark]

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2020
Paper 2
Section 1
Question 7

Describing biodiversity

Species richness (S) can be determined using the Menhinick's Index, where s is the number of different species represented in a sample and N is the total number of individual organisms in the sample.

$$\text{Species richness (S)} = \frac{s}{\sqrt{N}}$$

Sampling of two communities (Community A and Community B) were completed, with Community A having S = 0.5 for the six species identified. The results for Community B are shown in the table.

Community B	
Species	**Number of individuals**
A	12
B	15
C	19
D	22
E	25
F	7

Use S to compare Community A with Community B. [4 marks]

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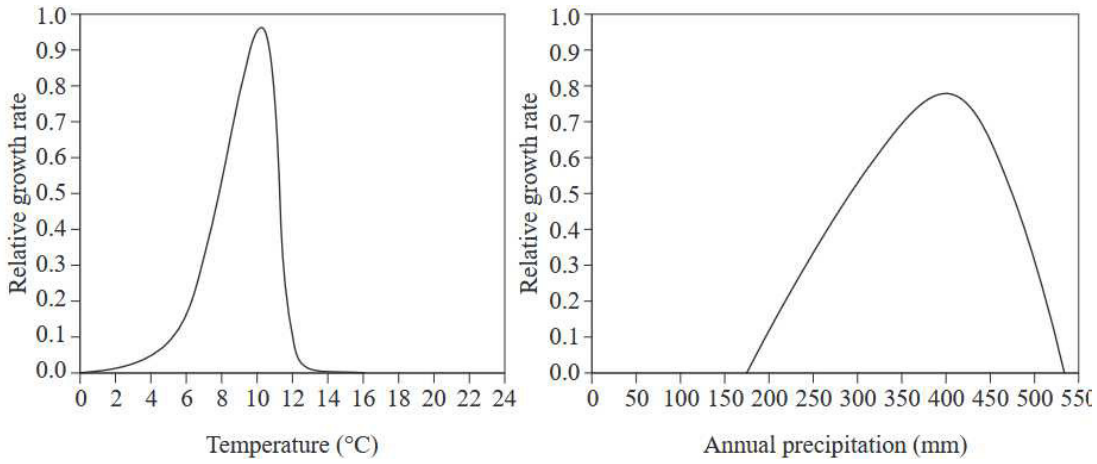
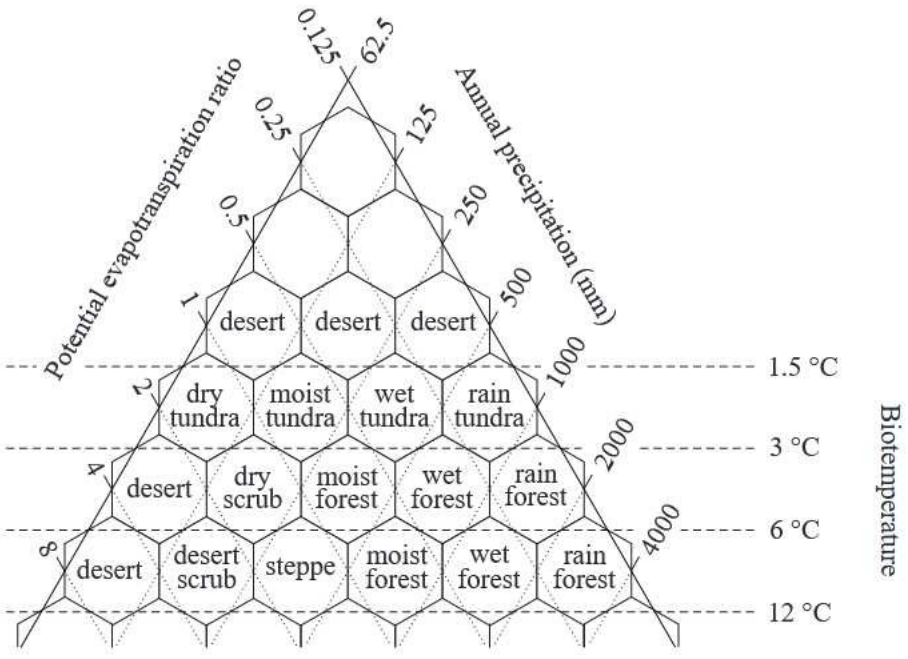
Marking Guide – Paper 1 Section 1

2024 Paper 1 Section 1 Question 1 Describing biodiversity	Which term describes a group of organisms consisting of a common ancestor and all its lineal descendants? **(A) clade – Answer** (B) subgroup (C) population (D) community

2024 Paper 1 Section 1 Question 5 Describing biodiversity	A limitation of the biological species concept is that it does not account for species that **(A) reproduce asexually. – Answer** (B) are reproductively isolated. (C) are morphologically indistinguishable. (D) have a different number of chromosomes

2024 Paper 1 Section 1 Question 7 Describing biodiversity	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. – Answer** (C) wet tundra. (D) moist forest.

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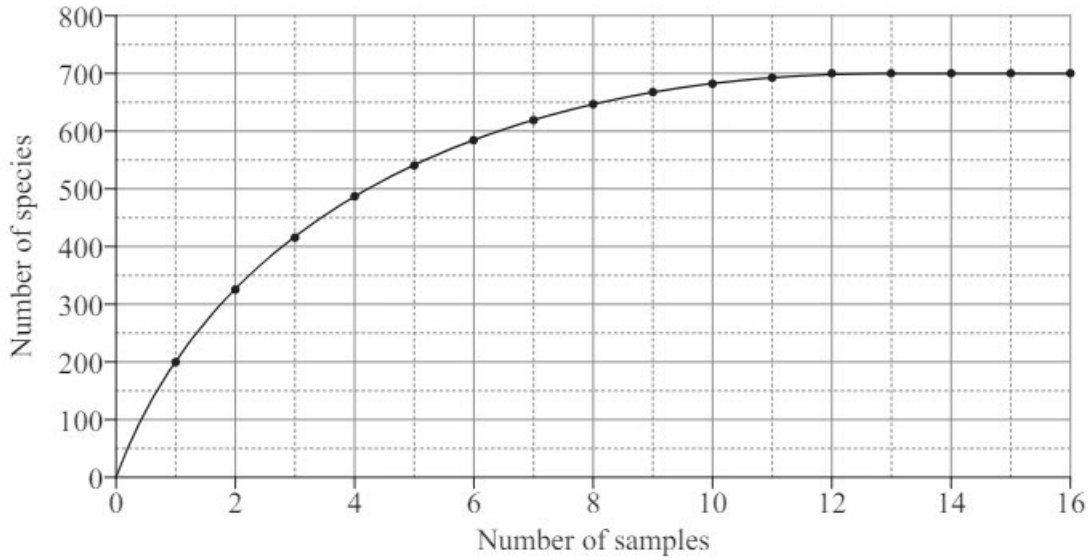
2024 **Paper 1** **Section 1** **Question 8** **Describing biodiversity**	In the Linnaean system of classification, two species of the same class will also belong to the same (A) order. (B) genus. (C) family. **(D) phylum. – Answer**

2023 **Paper 1** **Section 1** **Question 1** **Describing biodiversity**	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. – Answer**

2023 **Paper 1** **Section 1** **Question 2** **Describing biodiversity**	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. – Answer** (D) are first to colonise a new environment created by a disturbance.

2023 **Paper 1** **Section 1** **Question 12** **Describing biodiversity**	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 – Answer** (D) 16

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2022 Paper 1 Section 1 Question 3

Describing biodiversity

A survey of grasshopper species was conducted across four eucalypt communities. Counts were conducted and the average abundance per 400 m^2 recorded.

	Grasshopper species (A–F)						
Community	**A**	**B**	**C**	**D**	**E**	**F**	**Total**
I	32	18	1	3	0	46	100
II	3	2	0	1	3	12	21
III	3	2	28	3	18	51	105
IV	18	13	12	14	16	15	88

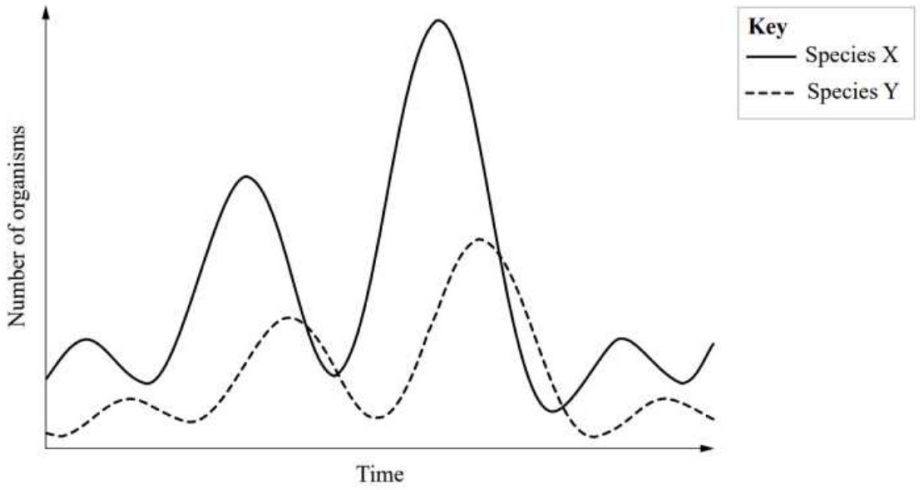
Which community has both the highest species richness and highest evenness for grasshoppers?

(A) I
(B) II
(C) III
(D) IV – Answer

2022 Paper 1 Section 1 Question 8

Describing biodiversity

The graph shows how the populations of two species in an ecosystem change over time.



Which species interaction is represented?

(A) predation, where species X preys on species Y
(B) predation, where species Y preys on species X – Answer
(C) competition, where species X outcompetes species Y
(D) competition, where species Y outcompetes species X

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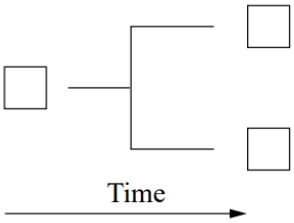
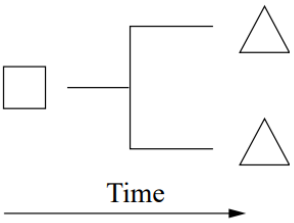
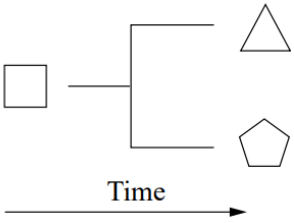
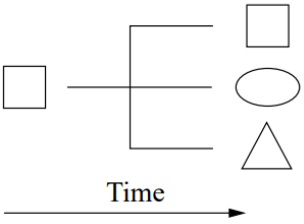
2022 Paper 1 Section 1 Question 16 Describing biodiversity	If each shape represents a different species, which diagram shows the common assumptions of cladistics? (A)  (B)  (C)  (D)  **Answer is C.**

2022 Paper 1 Section 1 Question 17 Describing biodiversity	Students used quadrats to investigate biodiversity in a grassland community with scattered distribution of plant species. The students agreed on a counting criteria for each quadrat to (A) reduce the time taken to count the different species. (B) minimise statistical uncertainty. (C) ensure all strata were sampled. **(D) minimise bias. – Answer**

2021 Paper 1 Section 1 Question 8 Describing biodiversity	The place where an organism lives is called its (A) niche. **(B) habitat. – Answer** (C) community. (D) environment.

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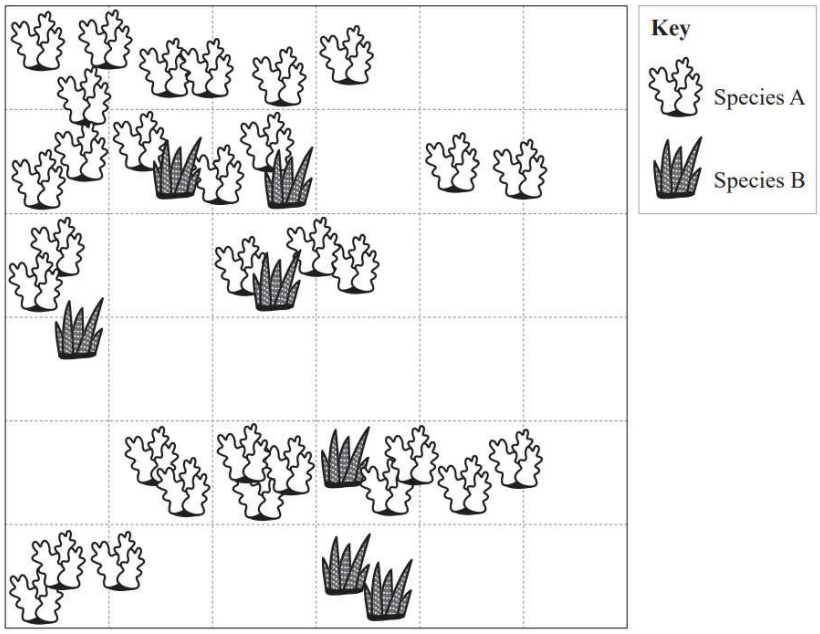
2021 Paper 1 Section 1 Question 9

Describing biodiversity

The image represents a gridded quadrat of 20 cm×20 cm squares used in a plant survey. To calculate cover for a species, the surveyor identified each plant species and then counted the number of squares in which the species appeared.



Not to scale

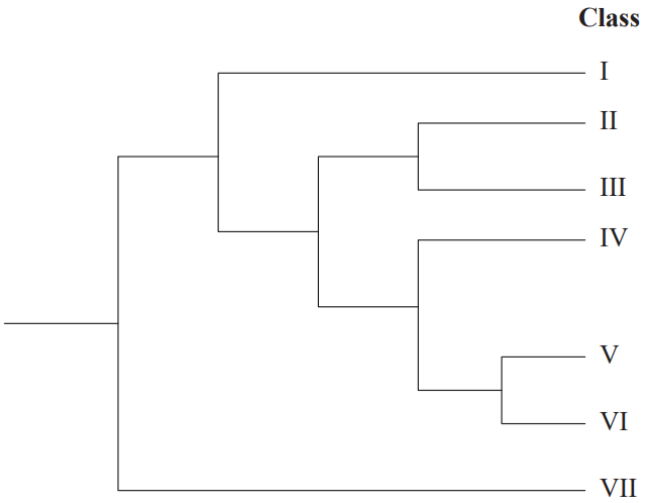
What is the approximate percentage cover of Species A?

(A) 22%
(B) 44%
(C) 53% – Answer
(D) 58%

2021 Paper 1 Section 1 Question 17

Describing biodiversity

This is a cladogram for seven different classes of organisms (I–VII).



Which two classes of organisms are most closely related?
(A) I and VII
(B) IV and VI – Answer
(C) I and II
(D) III and IV

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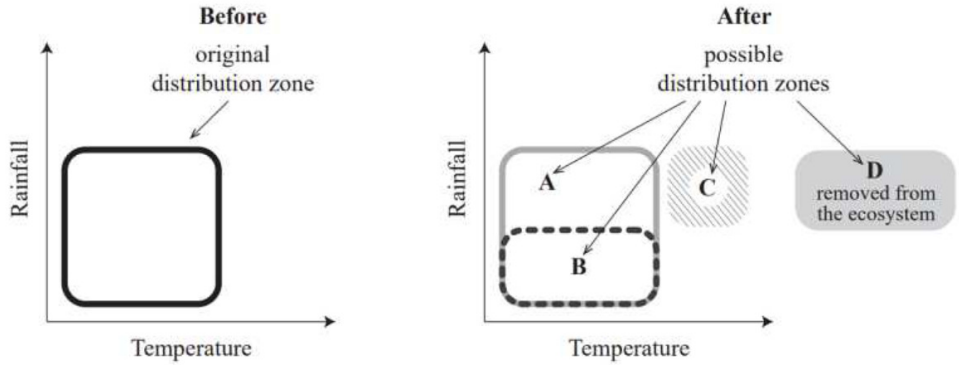
2020 Paper 1 Section 1 Question 11 Describing biodiversity	The Linnaean system originally used which type of evidence for classifying organisms? **(A) physical features – Answer** (B) common ancestry (C) molecular phylogeny (D) reproduction methods

2020 Paper 1 Section 1 Question 14 Describing biodiversity	One of the common assumptions in cladistics is that (A) not all organisms are related by descent. (B) the characteristics of organisms in a population stay the same over time. **(C) new kinds of organisms may arise when existing populations divide into two groups. – Answer** (D) the more shared characteristics two organisms have, the more closely related they are.

2020 Paper 1 Section 1 Question 16 Describing biodiversity	The figures show the original distribution zone of Species I and some possible distribution zones of Species I after the introduction of Species II.  Species II has a competitive advantage over Species I; however, it does not tolerate areas of lower rainfall. Which of the following would be an accurate prediction of the new distribution zone for Species I? (A) Zone A, i.e. no change to the distribution **(B) Zone B, i.e. reduced distribution within the original zone – Answer** (C) Zone C, i.e. new distribution outside the original zone (D) Zone D, i.e. complete removal of the species from the ecosystem

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2024 Paper 1 Section 2 Question 21

Describing biodiversity

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]*

Sample response	The response
$SDI = 1 - \left(\frac{(133 \times 132) + (96 \times 95) + (256 \times 255)}{485 \times 484} \right)$ $= 0.61$	• determines SDI as 0.61 **[1 mark]** • provides appropriate working **[1 mark]**

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]

Sample response	The response
Species evenness decreased over the 10-year period. SDI considers both species richness and evenness — the greater the species richness and evenness, the higher the SDI value. As species richness was the same in both years but SDI decreased from 0.84 to 0.61, it can be inferred that species evenness was lower in 2024 than in 2014.	• infers that species evenness decreased over the 10-year period **[1 mark]** • justifies inference using SDI data **[1 mark]**

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

Sample response	The response
Quadrats could be randomly placed throughout the forest, and the number and type of plants observed in each quadrat recorded. This data could then be pooled and used to estimate the total number of each plant species at the site. The researchers could ensure that at least 10% of the site is sampled (by considering number and size of quadrats) and use a random-number generator to decide where to place the quadrats.	• describes an appropriate surveying technique **[1 mark]** • identifies one strategy to minimise bias **[1 mark]** • identifies a second strategy to minimise bias **[1 mark]**

2024 Paper 1 Section 2 Question 25

Describing biodiversity

Describe what is meant by an interspecific hybrid, using an example. [2 marks]

Sample response	The response
An interspecific hybrid is an offspring produced by the mating of individuals from two different species, e.g. a mule, which is the offspring of a horse and a donkey.	• describes interspecific hybrid **[1 mark]** • provides an example **[1 mark]**

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2023 Paper 1 Section 2 Question 23

Describing biodiversity

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 it branches to die.

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

Sample response	The response
Parasitism	• identifies parasitism **[1 mark]**

b) Explain how this relationship differs from predation. [1 mark]

Sample response	The response
Predatory relationships involve an organism capturing, killing and feeding on another organism. This relationship is parasitic because the eucalyptus tree is harmed, not killed.	• describes predation **[1 mark]** • explains how the relationship differs from predation **[1 mark]**

2023 Paper 1 Section 2 Question 25

Describing biodiversity

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%).

Sample response	The response
Species richness is higher in areas with low invasive species cover (seven different species compared to two).	• identifies species richness is higher in areas with low invasive species cover **[1 mark]**

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

Sample response	The response
The presence of the invasive species has a negative effect on biodiversity. While the same number of species were observed in the area when invasive species cover was 0–60% (7, as indicated by species richness), the SDI decreased from 0.83 to 0.3 as percentage cover increased. This indicates that overall, biodiversity decreased as percentage cover increased.	• identifies a relevant trend in the data **[1 mark]** • draws a valid conclusion about the effect of the invasive species **[1 mark]**

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

Sample response	The response
Species richness indicates the number of species that can coexist in the area; however, it doesn't account for the abundance of each species, so one or two species may be dominating. SDI considers the number of species and their relative abundance (evenness), but the number of species is not obvious from the index. Having both values is more informative because it allows the researcher to identify the number of species in the area (7) and infer evenness from the SDI. For example, the same number of species was present for 0–60% coverage (7), but the evenness was not the same, as the SDI decreased as % coverage got higher.	• recognises species richness is the total number of species present **[1 mark]** • recognises SDI considers species number and abundance/evenness **[1 mark]** • uses data to explain why data on species richness and SDI is more informative than a single measure **[1 mark]**

2022 Paper 1 Section 2 Question 22

Describing biodiversity

Explain how two abiotic factors affect the distribution of species in an ecosystem. [2 marks]

Sample Response	The response
Ecosystem: Rainforest Abiotic factor 1: Availability of light: In a rainforest, light becomes less available in the understorey, so only plants that are adapted to low-light conditions can survive there.	• explains how one abiotic factor affects the distribution of species in the identified ecosystem [1 mark]
Abiotic factor 2: Availability of water: Rainforest frogs need to be distributed near pools of water for their tadpoles to grow and survive.	• explains how a second abiotic factor affects the distribution of species in the identified ecosystem [1 mark]

2022 Paper 1 Section 2 Question 24

Describing biodiversity

Explain two ways that classifying ecosystems allows for effective management of old-growth forests. [2 marks]

Sample Response	The response
Classification allows us to document, monitor and communicate information about biodiversity, which can be used to monitor how old-growth forests recover after a disturbance, e.g. the progression from tall open woodland to tall closed forest.	• explains one way classification allows for effective management of old-growth forests [1 mark]
Classification can also be used to identify which parts of an area have similar species composition and abiotic factors. This data can be used to inform effective management, as similar management principles would apply to old growth forests with similar species composition.	• explains a second way classification allows for effective management of old-growth forests [1 mark]

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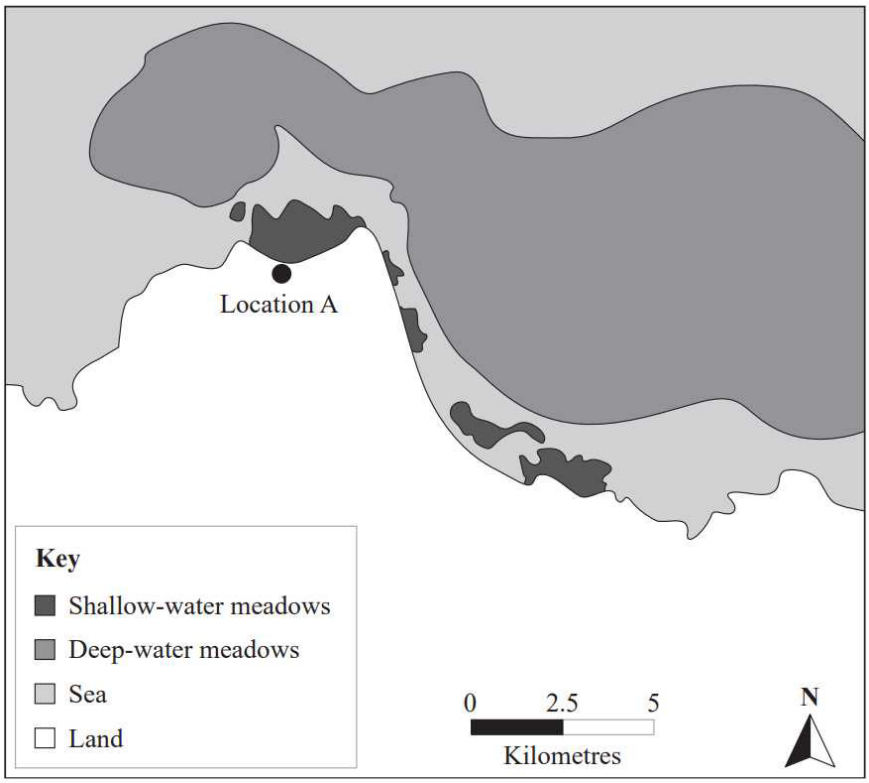
2022 Paper 1 Section 2 Question 25

Describing biodiversity

Severe weather events have caused widespread loss of seagrass in meadows off Location A.

Seagrasses have the capacity to recover from weather-associated disturbances and return to pre-impact levels within 4 to 60 months. Deep-water meadows have a higher rate of recovery than shallow-water meadows.



Describe how stratified sampling could be used to study how seagrass meadows off Location A recover after a severe weather event. Identify a surveying technique and purpose for the study in your response. [4 marks]

Sample Response	The response
Stratified sampling could be used to investigate how the percentage cover of seagrass changes along a depth gradient over a 60-month period. Quadrats could be used to estimate the percentage cover of seagrass at 250 km intervals along a 7 km belt transect north of location A, covering both shallow-water and deep-water meadows. Multiple quadrats should be placed at each interval to ensure the reliability of data, and the depth at each sampling point must be recorded. Data could be collected each month for 60 months.	• indicates the study will take place over time [1 mark] • indicates that sampling will occur in both deep and shallow water [1 mark] • identifies an appropriate surveying technique [1 mark] • identifies an appropriate purpose for the study [1 mark]

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2021 Paper 1 Section 2 Question 21

Describing biodiversity

In the Linnaean system of classification, the features used to classify living things change according to taxonomic levels. Describe, using relevant examples, how these features change. [4 marks]

Sample Response	The response
The features used to classify living things change as you go from the broader taxonomic level to the more specific. Kingdom is the most extensive, so the features encompass the widest variety of organisms, with features such as cell type and structure. Through the middle taxa, features become more specific, with an emphasis on minor shared similarities such as fur, body shape and leaf shape. At the species level, features such as teeth structure, body size, behaviour and distribution may be used, as well as the more recent use of biochemical similarities.	• states that the Linnaean system - starts with broad taxa that have major similarities [1 mark] - has lower taxa that become more specific, with minor similarities [1 mark] • provides a relevant example for broad taxa [1 mark] • provides a relevant example for mid OR narrow taxa [1 mark]

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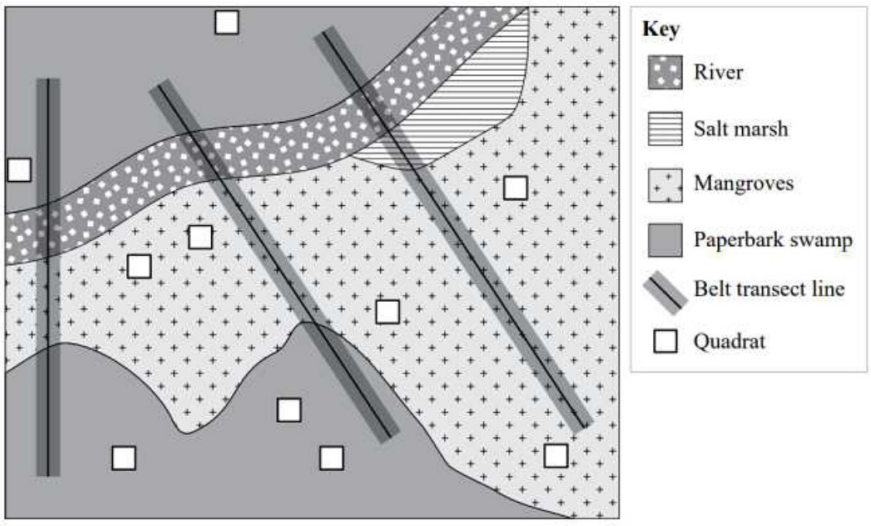
2021
Paper 1
Section 2
Question 23

Describing biodiversity

To determine the species diversity and species richness of a wetland ecosystem, ecologists surveyed communities adjacent to a river, using two methods for each community:
1. random species sampling with predetermined grid numbers, with 10 quadrats of 4 m2 each used for these grids.
2. three belt transect lines (50 m×2 m) across predetermined sampling locations based on strata variation.

The map shows the locations of quadrats and transect lines. The table shows survey results.



Not to scale

	Survey method	
	Quadrat	**Belt transect**
Species diversity (Simpson's diversity index)	0.6	0.8
Species richness (number of species)	16	22

a) Identify three differences between the survey methods used to determine species diversity and species richness in the ecosystem. [3 marks]

Sample Response	The response
Quadrats did not cover salt marsh area but transects were placed throughout the different strata. Quadrats sampled a smaller area of 40 m^2 compared to a larger area of 300 m^2 for transects. Bias was removed in quadrat sampling method by using random sampling, but it wasn't for transects.	• identifies first difference [1 mark] • identifies second difference [1 mark] • identifies third difference [1 mark]

b) Draw a conclusion about the most suitable method for estimating species diversity and species richness of the communities in this wetland ecosystem. Give a reason to support your conclusion. [2 marks]

Sample Response	The response
The belt transect was most the most suitable method as it identified more species.	• concludes that the transect method was most suitable [1 mark] • gives a reason [1 mark]

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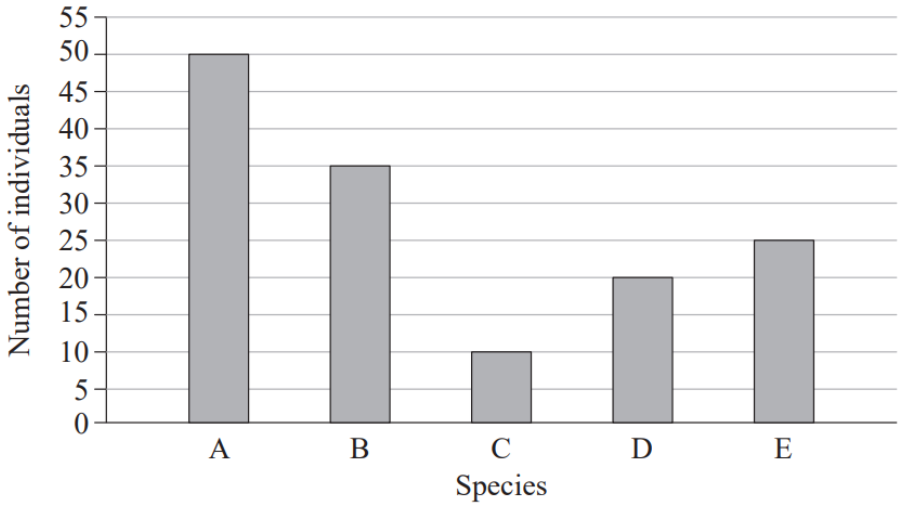
2020
Paper 1
Section 2
Question 21

Describing biodiversity

A count was conducted to determine the number of individuals for five different bird species in a woodland.



Calculate the relative percentage abundance of species B. Show your working. [2 marks]

Sample Response	The response
$\%\ abundance = \frac{no.\ individuals\ for\ species\ B}{no.\ individuals\ for\ all\ species} \times 100$ $\%\ abundance = \frac{35}{50+35+10+20+25} \times 100$ $\%\ abundance = \frac{35}{140} \times 100$ $= 25\%$	• shows accurate substitution [1 mark] • states 25% [1 mark]

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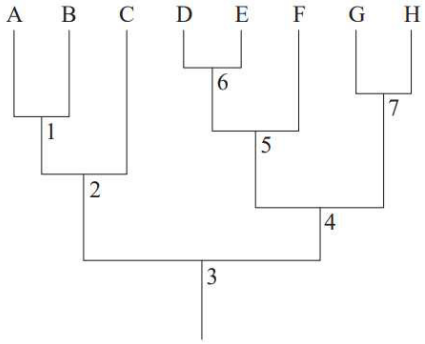
2020 Paper 1 Section 2 Question 22

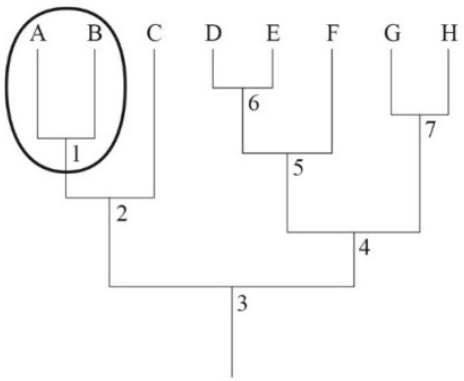
Describing biodiversity

The following cladogram proposes the evolutionary history of several fish phyla (A–H).



a) Define the term clade. Circle an example of a clade on the cladogram. [2 marks]

Note: If you make a mistake on the cladogram, cancel it by ruling a single diagonal line through your work and use the additional cladogram on page 13 of this question and response book.

Sample Response	The response
A clade is a group of organisms that consists of a common ancestor and all its lineal descendants.  	• states that a clade is a group of organisms that consists of a common ancestor and all its lineal descendants [1 mark] • identifies a clade [1 mark]
	•
	•

b) Which node (1–7) represents the most recent common ancestor for species E and G? [1 mark]

Sample Response	The response
Node 4	• states node 4 [1 mark]

c) Which two species shared the most recent common ancestor? [1 mark]

Sample Response	The response
D and E	• states D and E [1 mark]

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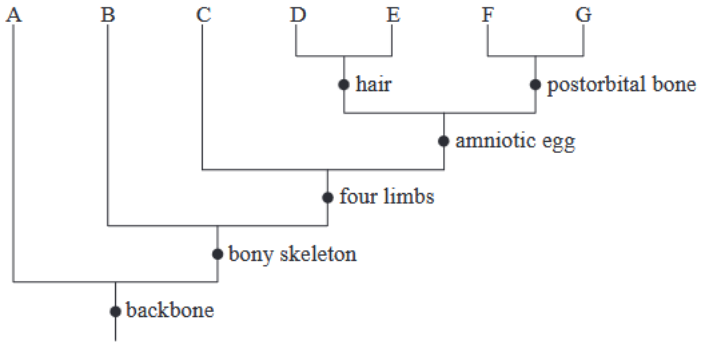
2024 Paper 2 Section 1 Question 1

Describing biodiversity

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



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

Sample response	The response
Species A	• identifies species A **[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]

Sample response	The response
Backbone, bony skeleton, four limbs	• identifies backbone, bony skeleton and four limbs **[1 mark]**

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

Sample response	The response
Hair and amniotic egg	• identifies hair and amniotic egg **[1 mark]**

2024 Paper 2 Section 1 Question 8

Describing biodiversity

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]

Sample response	The response
Species richness is five times higher in zone D than zone A. Zone A has two different species, whereas zone D has 10.	• identifies species richness is higher in zone D **[1 mark]** • provides appropriate data **[1 mark]**

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

Sample response	The response
As organic matter increased from 1% to 30%, the pH decreased from 8.4 to 6. This suggests that organic matter lowers soil pH.	• infers that organic matter lowers soil pH **[1 mark]** • justifies response using data **[1 mark]**

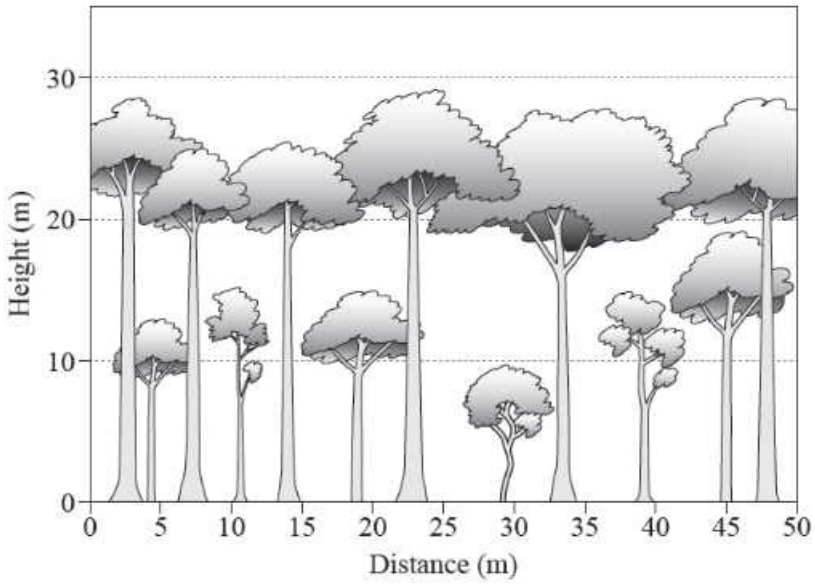
c) Predict which zone would have the highest proportion of K-selected species.
Explain your reasoning. [2 marks]

Sample response	The response
Zone D. Zone D is the oldest dune and has the highest species richness. This suggests it may be further along in succession. The number of K-selected species tends to increase as succession progresses.	• predicts zone D **[1 mark]** • provides appropriate reasoning **[1 mark]**

2023 Paper 2 Section 1 Question 1

Describing biodiversity

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

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a) Classify this ecosystem. [1 mark]

Sample response	The response
Closed-forest	• classifies the ecosystem as closed-forest **[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]

Sample response	The response
Set up three transects in representative sections of the community. Walk along each transect line, recording data on the height and type of vegetation. Use randomly placed quadrats along each transect line to collect data on percentage foliage cover of the tallest plant layer. Use the data to construct a profile diagram and identify the height and dominant vegetation in the tallest strata. A random number generator could be used to determine the location of quadrats to minimise bias.	• describes an appropriate technique to collect data on height of tallest plant layer **[1 mark]** • describes an appropriate technique to collect data on percentage foliage cover of the tallest plant layer **[1 mark]** • identifies a strategy for minimising bias **[1 mark]**

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]

Sample response	The response
If the logging event involved removing trees in the tallest plant layer, the percentage foliage cover and tallest plant layer could change. This would change the classification of the ecosystem. Specht's classification system would allow researchers to communicate information about changes in height and percentage cover of the tallest plant layer over time, so the progression back to closed-forest could be monitored.	• recognises that the logging could change the classification of the ecosystem **[1 mark]** • explains how Specht's classification system allows researchers to monitor recovery **[1 mark]**

2023 Paper 2 Section 1 Question 5

Describing biodiversity

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

Species	Nucleic acid sequence
B. bartonus	GACCGCATTTACGTA
B. deakinii	GACGTCATATCCGTA
B. reidus	GACCGCATTTCCGTA
B. watsonii	GACGGCATATCCGTA

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

Sample response	The response
Conserved sequences are assumed to accumulate mutations at a constant rate over time, so time since divergence can be predicted by the amount of genetic difference. Greater genetic difference means more time since divergence.	• explains that mutations occur at a constant rate in conserved sequences **[1 mark]** • recognises that greater genetic difference corresponds to more time since divergence **[1 mark]**

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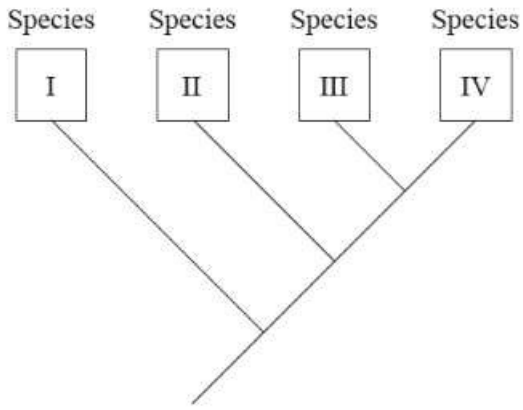
b) Use the data to infer species II-IV in the cladogram. [1 mark]



I: B. bartonus

Sample response	The response
I: *B. bartonus* II: ***B. reidus*** III: ***B. watsonii*** IV: ***B. deakinii***	• infers species II–IV **[1 mark]**

2022 Paper 2 Section 1 Question 9

Describing biodiversity

The biological species concept defines species as a group of organisms that can interbreed to produce fertile offspring.

a) Identify another method for defining a species. [1 mark]

Sample Response	The response
Phylogenetic species concept	• identifies another method for defining a species [1 mark]

b) Describe one limitation of the biological species concept and one limitation of the method identified in Question 9a). [2 marks]

Sample Response	The response
A limitation of the biological species concept is that it only applies to sexually reproducing organisms. A limitation of the phylogenetic species concept is that it requires significant morphological differences to allow for appropriate evaluation.	• identifies a limitation of the biological species concept [1 mark] • identifies a limitation of the method identified in Question 9a) [1 mark]

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2021 Paper 2 Section 1 Question 6

Describing biodiversity

The term *species* could be defined as 'one group of individuals that actually or potentially interbreed in nature'.

Identify two limitations of this definition. [2 marks]

Sample Response	The response
Two limitations are: 1. Sometimes only fossil evidence is available, so a species may be differentiated based on physiological and morphological features. 2. In some areas, hybridisation of plants and animals occurs, yet they are different species.	• states a limitation [1 mark] • states another limitation [1 mark]

2021 Paper 2 Section 1 Question 12

Describing biodiversity

An investigation compared mangrove species diversity for two areas of different size in the same catchment. The table shows species population counts for each area.

		Area 1	Area 2
Total species count	Grey mangrove	37	7
	Red mangrove	32	3
	Yellow mangrove	25	88
	SDI	0.67	?

a) Calculate Simpson's diversity index for Area 2. Show your working. [2 marks]

$$SDI = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

Sample Response	The response
$SDI = 1 - (\frac{7(7-1)+3(3-1)+88(88-1)}{98(98-1)})$ $= 0.19$	• shows substitution correctly performed [1 mark] • determines SDI = 0.19 [1 mark]

b) Using your answer for Question 12a), compare the diversity of the two areas. [3 marks]

Sample Response	The response
Area 2 has lower SDI than Area 1. While the communities' total populations are similar (94 to 98), Area 2 has a species that is dominant (Yellow mangroves) which causes the SDI in Area 2 to be much lower than Area 1.	• states a relevant similarity [1 mark] • states a relevant difference [1 mark] • states the significance of the identified differences [1 mark]

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2020 Paper 2 Section 1 Question 1

Describing biodiversity

a) Explain how a species interaction may be classified as symbiotic. [2 marks]

Sample Response	The response
Symbiosis is an interspecific interaction in which the species live together in a long term relationship.	• states that the interaction is -between different species [1 mark] -long-term [1 mark]

b) Using an example, describe the symbiotic relationship of mutualism. [2 marks]

Sample Response	The response
Mutualism means that both species benefit from the interaction. An example is the relationship between zooxanthellae (photosynthesis producing nutrients for coral) and coral polyps (hosting the zooxanthellae, providing home).	• describes mutualism [1 mark] • describes a relevant example where each organism benefits [1 mark]

2020 Paper 2 Section 1 Question 4

Describing biodiversity

An ecologist investigated the species composition of mangrove trees in a natural mangrove forest and an adjacent 30-year-old planted mangrove forest.

Three 10 m-wide belt transects were sampled from inland to the sea for each of the forests, each covering 100 m on average and placed to cover various strata.

The species diversity of Forest A was determined using the Simpson's Diversity Index (SDI):

$$SDI = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

	Population count	
Species	**Forest A (natural)**	**Forest B (planted)**
Grey mangrove	91	77
Red mangrove	23	14
River mangrove	11	8
Orange mangrove	3	0
Diversity	0.46	?

a) Use the SDI formula to calculate the diversity index for Forest B. Round your answer to two decimal places. [2 marks]

Sample Response	The response
SDI $= 1 - \frac{77(77-1) + 14(14-1) + 8(8-1)}{99(99-1)}$ $= 0.37$	• demonstrates correct substitution [1 mark] • states SDI = 0.37 [1 mark]

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b) Identify three reasons why the ecologist used a belt transect rather than line transects or randomly placed quadrats for collecting data to compare these two forests. [3 marks]

Sample Response	The response
Belt transects are used for abundance and distribution of species. Random quadrats can be used for abundance, not distribution, and line transects can be used for distribution, not abundance. Random sampling doesn't take into account strata (different areas) and may not cover all areas of habitat equally, giving inaccurate measures of diversity and abundance.	• states 3 reasons = 3 marks • states 2 reasons = 2 marks • states a reason = 1 mark • does not satisfy any of the descriptors above. = 0 marks

c) Identify one way in which the ecologist minimised bias in the sampling. [1 mark]

Sample Response	The response
The locations of belt transects were chosen to take strata into account.	• states a way to minimise bias [1 mark]

2020 Paper 2 Section 1 Question 7

Describing biodiversity

Species richness (S) can be determined using the Menhinick's Index, where s is the number of different species represented in a sample and N is the total number of individual organisms in the sample.

$$\text{Species richness (S)} = \frac{s}{\sqrt{N}}$$

Sampling of two communities (Community A and Community B) were completed, with Community A having S = 0.5 for the six species identified. The results for Community B are shown in the table.

Community B	
Species	**Number of individuals**
A	12
B	15
C	19
D	22
E	25
F	7

Use S to compare Community A with Community B. [4 marks]

Sample Response	The response
S = 6/√100 = 6/10 = 0.6 Community B has greater richness than Community A. Community B has a same number of different species as Community A (i.e. 6); however, Community A must have been for a larger sample.	• states that S = 0.6 [1 mark] • states that Community B has greater richness than Community A [1 mark] • states that Community A and Community B have same number of species [1 mark] • infers that Community B's sample size is smaller than Community A [1 mark]

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Unit 3 - Topic 2: Ecosystem dynamics

Paper 1 Section 1

2024 Paper 1 Section 1 Question 4

Ecosystem dynamics

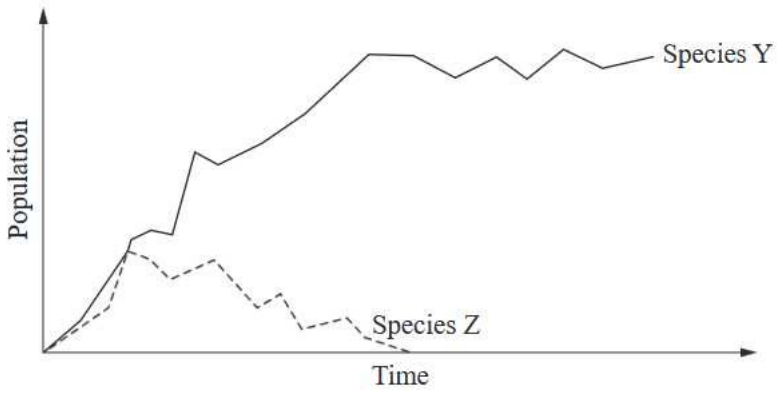
The table shows data on four plant species. Which is most likely to be a pioneer species?

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

2024 Paper 1 Section 1 Question 9

Ecosystem dynamics

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

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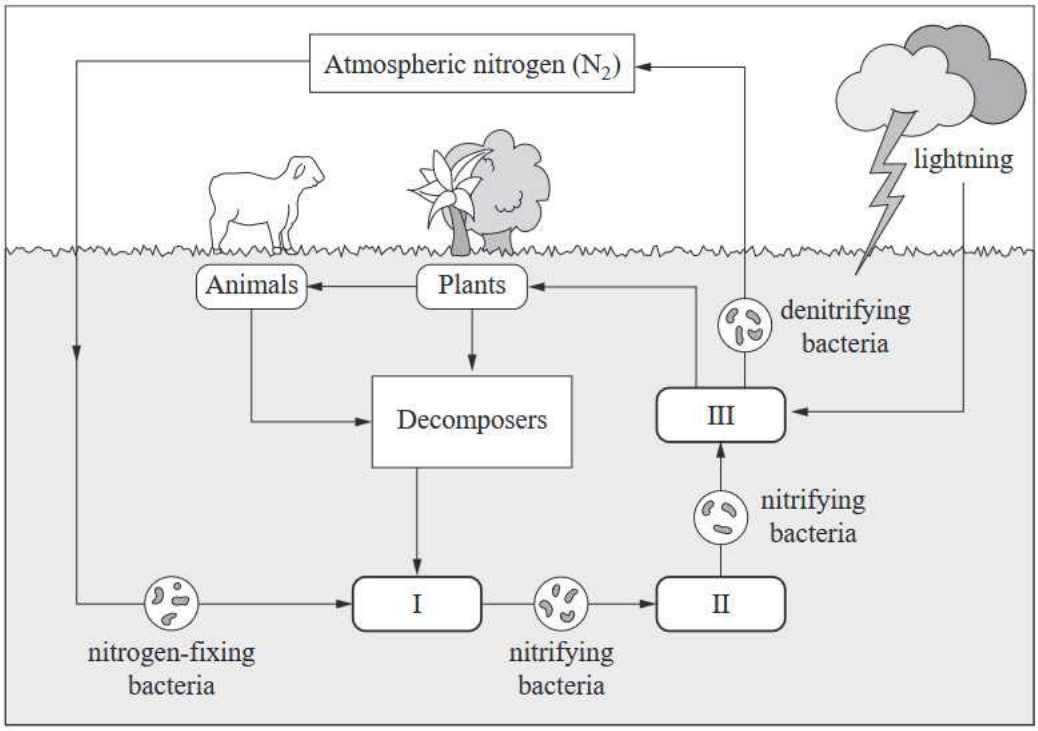
2024 Paper 1 Section 1 Question 12

Ecosystem dynamics

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^-)

2024 Paper 1 Section 1 Question 13

Ecosystem dynamics

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

(A) niche.
(B) ecoregion.
(C) environment.
(D) microhabitat.

2024 Paper 1 Section 1 Question 14

Ecosystem dynamics

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.

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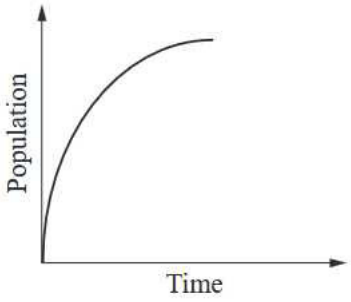
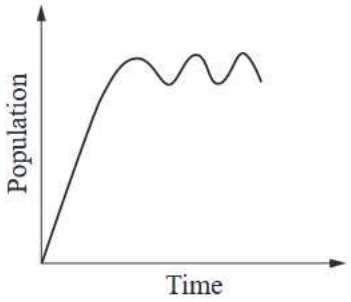
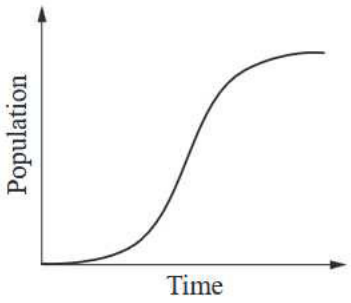
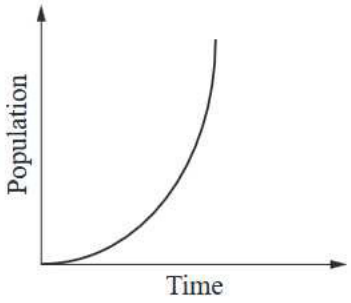
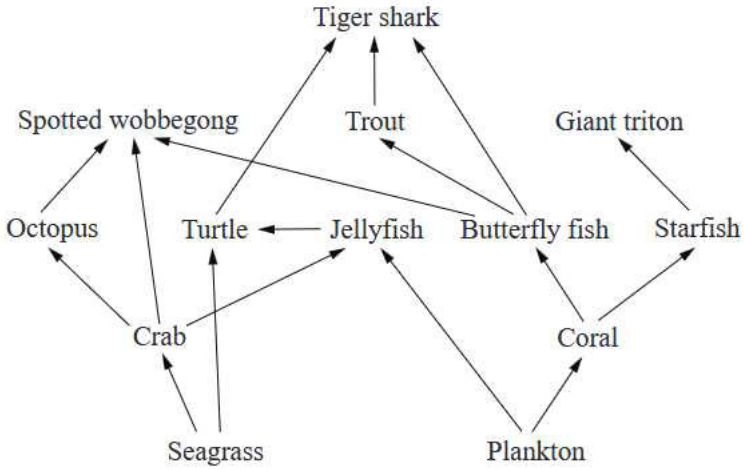
2024 Paper 1 Section 1 Question 15 Ecosystem dynamics	Which graph best illustrates exponential growth? (A)  (B)  (C)  (D) 

2024 Paper 1 Section 1 Question 16 Ecosystem dynamics	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

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2023 Paper 1 Section 1 Question 3

Ecosystem dynamics

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%

2023 Paper 1 Section 1 Question 9

Ecosystem dynamics

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.

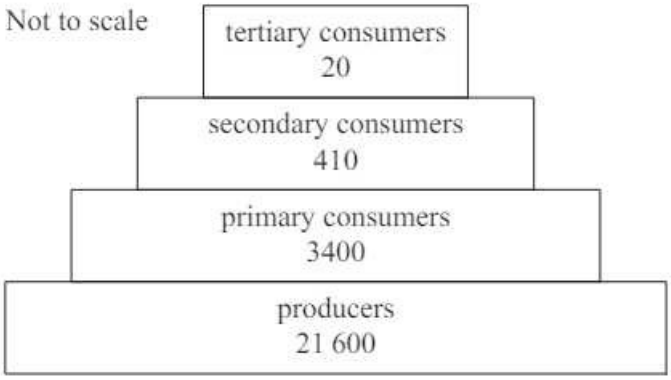
(C) all organisms occupying a physical space close enough to interact with each other.

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

2023 Paper 1 Section 1 Question 14

Ecosystem dynamics

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%

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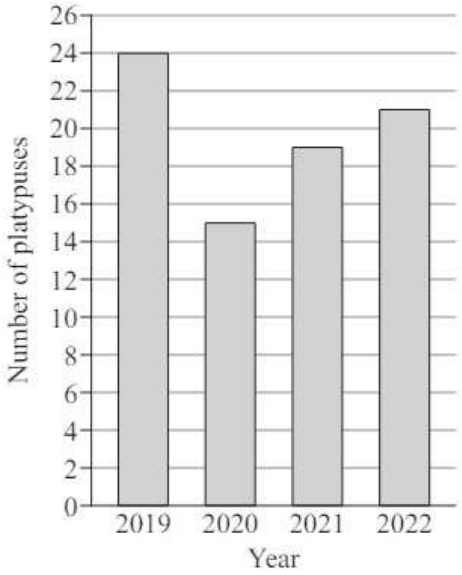
2023 Paper 1 Section 1 Question 20

Ecosystem dynamics

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

2022 Paper 1 Section 1 Question 5

Ecosystem dynamics

A researcher captured, marked and released 36 frogs. The following day they captured 24 frogs and 18 were marked.

Calculate the approximate size of the frog population using the Lincoln index: $N = \frac{M \times n}{m}$

(A) 27
(B) 48
(C) 54
(D) 60

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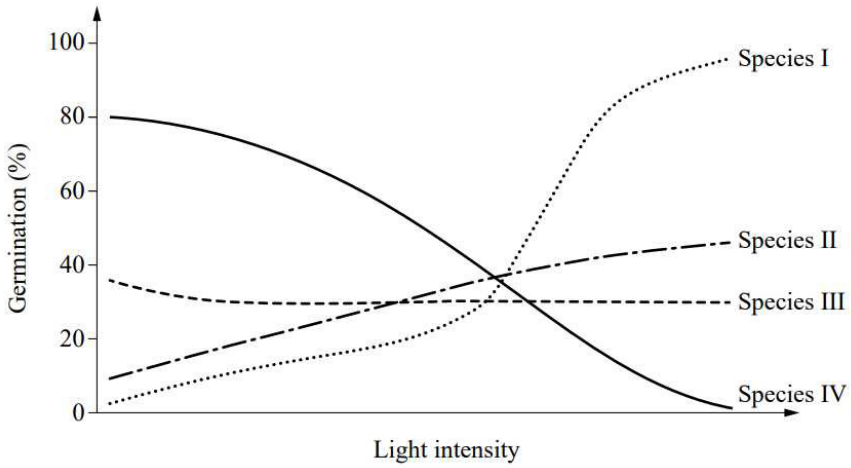
2022 Paper 1 Section 1 Question 18 Ecosystem dynamics	The competitive exclusion principle applies to different species occupying the same (A) niche. (B) habitat. (C) environment. (D) trophic level.

2022 Paper 1 Section 1 Question 19 Ecosystem dynamics	The graph shows the effect of light intensity on the germination success of seeds from four plant species.  Which is most likely to be a pioneer species? (A) I (B) II (C) III (D) IV

2021 Paper 1 Section 1 Question 2 Ecosystem dynamics	The process of change in the species structure of an ecological community over time is known as (A) cyclic succession. (B) primary succession. (C) ecological succession. (D) secondary succession

2021 Paper 1 Section 1 Question 3 Ecosystem dynamics	In ocean food webs, where phytoplankton is in the first trophic level, the second trophic level of zooplankton often has a higher biomass than the phytoplankton at any given time. Which explanation would account for this? (A) The zooplankton are also able to photosynthesise. (B) Different phytoplankton species are preying on each other. (C) Carnivores in the third trophic level have increased their consumption of zooplankton. (D) The phytoplankton multiply much faster than zooplankton, but their lifespan is shorter.

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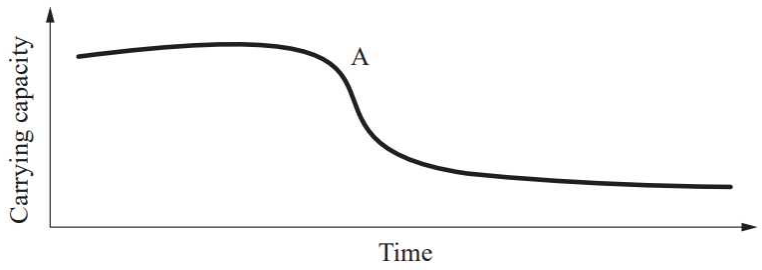
2021 Paper 1 Section 1 Question 5 Ecosystem dynamics	The graph shows changes for a penguin population and the theoretical carrying capacity of the environment.  Point A on the graph indicates a change in carrying capacity triggered by (A) an increase in penguin pathogens. (B) a decrease in the number of mates available. (C) a reduction in space available for nesting sites. (D) an introduced disease affecting the penguins' survival rates.

2021 Paper 1 Section 1 Question 11 Ecosystem dynamics	In which environment would primary succession occur? (A) fresh lava field (B) harvested wheat crop (C) grassland cleared by fire (D) forest damaged by a cyclone

2021 Paper 1 Section 1 Question 20 Ecosystem dynamics	A keystone species is defined as a species that (A) is the top predator in an ecosystem. (B) is a major producer in an ecosystem. (C) has a unique and crucial role in an ecosystem. (D) directly influences all species in an ecosystem.

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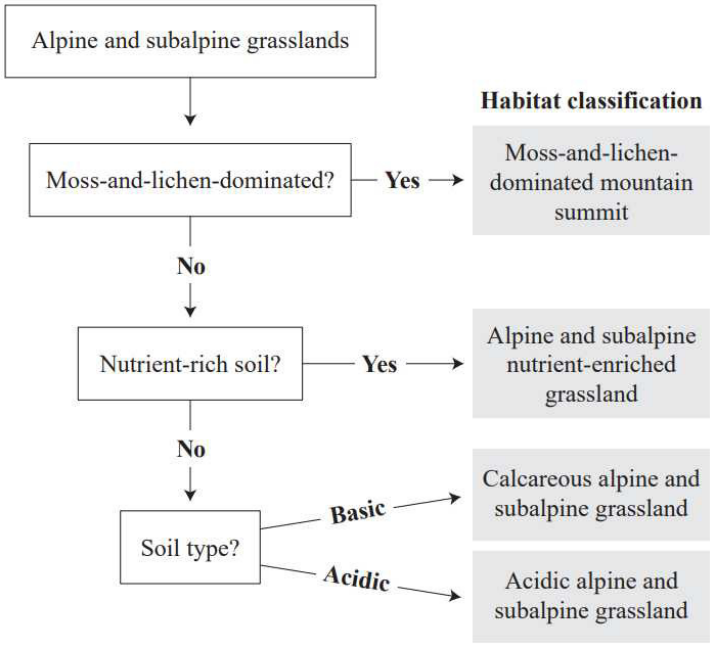
2020 Paper 1 Section 1 Question 4

Ecosystem dynamics

The following information includes:
• a key that is used to classify the types of alpine and subalpine grassland habitats
• a table of abiotic and biotic data obtained from a habitat survey.



Abiotic physical parameter	Reading	Reference range for nutrient-poor soil (mg/kg)
pH	6.1	
Nitrates/nitrites (mg/kg)	4	< 5
Ammonia (mg/kg)	1	< 4
Total phosphorous	16	< 20

Biotic description: Small amount of low-lying moss, growing on soil substrate. Predominantly low-lying grasses.

Using the data in the table and the key, this alpine and subalpine grassland would be classified as
(A) a moss-and-lichen-dominated mountain summit.
(B) an alpine and subalpine nutrient-enriched grassland.
(C) a calcareous alpine and subalpine grassland.
(D) an acidic alpine and subalpine grassland.

2020 Paper 1 Section 1 Question 6

Ecosystem dynamics

The carrying capacity of an ecosystem refers to the

(A) total biomass of primary producers in the ecosystem at a given time that supports the higher trophic levels.
(B) size of a population that can be supported indefinitely on the available resources and services of that ecosystem.
(C) number of individual top predators in the ecosystem at a given time that can be supported by the lower trophic levels.
(D) maximum population of individuals of different species that the ecosystem can support for an extended period of time.

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2020 Paper 1 Section 1 Question 7

Ecosystem dynamics

When predicting successional change, which of the following would typically indicate that an ecosystem is progressing toward its climax community?

	Abundance of K-selected species	Biomass
(A)	Increasing	Decreasing
(B)	Decreasing	Increasing
(C)	Increasing	Increasing
(D)	Decreasing	Decreasing

2020 Paper 1 Section 1 Question 8

Ecosystem dynamics

The table shows the daily energy input and output for a typical leaf.

Process	Energy value (kJ)
Incident sunlight	42.3
Evaporation	31.2
Heat loss (radiation)	2.1
Reflection of sunlight	6.1
Transmission of sunlight	2.1

Calculate the daily net energy stored by the leaf.

(A) 0.8 kJ
(B) 5.0 kJ
(C) 36.2 kJ
(D) 73.5 Kj

2020 Paper 1 Section 1 Question 9

Ecosystem dynamics

The table provides population statistics for a species of tree kangaroo in northern Queensland.

Year	Births	Deaths	Immigration	Emigration	Final population
2016	253	175	153	131	1100
2017	290	167	182	140	

Determine the population growth rate for tree kangaroos in 2017.

(A) 14.6%
(B) 15.0%
(C) 26.5%
(D) 86.9%

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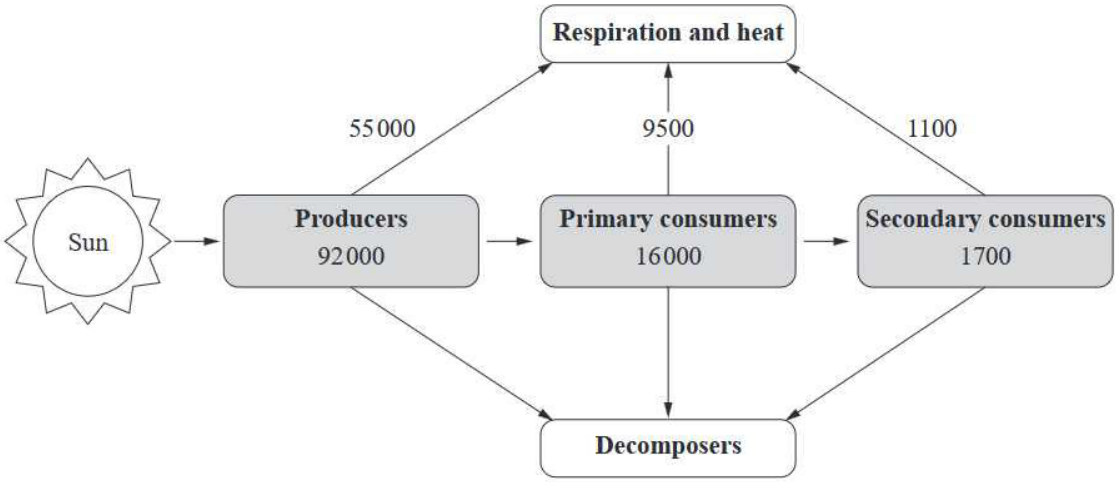
2024 Paper 1 Section 2 Question 26

Ecosystem dynamics

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]

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]

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2024 Paper 1 Section 2 Question 27

Ecosystem dynamics

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.

2023 Paper 1 Section 2 Question 22

Ecosystem dynamics

Describe two ways bacteria assist matter to cycle through ecosystems. [2 marks]

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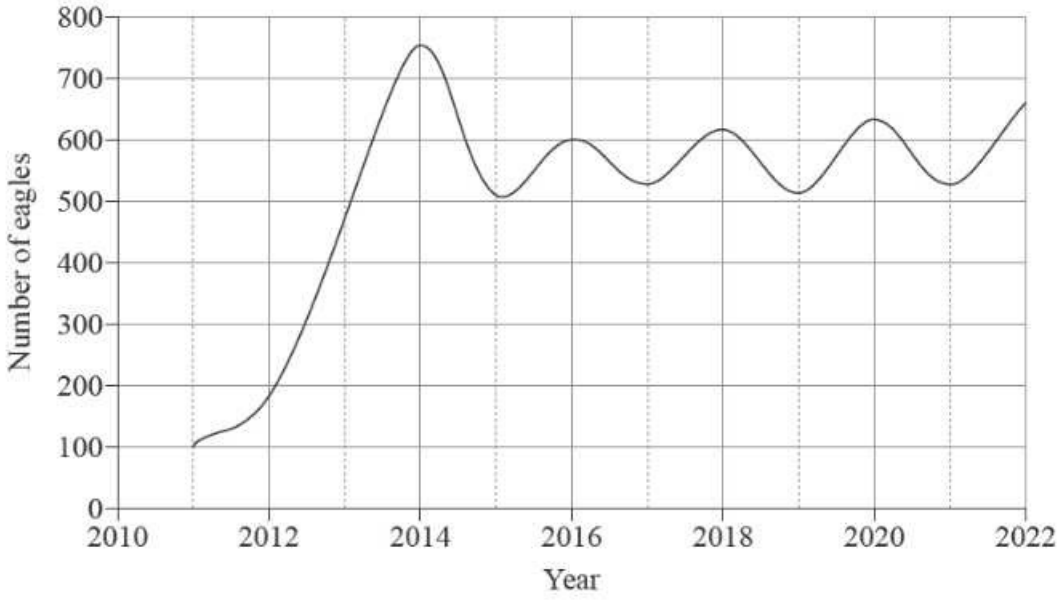
2023 Paper 1 Section 2 Question 26 Ecosystem dynamics	Wedge-tailed eagles are large birds that reside in tall trees, where they build nests for their young. They often feed on ground-dwelling herbivores such as kangaroos and rabbits. The graph shows the number of wedge-tailed eagles observed in an ecosystem over time. [3 marks]  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]
2022 Paper 1 Section 2 Question 21 Ecosystem dynamics	Describe two reproductive strategies used to distinguish K-strategists from r-strategists. [2 marks] Strategy 1: Strategy 2:

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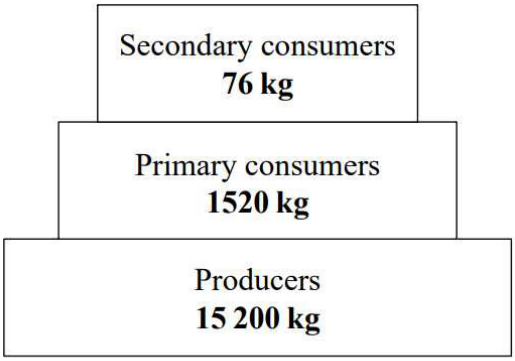
2021 Paper 1 Section 2 Question 22 Ecosystem dynamics	Describe two ways carbon is transformed and one way it is transferred as it cycles through the biotic components of an ecosystem. [3 marks]

2021 Paper 1 Section 2 Question 24 Ecosystem dynamics	The diagram is a hypothetical biomass pyramid for a community.  Not to scale a) Contrast the efficiency of the biomass transfers between each level of the pyramid. [3 marks] b) Explain the difference in biomass transfer efficiency identified in Question 24a). [2 marks]

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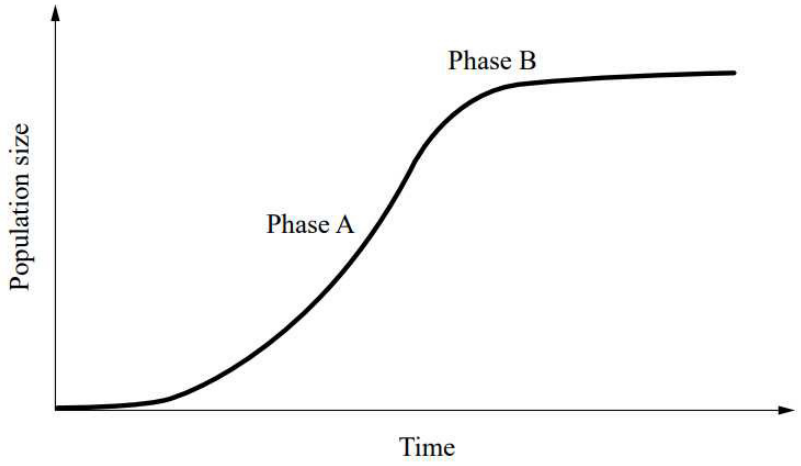
2021 Paper 1 Section 2 Question 28 **Ecosystem dynamics**	The graph depicts the population change of a species after it is introduced into a previously disturbed environment.  Referring to Phase A and Phase B, determine the population growth model for the species. [3 marks]

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2020 Paper 1 Section 2 Question 23

Ecosystem dynamics

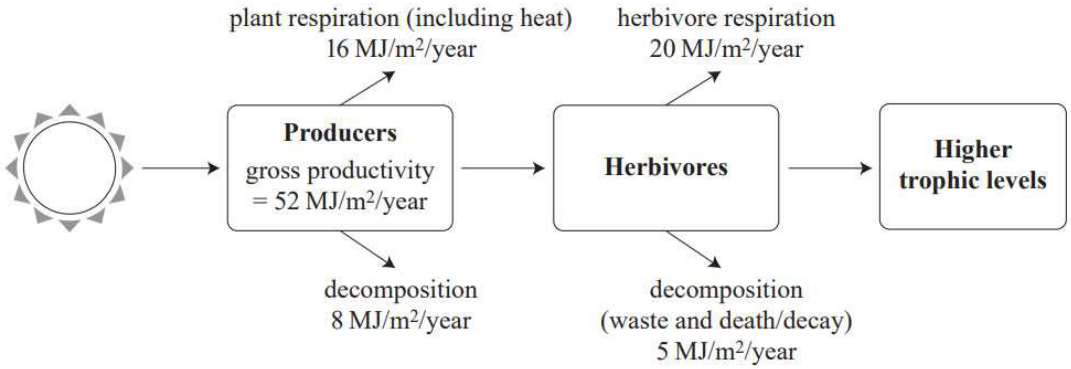
Describe differences between r-selected and K-selected species in terms of:
- number of offspring
- parental care and involvement
- lifespan. [3 marks]

	r-selected	K-selected
Number of offspring		
Parental care and involvement		
Lifespan		

2020 Paper 1 Section 2 Question 25

Ecosystem dynamics

The following simplified energy-flow diagram provides the gross productivity figures for producers and herbivores in an ecosystem.



a) Determine the net productivity for the producers and herbivores in this ecosystem. [2 marks]

Producers:

Net productivity = _____ MJ/m²/year

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	Herbivores: Net productivity = _____ $MJ/m^2/year$ b) Contrast the outputs of energy for the two trophic levels in the diagram. [2 marks]

2020 Paper 1 Section 2 Question 28 Ecosystem dynamics	Identify two differences between primary and secondary ecological succession. Refer to one example of each type of succession in your response. [4 marks]

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Paper 2 Section 1

2024 Paper 2 Section 1 Question 2 **Ecosystem dynamics**	a) Define carrying capacity. [1 mark] b) Identify two factors that affect the carrying capacity of plant species in an ecosystem. [2 marks]

2024 Paper 2 Section 1 Question 3 **Ecosystem dynamics**	The table shows data for a population in 2023. Calculate the population growth rate. Show your working

Starting population	Births	Deaths	Immigration	Emigration
4000	835	324	34	65

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2024 Paper 2 Section 1 Question 11 Ecosystem dynamics	a) Describe the process of ecological succession. [3 marks] b) Distinguish between primary and secondary succession. [1 mark]

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2023 Paper 2 Section 1 Question 2 Ecosystem dynamics	The diagram shows feeding relationships for an Australian ecosystem. ***Copyright restrictions prohibit the release of this QCAA exam material.*** a) Use the data to explain why dingoes are a keystone species. [2 marks] 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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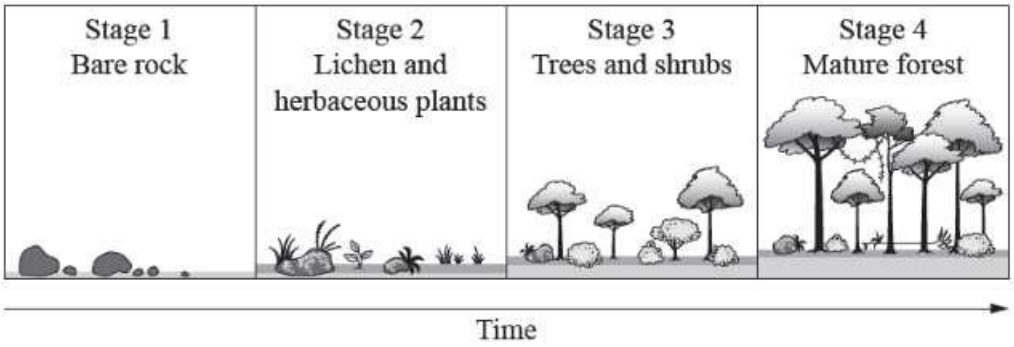
2023 Paper 2 Section 1 Question 7 Ecosystem dynamics	The diagram shows the stages of succession in an ecosystem.  a) Identify the type of ecological succession depicted. Explain your reasoning. [2 marks] b) Infer two features of the species in stage 2 and describe the role of these species in ecological succession. [3 marks]

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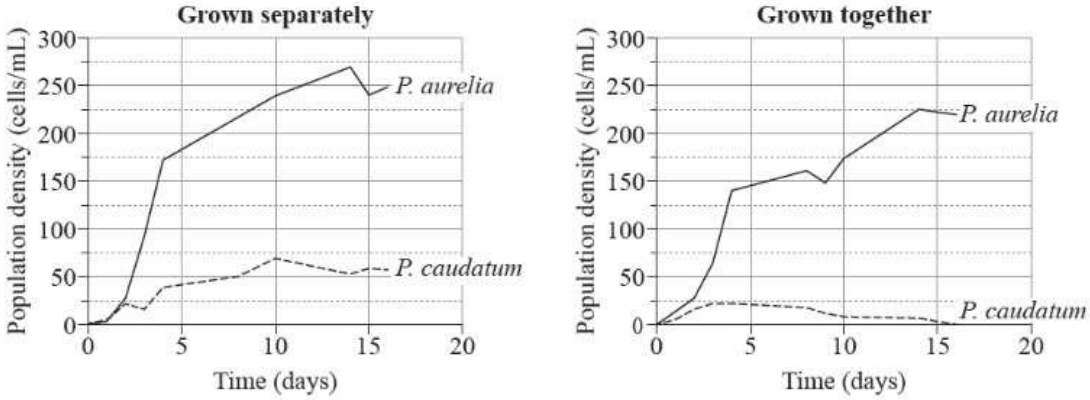
2023 Paper 2 Section 1 Question 9

Ecosystem dynamics

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. auerlia* in the two graphs. [3 marks]

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

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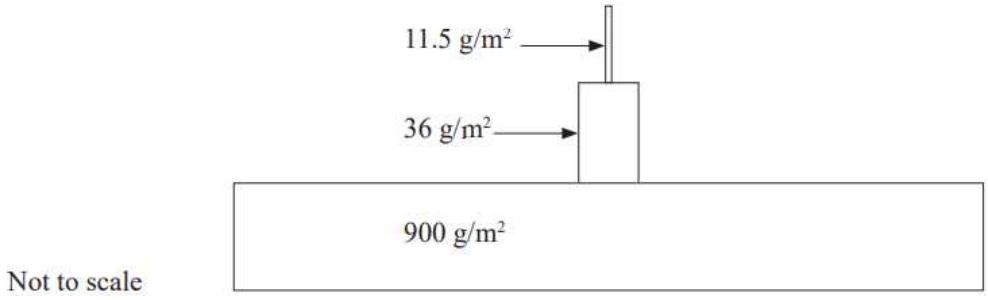
2022 Paper 2 Section 1 Question 2

Ecosystem dynamics

This is a biomass pyramid for a grassland community.



a) Calculate the percentage energy transfer between the first two trophic levels.
Show your working. [2 marks]

b) Explain the loss of biomass between trophic levels. [2 marks]

2022 Paper 2 Section 1 Question 3

Ecosystem dynamics

A glacier has retreated, leaving a large amount of gravel, small rocks, sand and mud.

a) Explain the steps of succession that would occur if the glacier continues to retreat. [3 marks]

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b) Identify the type of ecological succession. [1 mark]

2022 Paper 2 Section 1 Question 4

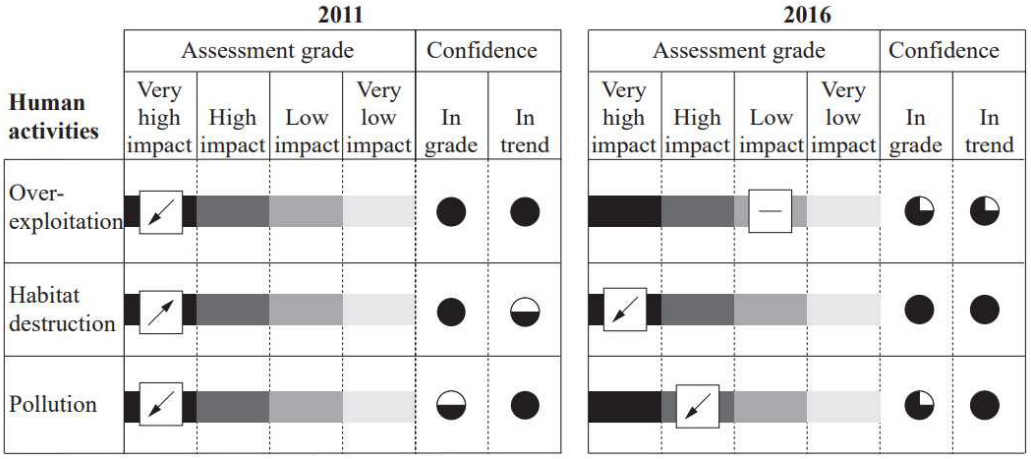
Ecosystem dynamics

Define keystone species. (1 mark)

2022 Paper 2 Section 1 Question 6

Ecosystem dynamics

An environmental report identified overexploitation, habitat destruction and pollution as human activities affecting biodiversity in Australia. The tables show the estimated impact of each activity in 2011 and 2016.



Recent trends	Grade	Confidence
Improving Getting worse Stable	**Very low impact:** Few, if any, species and/or ecosystems are suffering substantial adverse effects from this pressure	**Adequate:** Adequate high-quality evidence **and** high level of consensus
	Low impact: A small proportion of species and/or ecosystems are suffering substantial adverse effects from this pressure	**Somewhat adequate:** Adequate high-quality evidence **or** high level of consensus
	High impact: A significant proportion of species and/or ecosystems are suffering substantial adverse effects from this pressure	**Limited:** Limited evidence **or** limited consensus
	Very high impact: A large proportion of species and/or ecosystems are suffering substantial adverse effects from this pressure	**Very limited:** Limited evidence **and** limited consensus

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a) Explain how one human activity identified in the tables could reduce biodiversity. [1 mark]

b) Predict which human activities will have the highest and lowest impact on biodiversity in 2023. Explain your reasoning using evidence from the tables. [4 marks]

Highest impact:

Lowest impact:

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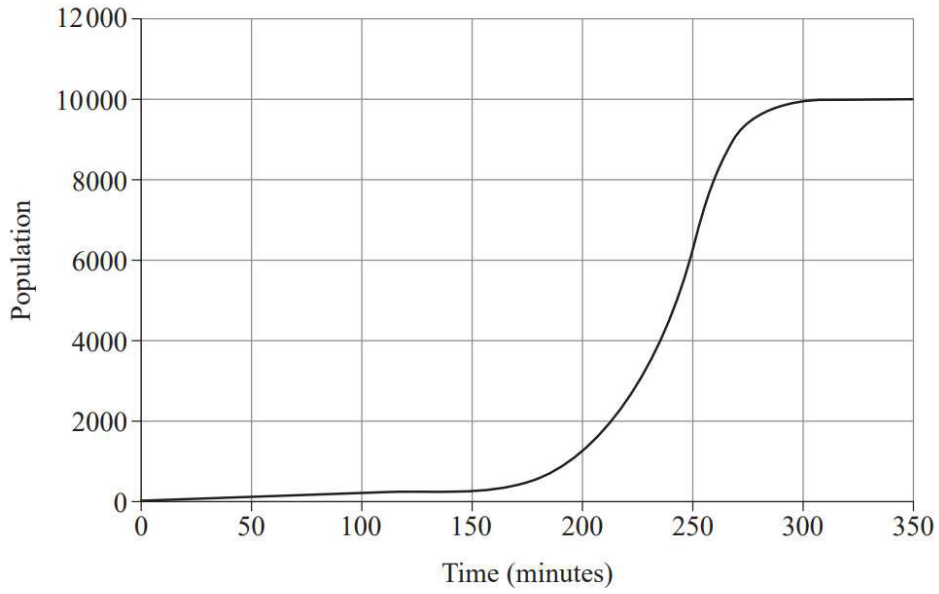
2022
Paper 2
Section 1
Question 7

Ecosystem dynamics

The graph shows the population of bacteria in a Petri dish over time.

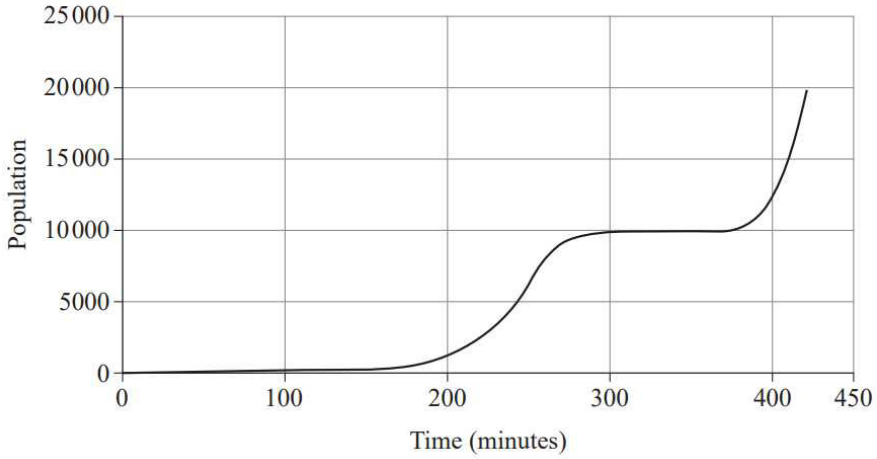


a) Identify the mode of population growth. [1 mark]

---

b) Determine the carrying capacity under these conditions. [1 mark]

Conditions were modified at 380 minutes and the population continued to be monitored. Results are shown.



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	c) Identify two modifications that could cause this change. Explain your reasoning. [4 marks]

2021 Paper 2 Section 1 Question 1 **Ecosystem dynamics**	Explain how one abiotic and one biotic factor will affect the population of mosquito larvae in a freshwater pond. [4 marks]

2021 Paper 2 Section 1 Question 3 **Ecosystem dynamics**	In coastal areas and deserts, bare sand dunes may be colonised by plants such as members of the Poaceae family (grasses). Identify three features of these plants that make them effective colonisers. [3 marks]

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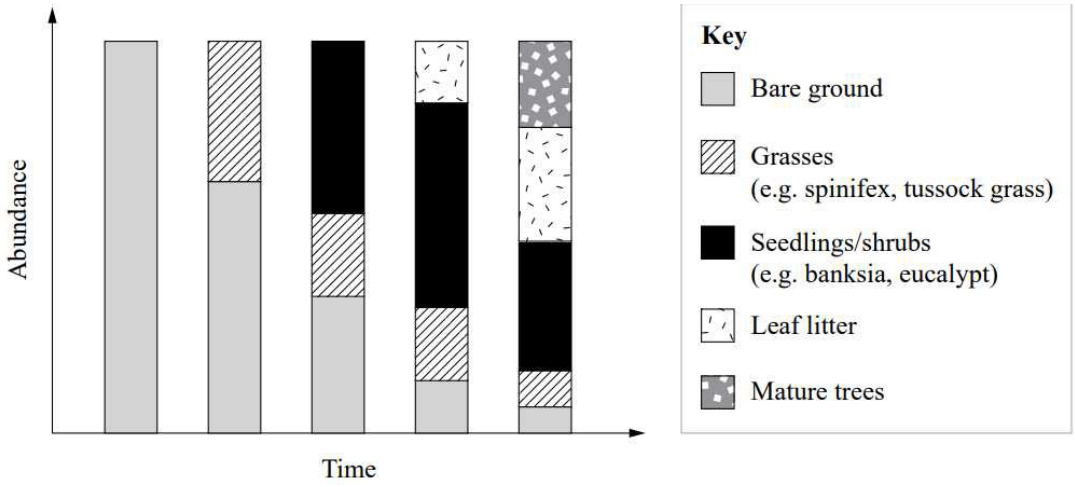
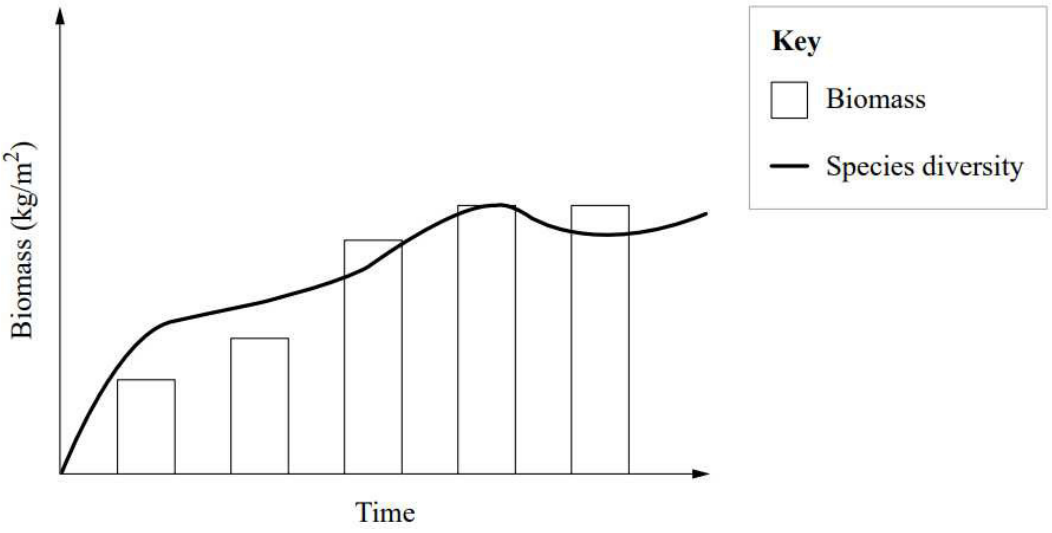
2021
Paper 2
Section 1
Question 13

Ecosystem dynamics

The data shows changes in relative abundance of ground cover, biomass and species diversity for an abandoned sand mine site over time.





Based on the information provided, predict whether further ecological succession would occur in this community. Justify your answer with two relevant reasons. [3 marks]

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2020 Paper 2 Section 1 Question 2

Ecosystem dynamics

Two species of *Paramecium*, single-celled microorganisms, were grown for 4 days in test tubes with a fixed amount of algae added to each tube daily as their food source. The life span for each species ranges from 4–6 hours.

Test tubes 1 and 2 each contained a single species, and test tube 3 initially contained both species.

	Live *Paramecium* population after 4 days (per mL)	
Test tube	**Species A**	**Species B**
1	245	0
2	0	104
3	120	0

a) Identify and describe the ecological principle that relates to these observations. [2 marks]

b) Explain the results of the experiment. [3 marks]

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2020 Paper 2 Section 1 Question 6

Ecosystem dynamics

The Bush Stone-curlew is a large, mainly nocturnal, ground-dwelling bird found on Hamilton Island. Bush Stone-curlews have a wide-ranging diet but prefer to feed on insects, molluscs, small lizards, seeds and, occasionally, small mammals. During the breeding season, nesting birds will search for food in the vicinity of the nest site.

a) Identify one factor that would influence carrying capacity on the island. [1 mark]

b) Discuss one way the carrying capacity of the Bush Stone-curlew on Hamilton Island could be positively or negatively affected in the future. [2 marks]

2020 Paper 2 Section 1 Question 8

Ecosystem dynamics

In an experiment studying the population dynamics of the house fly, two adult house flies were placed in a fly cage with a limited food supply. Population data was collected, as summarised in the table.

Generation	Number of eggs	Number of larvae	Number of pupae	Number of adults
1	0	0	0	2
2	120	110	95	88
3	250	225	213	210
4	500	475	462	12
5	20	2	0	0

Determine the population growth model exhibited by the house fly. Explain your reasoning. [3 marks]

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2024 Paper 1 Section 1 Question 4

Ecosystem dynamics

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

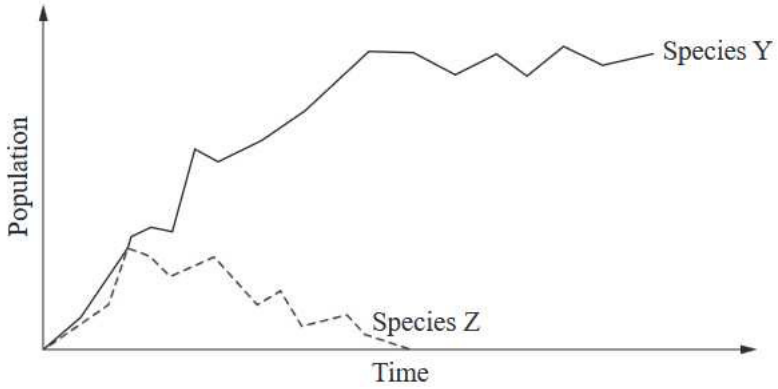
	Germination rate	Presence of nitrogen-fixing bacteria
(A)	slow	present
(B)	slow	not present
(C)	rapid	present
(D)	rapid	not present

Answer is C.

2024 Paper 1 Section 1 Question 9

Ecosystem dynamics

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 – Answer
(D) competition, where species Z outcompeted species Y

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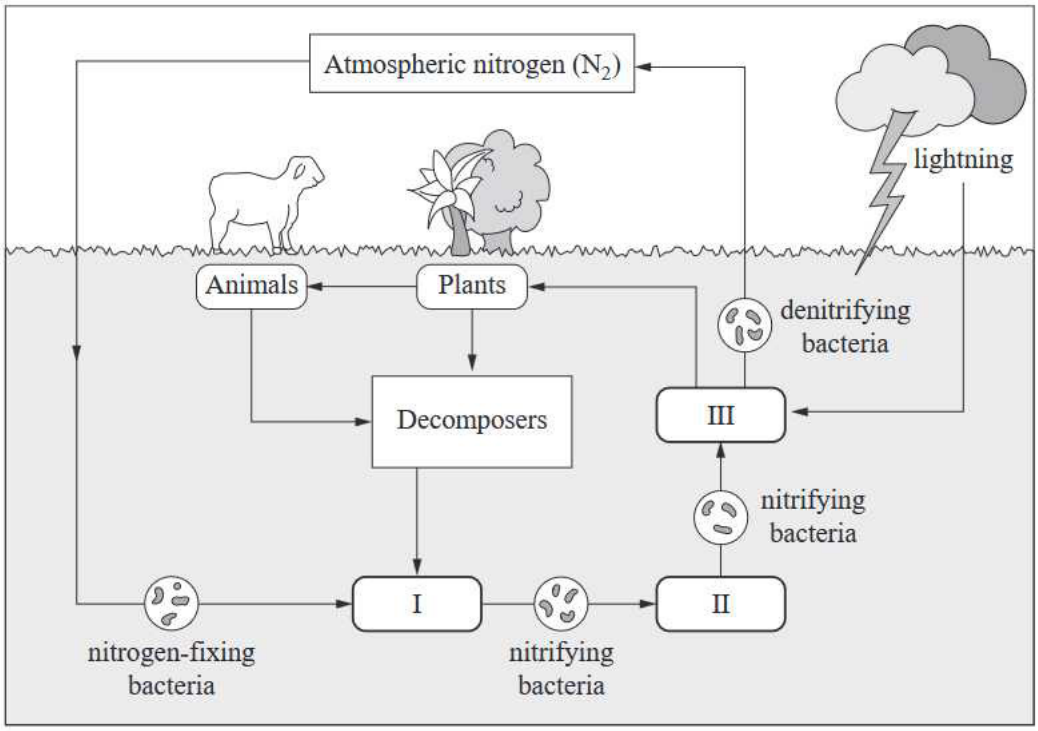
2024 Paper 1 Section 1 Question 12

Ecosystem dynamics

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^-)

Answer is D.

2024 Paper 1 Section 1 Question 13

Ecosystem dynamics

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

(A) niche. – Answer
(B) ecoregion.
(C) environment.
(D) microhabitat.

2024 Paper 1 Section 1 Question 14

Ecosystem dynamics

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

(A) have more offspring. – Answer
(B) have longer lifespans.
(C) reach sexual maturity later.
(D) live in more stable habitats.

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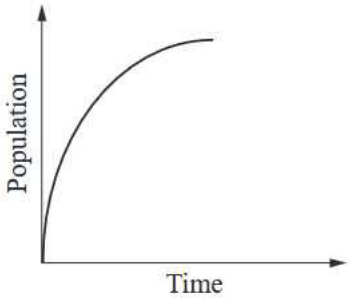
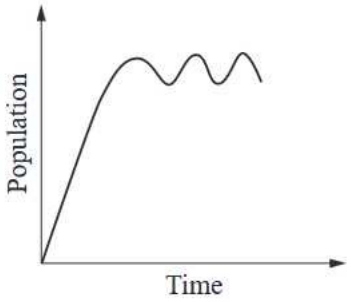
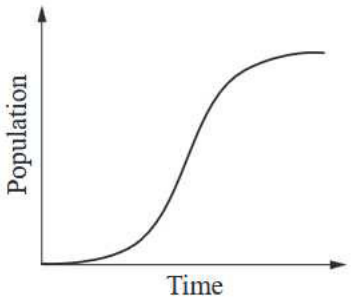
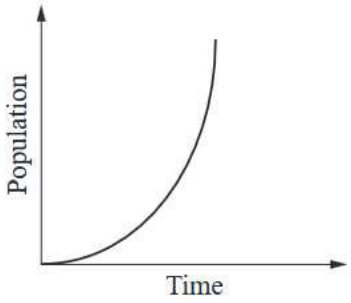
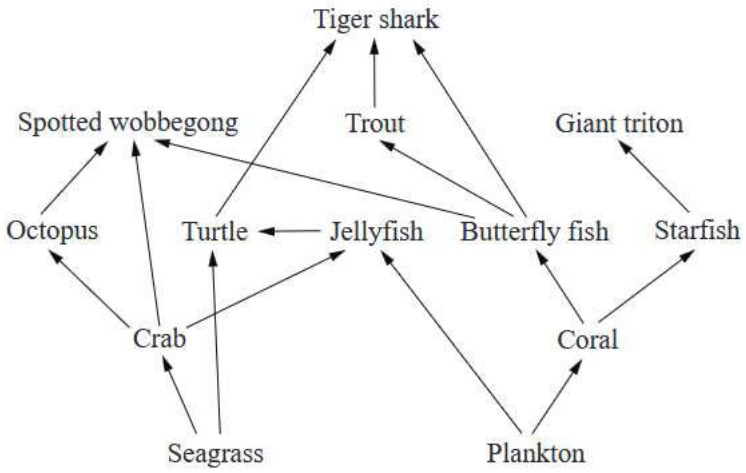
2024 Paper 1 Section 1 Question 15 Ecosystem dynamics	Which graph best illustrates exponential growth? (A)  (B)  (C)  (D)  **Answer is D.**

2024 Paper 1 Section 1 Question 16 Ecosystem dynamics	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 – Answer** (D) spotted wobbegong

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2023 Paper 1 Section 1 Question 3

Ecosystem dynamics

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% – Answer
(C) 55%
(D) 73%

2023 Paper 1 Section 1 Question 9

Ecosystem dynamics

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.

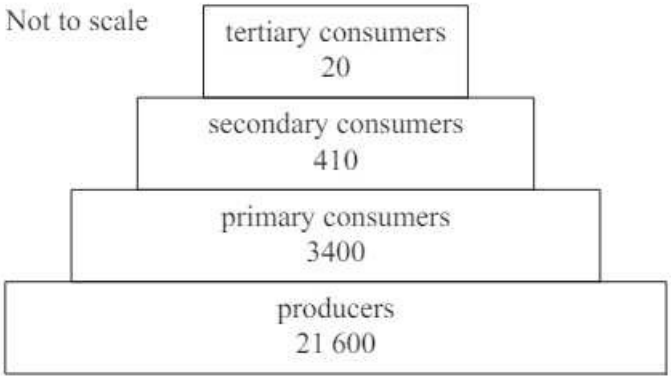
(D) the largest population of a particular species that can be supported by an ecosystem.

Answer is B.

2023 Paper 1 Section 1 Question 14

Ecosystem dynamics

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% – Answer

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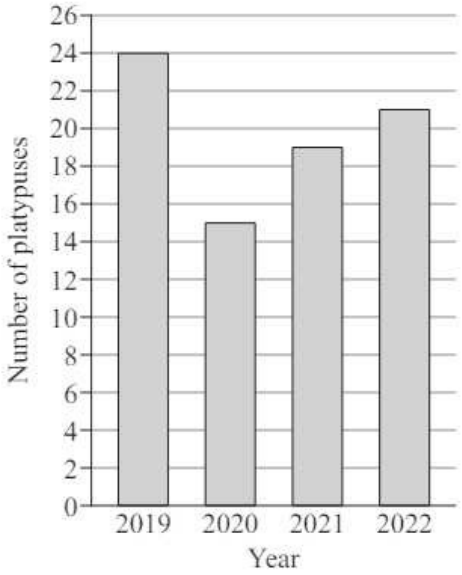
2023 Paper 1 Section 1 Question 20

Ecosystem dynamics

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 – Answer

2022 Paper 1 Section 1 Question 5

Ecosystem dynamics

A researcher captured, marked and released 36 frogs. The following day they captured 24 frogs and 18 were marked.

Calculate the approximate size of the frog population using the Lincoln index: $N = \frac{M \times n}{m}$

(A) 27
(B) 48 – Answer
(C) 54
(D) 60

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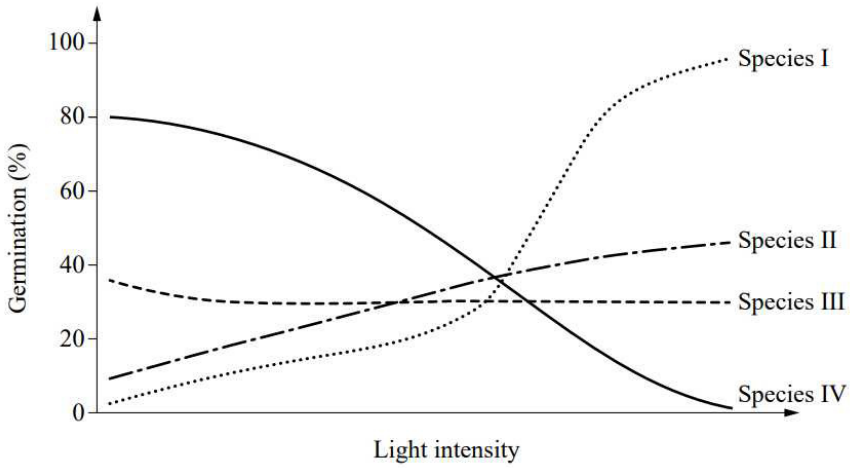
2022 Paper 1 Section 1 Question 18 Ecosystem dynamics	The competitive exclusion principle applies to different species occupying the same **(A) niche. – Answer** (B) habitat. (C) environment. (D) trophic level.

2022 Paper 1 Section 1 Question 19 Ecosystem dynamics	The graph shows the effect of light intensity on the germination success of seeds from four plant species.  Which is most likely to be a pioneer species? **(A) I – Answer** (B) II (C) III (D) IV

2021 Paper 1 Section 1 Question 2 Ecosystem dynamics	The process of change in the species structure of an ecological community over time is known as (A) cyclic succession. (B) primary succession. **(C) ecological succession. – Answer** (D) secondary succession

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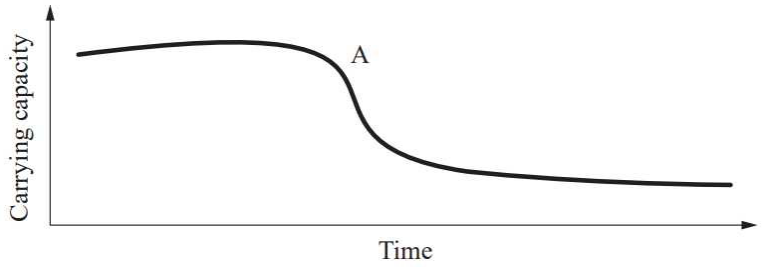
2021 Paper 1 Section 1 Question 3 Ecosystem dynamics	In ocean food webs, where phytoplankton is in the first trophic level, the second trophic level of zooplankton often has a higher biomass than the phytoplankton at any given time. Which explanation would account for this? (A) The zooplankton are also able to photosynthesise. (B) Different phytoplankton species are preying on each other. (C) Carnivores in the third trophic level have increased their consumption of zooplankton. **(D) The phytoplankton multiply much faster than zooplankton, but their lifespan is shorter. – Answer**

2021 Paper 1 Section 1 Question 5 Ecosystem dynamics	The graph shows changes for a penguin population and the theoretical carrying capacity of the environment.  Point A on the graph indicates a change in carrying capacity triggered by (A) an increase in penguin pathogens. (B) a decrease in the number of mates available. **(C) a reduction in space available for nesting sites. – Answer** (D) an introduced disease affecting the penguins' survival rates.

2021 Paper 1 Section 1 Question 11 Ecosystem dynamics	In which environment would primary succession occur? **(A) fresh lava field – Answer** (B) harvested wheat crop (C) grassland cleared by fire (D) forest damaged by a cyclone

2021 Paper 1 Section 1 Question 20 Ecosystem dynamics	A keystone species is defined as a species that (A) is the top predator in an ecosystem. (B) is a major producer in an ecosystem. **(C) has a unique and crucial role in an ecosystem. – Answer** (D) directly influences all species in an ecosystem.

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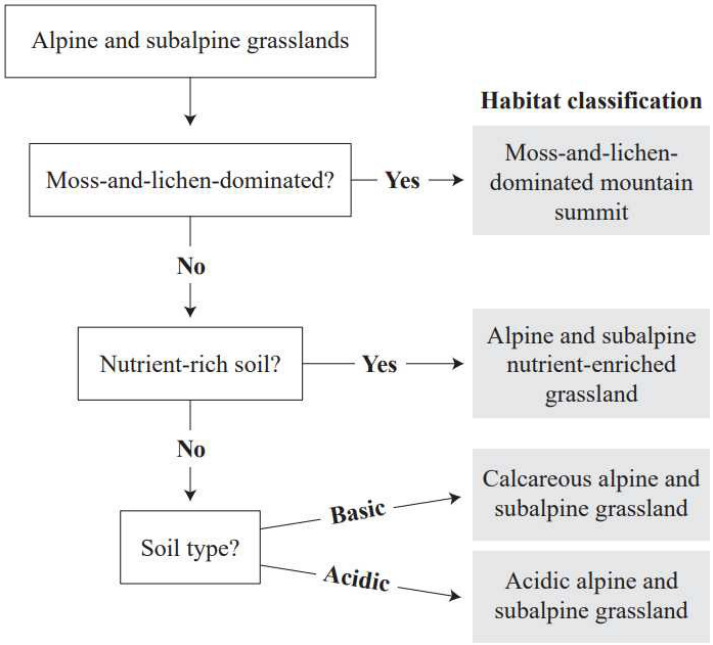
2020 Paper 1 Section 1 Question 4

Ecosystem dynamics

The following information includes:
• a key that is used to classify the types of alpine and subalpine grassland habitats
• a table of abiotic and biotic data obtained from a habitat survey.



Abiotic physical parameter	Reading	Reference range for nutrient-poor soil (mg/kg)
pH	6.1	
Nitrates/nitrites (mg/kg)	4	< 5
Ammonia (mg/kg)	1	< 4
Total phosphorous	16	< 20

Biotic description: Small amount of low-lying moss, growing on soil substrate. Predominantly low-lying grasses.

Using the data in the table and the key, this alpine and subalpine grassland would be classified as
(A) a moss-and-lichen-dominated mountain summit.
(B) an alpine and subalpine nutrient-enriched grassland.
(C) a calcareous alpine and subalpine grassland.
(D) an acidic alpine and subalpine grassland. – Answer

2020 Paper 1 Section 1 Question 6

Ecosystem dynamics

The carrying capacity of an ecosystem refers to the

(A) total biomass of primary producers in the ecosystem at a given time that supports the higher trophic levels.
(B) size of a population that can be supported indefinitely on the available resources and services of that ecosystem. – Answer
(C) number of individual top predators in the ecosystem at a given time that can be supported by the lower trophic levels.
(D) maximum population of individuals of different species that the ecosystem can support for an extended period of time.

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2020 Paper 1 Section 1 Question 7

Ecosystem dynamics

When predicting successional change, which of the following would typically indicate that an ecosystem is progressing toward its climax community?

	Abundance of K-selected species	Biomass
(A)	Increasing	Decreasing
(B)	Decreasing	Increasing
(C)	Increasing	Increasing
(D)	Decreasing	Decreasing

Answer is C.

2020 Paper 1 Section 1 Question 8

Ecosystem dynamics

The table shows the daily energy input and output for a typical leaf.

Process	Energy value (kJ)
Incident sunlight	42.3
Evaporation	31.2
Heat loss (radiation)	2.1
Reflection of sunlight	6.1
Transmission of sunlight	2.1

Calculate the daily net energy stored by the leaf.

(A) 0.8 kJ – Answer
(B) 5.0 kJ
(C) 36.2 kJ
(D) 73.5 Kj

2020 Paper 1 Section 1 Question 9

Ecosystem dynamics

The table provides population statistics for a species of tree kangaroo in northern Queensland.

Year	Births	Deaths	Immigration	Emigration	Final population
2016	253	175	153	131	1100
2017	290	167	182	140	

Determine the population growth rate for tree kangaroos in 2017.

(A) 14.6%
(B) 15.0% – Answer
(C) 26.5%
(D) 86.9%

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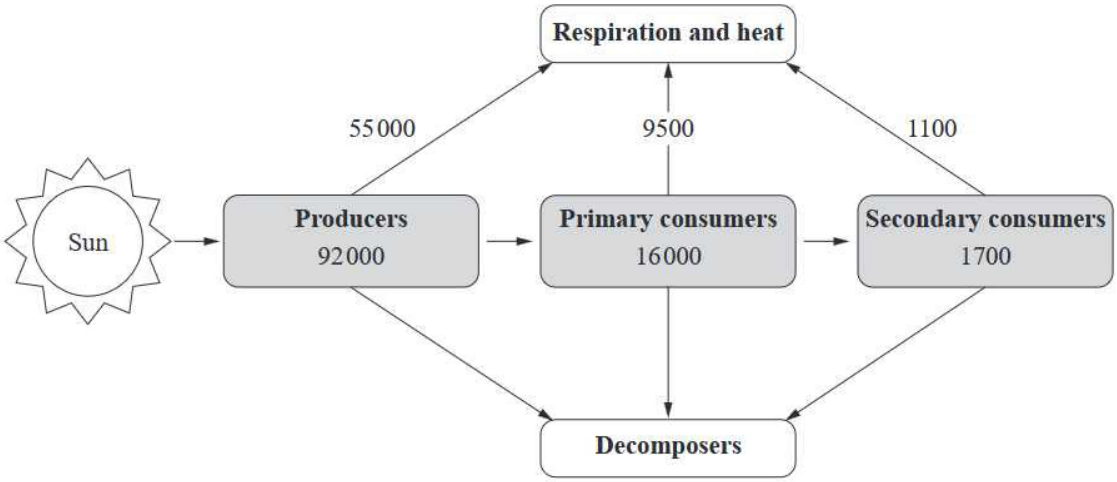
2024 Paper 1 Section 2 Question 26

Ecosystem dynamics

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]

Sample response	The response
Transfer efficiency = (1700/16 000) x 100% = 11%	• determines transfer efficiency **[1 mark]** • provides appropriate working **[1 mark]**

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

Sample response	The response
Energy lost to decomposers = 92 000 – (55 000 + 16 000) = 21 000 kJ m^{-2} $year^{-1}$	• determines 21 000 **[1 mark]** • provides appropriate working **[1 mark]**

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

Sample response	The response
Primary producers convert solar energy into chemical energy in the form of glucose through photosynthesis. At each level of the food chain some chemical energy is transformed into heat energy as organisms use it to drive their biochemical processes (respiration).	• describes one way energy is transformed **[1 mark]** • describes a second way energy is transformed **[1 mark]**

2024 Paper 1 Section 2 Question 27

Ecosystem dynamics

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	?

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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.

Sample response	The response
$N(\text{researcher I}) = \frac{M \times n}{m}$ $= \frac{160 \times 140}{80}$ $= 280$ $280 = \frac{100 \times 60}{m(\text{researcher II})}$ $m = \frac{100 \times 60}{280}$ $= 21 \text{ mice}$	• calculates *N* for researcher I **[1 mark]** • determines expected *m* for researcher II **[1 mark]**

2023 Paper 1 Section 2 Question 22

Ecosystem dynamics

Describe two ways bacteria assist matter to cycle through ecosystems. [2 marks]

Sample response	The response
Heterotrophic bacteria break down dead remains and organic waste into CO_2, which is released into the atmosphere for use by plants in photosynthesis. Nitrogen-fixing bacteria convert atmospheric nitrogen into nitrates, which can be used by plants for protein synthesis.	• describes a way that bacteria assist matter to cycle through ecosystems **[1 mark]** • describes another way that bacteria assist matter to cycle through ecosystems **[1 mark]**

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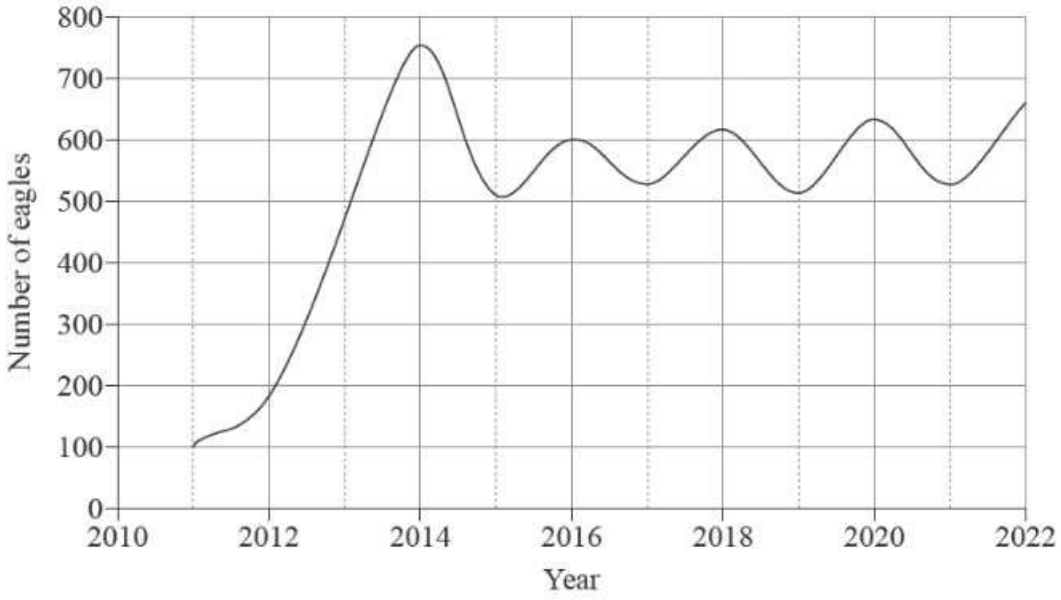
2023 Paper 1 Section 2 Question 26

Ecosystem dynamics

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. [3 marks]



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

Sample response	The response
Approximately 550	• identifies carrying capacity **[1 mark]**

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

Sample response	The response
Natural disasters (such as bushfire) could remove trees from the ecosystem, affecting the availability of nesting sites. This would reduce the number of offspring the ecosystem could support.	• identifies an abiotic factor that could reduce the carrying capacity **[1 mark]** • explains how a change to this abiotic factor could reduce the carrying capacity **[1 mark]**

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2022 Paper 1 Section 2 Question 21

Ecosystem dynamics

Describe two reproductive strategies used to distinguish K-strategists from r-strategists. [2 marks]

Sample Response	The response
Strategy 1: Number of offspring — K-strategists have fewer offspring than r-strategists.	• • describes one reproductive strategy used to distinguish K-strategists from r-strategists [1 mark]
Strategy 2: Age of reproduction — K-strategists reproduce at a later age than r-strategists.	• describes a second reproductive strategy used to distinguish K-strategists from r-strategists [1 mark]

2021 Paper 1 Section 2 Question 22

Ecosystem dynamics

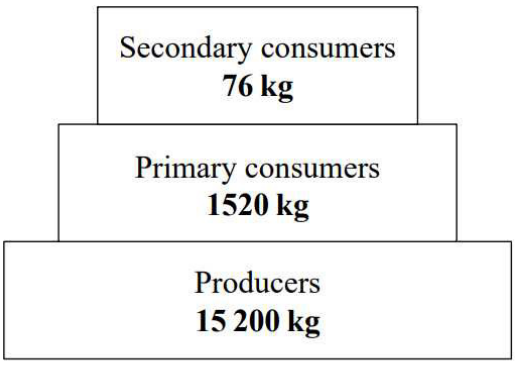
Describe two ways carbon is transformed and one way it is transferred as it cycles through the biotic components of an ecosystem. [3 marks]

Sample Response	The response
Atmospheric carbon exists mainly as carbon dioxide, which is transformed from carbon dioxide gas to produce glucose (and other complex organic molecules) via photosynthesis. This also covers the transfer from atmosphere to plants by diffusion. Respiration transforms glucose into carbon dioxide.	• states 1 transformation [1 mark] • states another transformation [1 mark] • states 1 transfer [1 mark]

2021 Paper 1 Section 2 Question 24

Ecosystem dynamics

The diagram is a hypothetical biomass pyramid for a community.



Not to scale

a) Contrast the efficiency of the biomass transfers between each level of the pyramid. [3 marks]

Sample Response	The response
Producers → Primary consumers 10% Primary → Secondary consumers 5% The ecosystem shows a drop in efficiency of transfer of biomass from 10% to 5%.	• provides - for producers to primary consumers, 10% [1 mark] - for primary to secondary consumers, 5% [1 mark] • contrasts efficiency [1 mark]

b) Explain the difference in biomass transfer efficiency identified in Question 24a). [2 marks]

Sample Response	The response
As you move through to higher tropic levels, a higher proportion of the energy is lost to respiration and heat, and to decomposers. Overall, a smaller percentage is passed on to the next trophic level.	• states that higher trophic levels lose a higher proportion of their energy due to other processes [1 mark] • states at least one process [1 mark]

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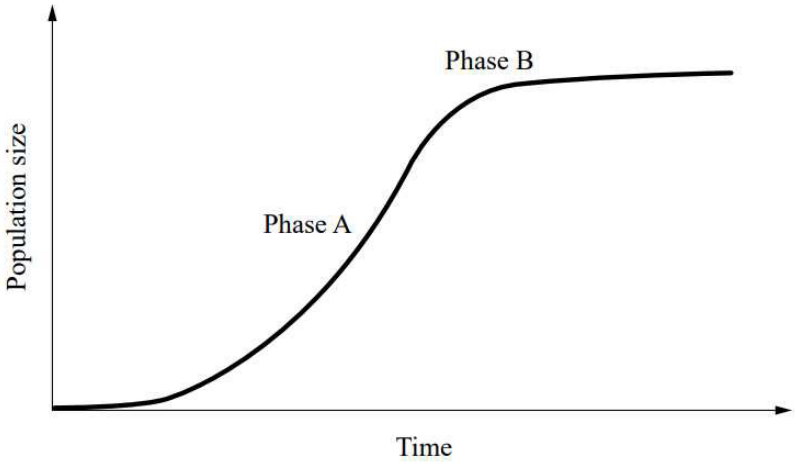
2021 Paper 1 Section 2 Question 28

Ecosystem dynamics

The graph depicts the population change of a species after it is introduced into a previously disturbed environment.



Referring to Phase A and Phase B, determine the population growth model for the species. [3 marks]

Sample Response	The response
Phase A: Population is low and resources are plentiful; maximum growth rate is observed; births consistently outnumber deaths. Phase B: Birth and death rates become balanced as population reaches carrying capacity. Population growth model: logistic.	• refers to a feature of - Phase A [1 mark] - Phase B [1 mark] - determines population growth model as logistic [1 mark]

2020 Paper 1 Section 2 Question 23

Ecosystem dynamics

Describe differences between r-selected and K-selected species in terms of:
• number of offspring
• parental care and involvement
• lifespan. [3 marks]

Sample Response	The response
r-selected species generally have a high number of offspring whereas K-selected species have a low number.	• describes r-selected as high number of offspring and K-selected as low number of offspring [1 mark]
r-selected species have less parental care or involvement with offspring whereas K-selected species have high care.	• describes r-selected as low care and K-selected as high care [1 mark]
r-selected species have shorter lifespans whereas K-selected species have longer lifespans.	• describes r-selected as short lifespan and K-selection as long lifespan [1 mark]

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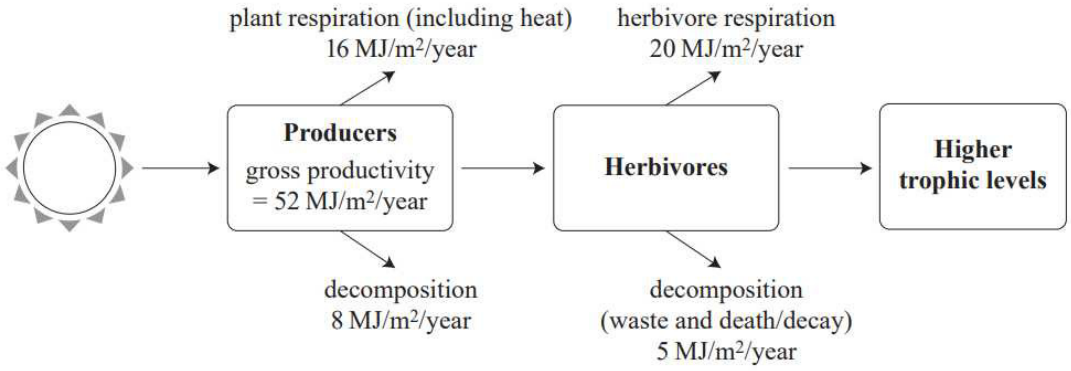
2020 Paper 1 Section 2 Question 25

Ecosystem dynamics

The following simplified energy-flow diagram provides the gross productivity figures for producers and herbivores in an ecosystem.



a) Determine the net productivity for the producers and herbivores in this ecosystem. [2 marks]

Sample Response	The response
Producers 52 – 16 – 8 = 28 MJ/m^2 /year Herbivores 28 – 20 – 5 = 3 MJ/m^2 /year	• states 28 MJ/m^2 /year for producers [1 mark] • states 3 MJ/m^2 /year for herbivores [1 mark]

b) Contrast the outputs of energy for the two trophic levels in the diagram. [2 marks]

Sample Response	The response
Respiration was higher for the herbivores. Decomposition was higher for the producers.	• identifies 1 relevant difference between respiration and decomposition [1 mark] • identifies another relevant difference between respiration and decomposition [1 mark] OR • determines % loss at each trophic level 24/52 = 46% for producers 25/28 = 89% for herbivores [1 mark] • identifies % loss is higher for herbivores than autotrophs [1 mark]

2020 Paper 1 Section 2 Question 28

Ecosystem dynamics

Identify two differences between primary and secondary ecological succession. Refer to one example of each type of succession in your response. [4 marks]

Sample Response	The response
Primary succession (e.g. after a volcanic eruption) begins with a bare site that hasn't been colonised before, whereas in secondary succession (e.g. a forest after a fire), the environment was previously colonised, but disturbed or damaged. A second difference is that in primary succession, a pioneer community is required to make the habitat fertile, whereas in secondary succession, the habitat is fertile with soil, seeds and remnants of vegetation.	• identifies one difference between primary and secondary succession [1 mark] • identifies a second difference between primary and secondary succession [1 mark] • provides an example of primary succession [1 mark] • provides an example of secondary succession [1 mark]

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Marking Guide – Paper 2 Section 1

2024 Paper 2 Section 1 Question 2

Ecosystem dynamics

a) Define carrying capacity. [1 mark]

Sample response	The response
Carrying capacity is the size of the population that can be supported indefinitely on the available resources and services of an ecosystem.	• provides an appropriate definition **[1 mark]**

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

Sample response	The response
Availability of space Availability of nutrients	• identifies one factor that affects the carrying capacity of plant species in an ecosystem **[1 mark]** • identifies a second factor that affects the carrying capacity of plant species in an ecosystem **[1 mark]**

2024 Paper 2 Section 1 Question 3

Ecosystem dynamics

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

Sample response	The response
Population growth = (835 + 34) – (324 + 65) = 480 Growth rate = (480/4000) x 100% = 12% / year	• calculates population growth **[1 mark]** • calculates growth rate **[1 mark]**

2024 Paper 2 Section 1 Question 11

Ecosystem dynamics

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

Sample response	The response
Pioneer species will move into an area and either create or improve the soil by adding organic material through their own death and decay. This makes the landscape more hospitable, allowing new species to colonise the area, changing the community composition. The community composition continues to change over time until a climax community is established.	• describes – the role of pioneer species **[1 mark]** – changes in community composition **[1 mark]** – establishment of a climax community **[1 mark]**

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

Sample response	The response
Primary succession occurs in an environment with no previous life/soil, whereas secondary succession occurs in an area that has previously been inhabited but experienced a disturbance.	• identifies a distinguishing feature of primary and secondary succession **[1 mark]**

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2023 Paper 2 Section 1 Question 2

Ecosystem dynamics

The diagram shows feeding relationships for an Australian ecosystem.

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

Sample response	The response
Based on this food web, the dingo is a predator for kangaroos, echidnas, wombats, emus and lizards. If dingoes were removed, the populations of these species would flourish, adding increased strain on their prey and potentially increasing competition for grasses. This would have a significant effect on the community structure at each trophic level and therefore energy flow through the ecosystem.	• recognises the critical role of dingoes in maintaining the structure of the community **[1 mark]** • uses data from the food web to support response **[1 mark]**

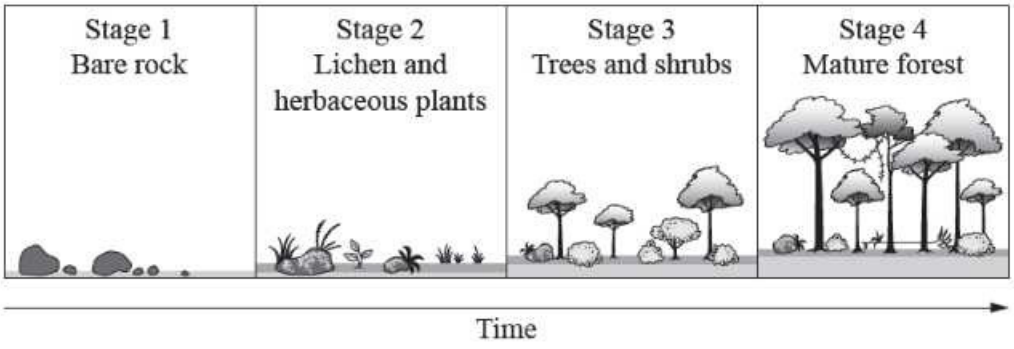
b) Predict the effect a drastic reduction in the number of dingoes would have on the termite population. Justify your response. [2 marks]

Sample response	The response
A reduction in dingo numbers would cause termite numbers to decrease because kangaroos and wombats would lose a predator. This would cause numbers for both to increase, increasing competition with termites for grasses.	• predicts termite numbers would decrease **[1 mark]** • justifies based on species interactions **[1 mark]**

2023 Paper 2 Section 1 Question 7

Ecosystem dynamics

The diagram shows the stages of succession in an ecosystem.



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

Sample response	The response
Primary succession. The image depicts the colonisation of a barren landscape.	• identifies primary succession **[1 mark]** • provides appropriate reasoning **[1 mark]**

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

Sample response	The response
Two key features of a pioneer species are that they can tolerate extreme conditions and photosynthesise. Their role is to make the area more habitable for the next colonisers.	• infers a key feature **[1 mark]** • infers another key feature **[1 mark]** • describes the role of pioneer species in ecological succession **[1 mark]**

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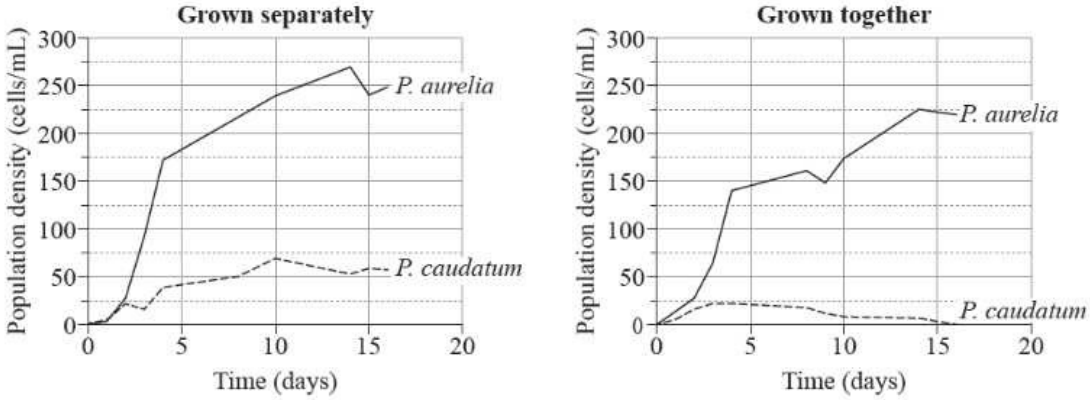
2023 Paper 2 Section 1 Question 9

Ecosystem dynamics

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]

Sample response	The response
70 cells/mL	• identifies 70 **[1 mark]**

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

Sample response	The response
P. aurelia follows a similar growth pattern when grown separately and together with *P. caudatum*, exhibiting exponential growth from day 1–4 and then continuing to increase in population density up until day 14, when the number of cells/mL starts to decrease. The difference is, when grown with *P. caudatum*, the maximum number of cells only reaches ~225 cells/mL, as opposed to ~273 when grown separately. This indicates that *P. aurelia* is still able to grow effectively in the presence of *P. caudatum*, but does experience some inhibition.	• identifies a similarity **[1 mark]** • identifies a difference **[1 mark]** • states the significance **[1 mark]**

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

Sample response	The response
The competitive exclusion principle states that two species cannot coexist indefinitely if they occupy the same niche, because they will compete for identical resources. This competition will eventually lead to exclusion of the weaker species unless they evolve to have a more distinct niche. This principle is demonstrated in the experiment because both *P. aurelia* and *P. caudatum* grow well individually, but when they are grown together, *P. aurelia* outcompetes the *P. caudatum*, causing its population to die out by day 16.	• explains the competitive exclusion principle **[1 mark]** • identifies that both species grow well individually **[1 mark]** • identifies that *P. aurelia* outcompetes *P. caudatum* when grown together **[1 mark]**

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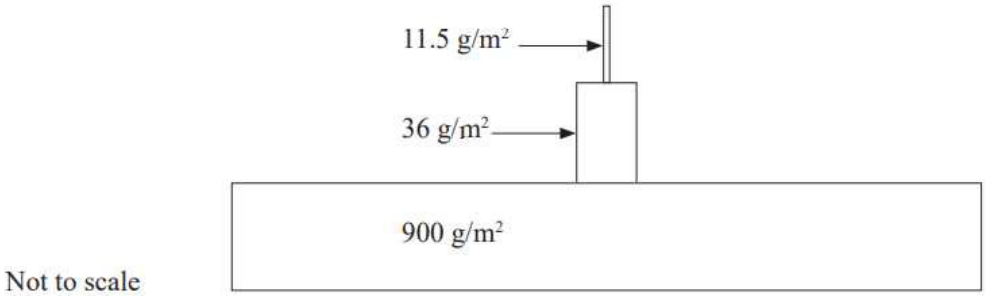
2022 Paper 2 Section 1 Question 2

Ecosystem dynamics

This is a biomass pyramid for a grassland community.



a) Calculate the percentage energy transfer between the first two trophic levels.
Show your working. [2 marks]

Sample Response	The response
Energy transfer = 36/900 × 100% = 4%	• correctly calculates energy transfer [1 mark] • shows appropriate working [1 mark]

b) Explain the loss of biomass between trophic levels. [2 marks]

Sample Response	The response
At each trophic level, some energy is lost to respiration and decomposition. In these processes, organic compounds that contribute to biomass are converted into inorganic substances, such as CO_2 and H_2O.	• identifies a process that accounts for loss of biomass [1 mark] • explains the process [1 mark]

2022 Paper 2 Section 1 Question 3

Ecosystem dynamics

A glacier has retreated, leaving a large amount of gravel, small rocks, sand and mud.

a) Explain the steps of succession that would occur if the glacier continues to retreat. [3 marks]

Sample Response	The response
Pioneer species, such as lichens will begin the process of soil formation by breaking down the substrate and adding organic material through their own death and decay. This will allow new species to colonise/inhabit the area, changing the community composition. The community composition will continue to change over time until a climax community is established.	• explains - pioneer species' role in establishing soil [1 mark] - changes in community composition [1 mark] - establishment of a climax community [1 mark]

b) Identify the type of ecological succession. [1 mark]

Sample Response	The response
Primary succession	• identifies primary succession [1 mark]

2022 Paper 2 Section 1 Question 4

Ecosystem dynamics

Define keystone species. (1 mark)

Sample Response	The response
A plant or animal that plays a unique and crucial role in the way an ecosystem functions.	• provides an appropriate definition [1 mark]

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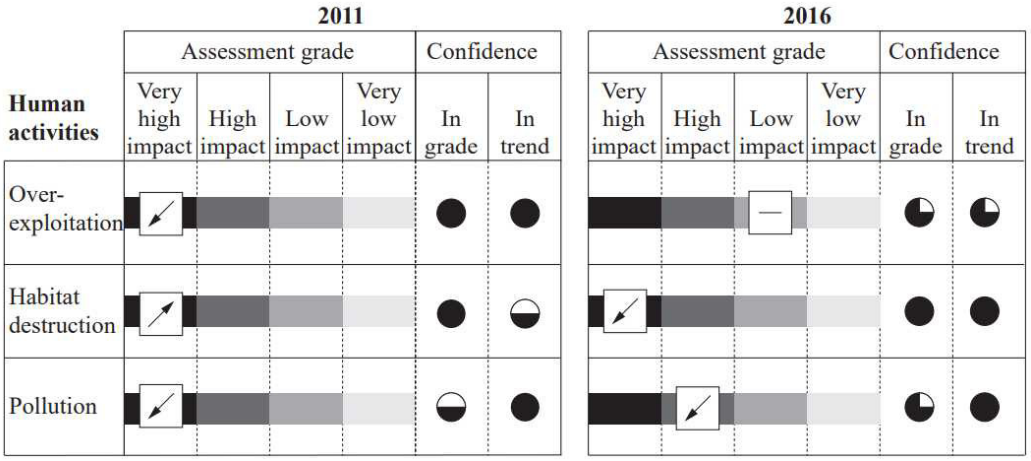
2022 Paper 2 Section 1 Question 6

Ecosystem dynamics

An environmental report identified overexploitation, habitat destruction and pollution as human activities affecting biodiversity in Australia. The tables show the estimated impact of each activity in 2011 and 2016.



Recent trends	Grade	Confidence
Improving Getting worse Stable	**Very low impact:** Few, if any, species and/or ecosystems are suffering substantial adverse effects from this pressure	**Adequate:** Adequate high-quality evidence **and** high level of consensus
	Low impact: A small proportion of species and/or ecosystems are suffering substantial adverse effects from this pressure	**Somewhat adequate:** Adequate high-quality evidence **or** high level of consensus
	High impact: A significant proportion of species and/or ecosystems are suffering substantial adverse effects from this pressure	**Limited:** Limited evidence **or** limited consensus
	Very high impact: A large proportion of species and/or ecosystems are suffering substantial adverse effects from this pressure	**Very limited:** Limited evidence **and** limited consensus

a) Explain how one human activity identified in the tables could reduce biodiversity. [1 mark]

Sample Response	The response
Habitat destruction: organisms that previously inhabited the site are displaced or killed, which could disrupt food chains	• explains how a human activity reduces biodiversity [1 mark]

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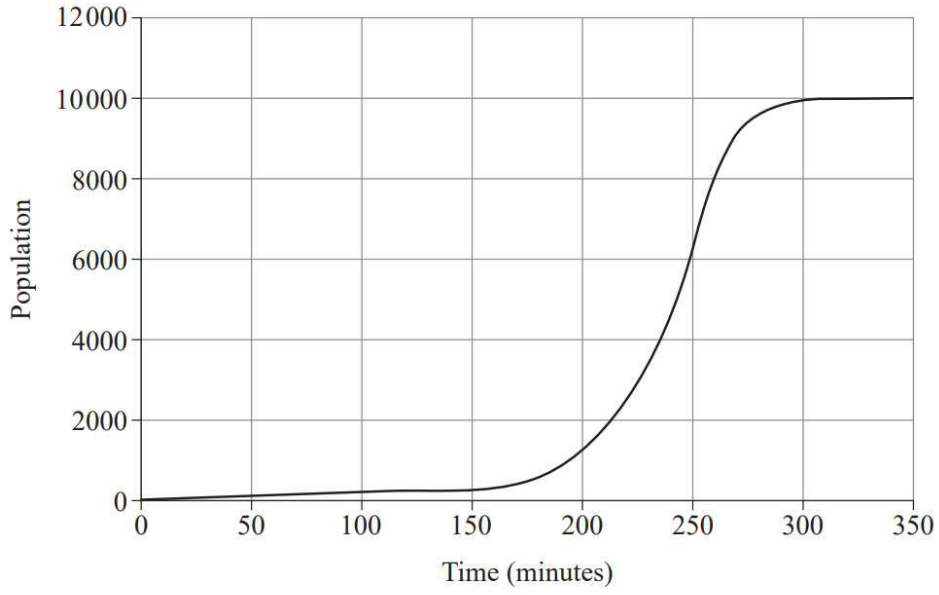
b) Predict which human activities will have the highest and lowest impact on biodiversity in 2023. Explain your reasoning using evidence from the tables. [4 marks]

Sample Response	The response
Highest impact: Habitat destruction In 2016, there was high-quality evidence and a high level of consensus that habitat destruction was causing a large proportion of species and/or ecosystems to suffer substantial adverse effects, and that the impact was deteriorating. This is in contrast to 2011, when the effects of the impact were improving	• predicts the highest impact will be from habitat destruction [1 mark] • explains the prediction using evidence [1 mark]
Lowest impact: Overexploitation In 2016, there was adequate high-quality evidence to suggest that overexploitation was affecting only a small proportion of species and/or ecosystems. This was an improvement from 2011 where there was high-quality evidence (and consensus) that a large proportion of species were affected. This implies that measures to improve overexploitation have been implemented since 2011.	• predicts the lowest impact will be from overexploitation [1 mark] • explains the prediction using evidence [1 mark]

2022
Paper 2
Section 1
Question 7

Ecosystem dynamics

The graph shows the population of bacteria in a Petri dish over time.



a) Identify the mode of population growth. [1 mark]

Sample Response	The response
Logistic growth.	• identifies logistic growth [1 mark]

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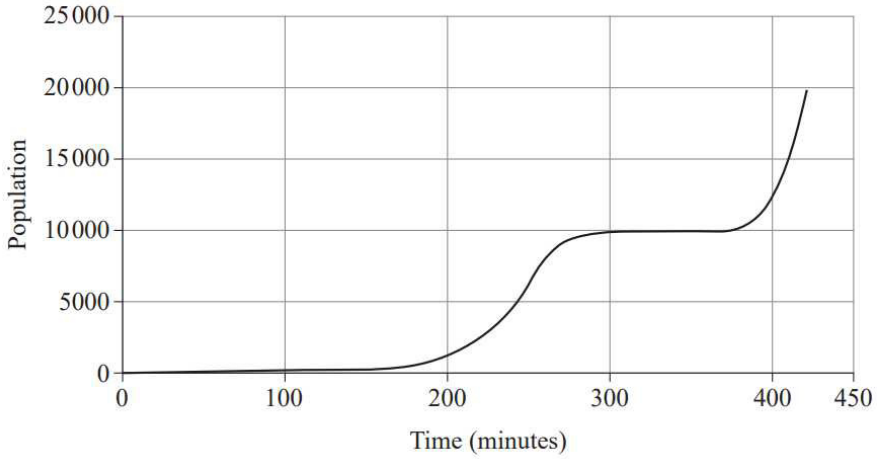
b) Determine the carrying capacity under these conditions. [1 mark]

Sample Response	The response
10 000.	• determines the carrying capacity is 10 000 [1 mark]

Conditions were modified at 380 minutes and the population continued to be monitored. Results are shown.



c) Identify two modifications that could cause this change. Explain your reasoning. [4 marks]

Sample Response	The response
More nutrients added to the Petri dish: an increase in food availability would allow a larger population to obtain vital nutrients, therefore increasing the carrying capacity. Increasing the size of the Petri dish: This would increase the available space, so more organisms can survive and be in contact with the nutrient agar.	• identifies one modification that could cause the change [1 mark] • explains how the first modification increases carrying capacity [1 mark] • identifies a second modification that could cause the change [1 mark] • explains how the second modification increases carrying capacity [1 mark]

2021 Paper 2 Section 1 Question 1

Ecosystem dynamics

Explain how one abiotic and one biotic factor will affect the population of mosquito larvae in a freshwater pond. [4 marks]

Sample Response	The response
An abiotic factor that would affect population would be temperature, because warmer water will evaporate faster, reducing the carrying capacity by limiting space. A biotic factor that would affect population would be food availability, because more food (e.g. algae or plankton) would result in a larger population of mosquito larvae.	• states a - relevant abiotic factor [1 mark] - relevant biotic factor [1 mark] • explains the effect of the identified - relevant abiotic factor [1 mark] - relevant biotic factor [1 mark]

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2021 Paper 2 Section 1 Question 3

Ecosystem dynamics

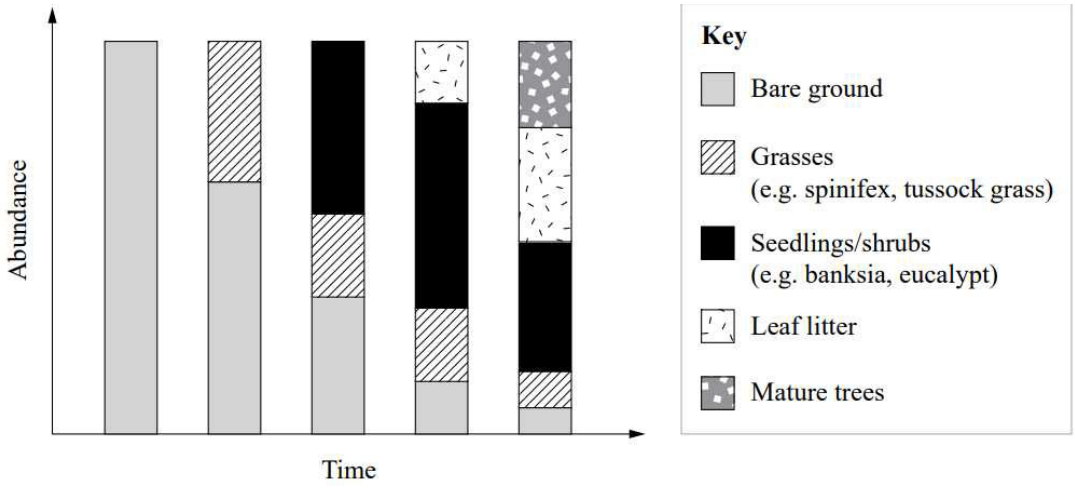
In coastal areas and deserts, bare sand dunes may be colonised by plants such as members of the Poaceae family (grasses). Identify three features of these plants that make them effective colonisers. [3 marks]

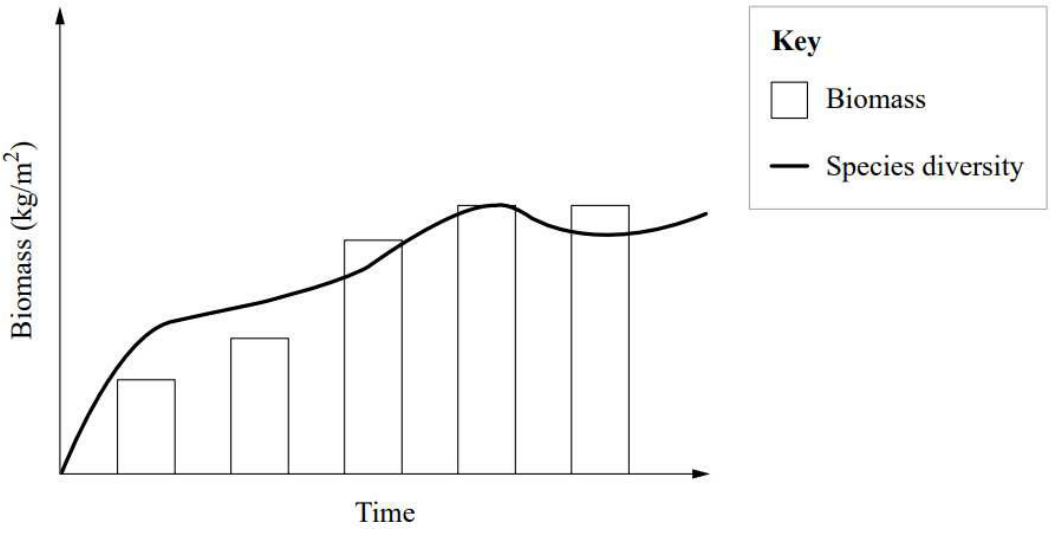
Sample Response	The response
Features that make these plants effective colonisers of dunes are that they grow rapidly, their seeds are dispersed by the wind and they are tolerant of the extreme heat and dryness of the environment.	• identifies first feature [1 mark] • identifies second feature [1 mark] • identifies third feature [1 mark]

2021 Paper 2 Section 1 Question 13

Ecosystem dynamics

The data shows changes in relative abundance of ground cover, biomass and species diversity for an abandoned sand mine site over time.





Based on the information provided, predict whether further ecological succession would occur in this community. Justify your answer with two relevant reasons. [3 marks]

Sample Response	The response
It is likely that no further ecological succession would occur — this appears to be a climax community as there is levelling in the biomass and biodiversity, a range of shrubs, trees and grasses with mature trees making up a large proportion of the community and the dominant species are K-selected (mature trees).	• predicts no further succession [1 mark] • provides a relevant reason [1 mark] • provides another relevant reason [1 mark]

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2020 Paper 2 Section 1 Question 2

Ecosystem dynamics

Two species of *Paramecium*, single-celled microorganisms, were grown for 4 days in test tubes with a fixed amount of algae added to each tube daily as their food source. The life span for each species ranges from 4–6 hours.

Test tubes 1 and 2 each contained a single species, and test tube 3 initially contained both species.

	Live *Paramecium* population after 4 days (per mL)	
Test tube	**Species A**	**Species B**
1	245	0
2	0	104
3	120	0

a) Identify and describe the ecological principle that relates to these observations. [2 marks]

Sample Response	The response
The competitive exclusion principle, which states that two species cannot occupy the same niche at the same time	• states competitive exclusion [1 mark] • describes that two species cannot occupy the same niche simultaneously [1 mark]

b) Explain the results of the experiment. [3 marks]

Sample Response	The response
Species A would have had an advantage over Species B, as it is better able to compete for the same resource. This can be identified in test tubes 1 and 2 where after 4 days the population was higher for A, possibly indicating a higher rate of reproduction. Therefore, A would have outcompeted B for the same algal food source available, algae, and after 4 days the population was not sustainable for B and they all died. Species A's numbers were lower after 4 days due to the competition for the same resource.	• identifies that -Species A and B competed for the same resource [1 mark] -Species A outcompeted Species B [1 mark] -Species A's population was affected by the competition [1 mark]

2020 Paper 2 Section 1 Question 6

Ecosystem dynamics

The Bush Stone-curlew is a large, mainly nocturnal, ground-dwelling bird found on Hamilton Island. Bush Stone-curlews have a wide-ranging diet but prefer to feed on insects, molluscs, small lizards, seeds and, occasionally, small mammals. During the breeding season, nesting birds will search for food in the vicinity of the nest site.

a) Identify one factor that would influence carrying capacity on the island. [1 mark]

Sample Response	The response
Food availability	• identifies a resource or service of an ecosystem [1 mark]

b) Discuss one way the carrying capacity of the Bush Stone-curlew on Hamilton Island could be positively or negatively affected in the future. [2 marks]

Sample Response	The response
A future limiting factor, negatively affecting the carrying capacity, could include development on the island (new villas, roads etc. taking away space for the curlew's nesting sites).	• describes a relevant cause [1 mark] • discusses the relevant consequence [1 mark]

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2020 Paper 2 Section 1 Question 8

Ecosystem dynamics

In an experiment studying the population dynamics of the house fly, two adult house flies were placed in a fly cage with a limited food supply. Population data was collected, as summarised in the table.

Generation	Number of eggs	Number of larvae	Number of pupae	Number of adults
1	0	0	0	2
2	120	110	95	88
3	250	225	213	210
4	500	475	462	12
5	20	2	0	0

Determine the population growth model exhibited by the house fly. Explain your reasoning. [3 marks]

Sample Response	The response
Initially there is a rapid increase in growth. This is followed by a sudden drop in population numbers. This pattern is typical for J-curve population growth.	• states initial rapid population increase [1 mark] • states sudden population drop [1 mark] • states J-curve [1 mark]

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Unit 4 – Heredity and continuity of life

Unit 4 – Topic 1: DNA, genes and the continuity of life

Paper 1 Section 1

2024 Paper 1 Section 1 Question 2 DNA, genes and the continuity of life	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.

2024 Paper 1 Section 1 Question 3 DNA, genes and the continuity of life	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.

2024 Paper 1 Section 1 Question 6 DNA, genes and the continuity of life	What can introduce new alleles into a population? (A) point mutations (B) non-disjunction (C) random fertilisation (D) independent assortment

2024 Paper 1 Section 1 Question 10 DNA, genes and the continuity of life	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

2024 Paper 1 Section 1 Question 11 DNA, genes and the continuity of life	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

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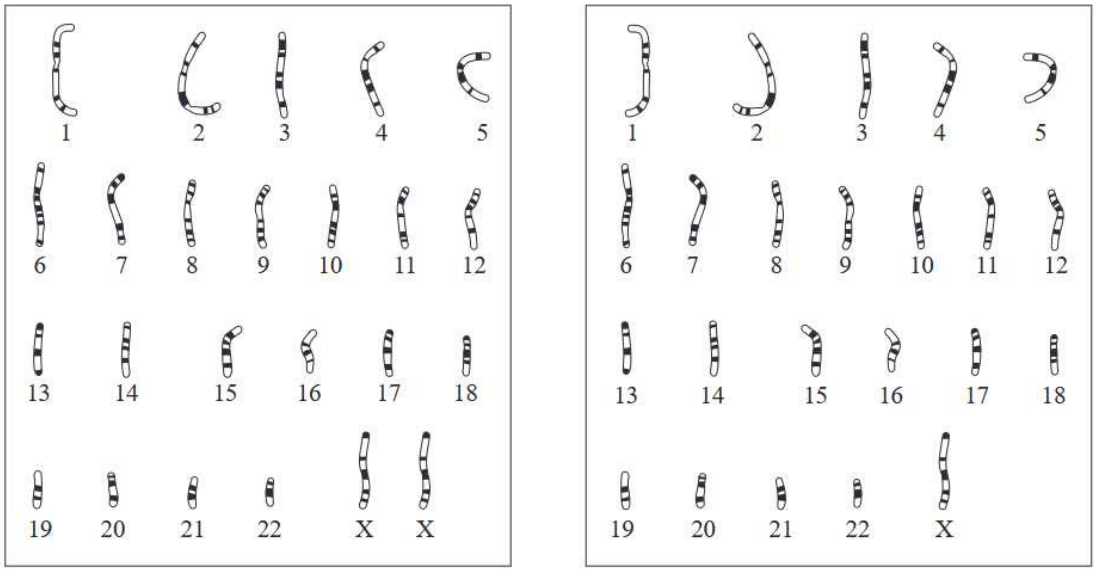
2024 Paper 1 Section 1 Question 17 DNA, genes and the continuity of life	Which genetic tool is **not** required to make recombinant DNA? (A) DNA ligase (B) plasmid vectors (C) restriction enzymes (D) transcription factors

2024 Paper 1 Section 1 Question 18 DNA, genes and the continuity of life	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.

2023 Paper 1 Section 1 Question 5 DNA, genes and the continuity of life	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.

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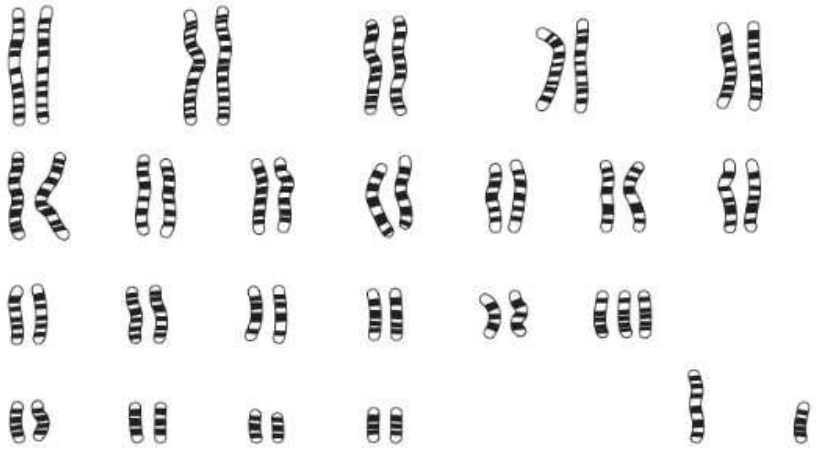
2023
Paper 1
Section 1
Question 8

DNA, genes and the continuity of life

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

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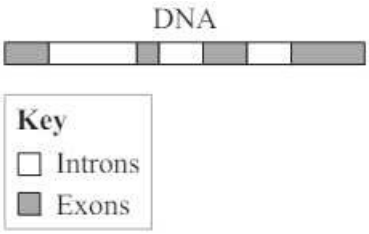
2023 **Paper 1** **Section 1** **Question 11** **DNA, genes and the continuity of life**	Restriction enzymes (A) join DNA into a single strand. (B) cut DNA at specific locations. (C) add nucleotides to a growing DNA strand. (D) assist in the amplification of recombinant DNA.

2023 **Paper 1** **Section 1** **Question 16** **DNA, genes and the continuity of life**	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:

2023 **Paper 1** **Section 1** **Question 17** **DNA, genes and the continuity of life**	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

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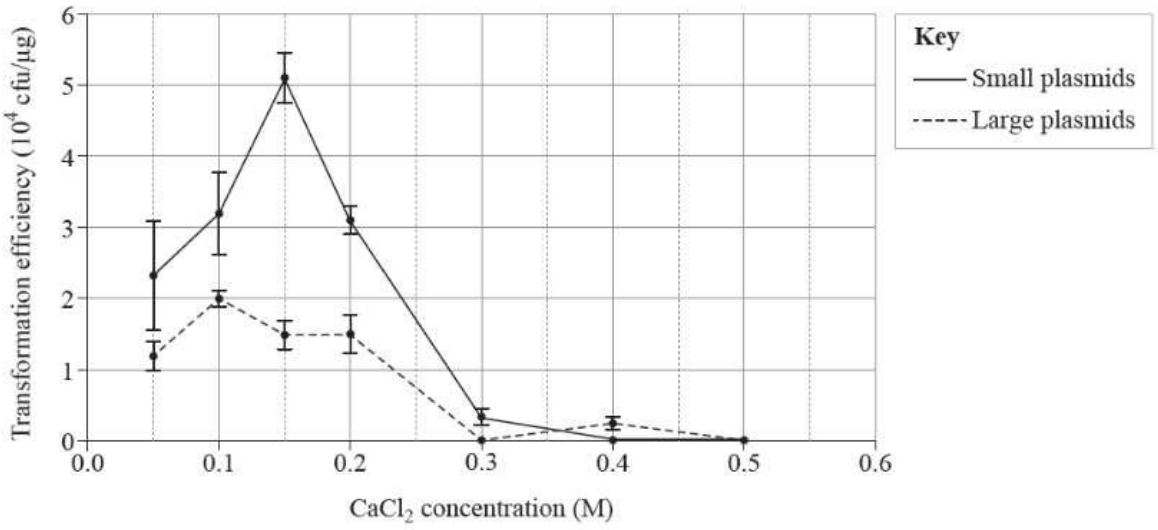
2023 Paper 1 Section 1 Question 18 **DNA, genes and the continuity of life**	Calcium chloride ($CaCl_2$) is a chemical used in bacterial transformation. An experiment was conducted to determine how the concentration of calcium chloride affects the transformation efficiency of large and small plasmids. 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.

2023 Paper 1 Section 1 Question 19 **DNA, genes and the continuity of life**	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.

2022 Paper 1 Section 1 Question 1 **DNA, genes and the continuity of life**	What is the molecular unit of heredity? (A) gene (B) genome (C) nucleotide (D) chromosome

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2022 Paper 1 Section 1 Question 2 DNA, genes and the continuity of life	Which stage of making recombinant DNA requires DNA ligase? (A) cutting (B) joining (C) isolation (D) transformation

2022 Paper 1 Section 1 Question 6 DNA, genes and the continuity of life	The role of helicase in DNA replication is to (A) initiate the process by binding to recognition sites along the template strand. (B) add complementary bases to the template strand. (C) unwind and separate DNA strands. (D) join DNA strands together.

2022 Paper 1 Section 1 Question 7 DNA, genes and the continuity of life	What is used directly by plants for protein synthesis? (A) nitrite, NO_2^- (B) nitrate, NO_3^- (C) ammonia, NH_3 (D) atmospheric nitrogen, N_2

2022 Paper 1 Section 1 Question 9 DNA, genes and the continuity of life	Polygenic inheritance involves multiple (A) alleles for a single gene. (B) genes with the same alleles. (C) genes coding for a single characteristic. (D) characteristics resulting from a single gene.

2022 Paper 1 Section 1 Question 13 DNA, genes and the continuity of life	An error during DNA replication resulted in the following change to mRNA transcripts. mRNA before: AUGAAGUUUGGCAUC … (continued) mRNA after: AUGAAGUUUGCAUCG … (continued) The DNA replication error most likely involved (A) deletion of cytosine. (B) insertion of guanine. (C) substitution of uracil with guanine. (D) substitution of guanine with cytosine.

2022 Paper 1 Section 1 Question 14 DNA, genes and the continuity of life	Prior to fertilisation, a secondary oocyte will arrest at which stage of meiosis? (A) prophase I (B) prophase II (C) metaphase I (D) metaphase II

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2022 Paper 1 Section 1 Question 15 DNA, genes and the continuity of life	The environment's influence on gene expression can be investigated by comparing the rate of concordance in monozygotic (identical) and dizygotic (non-identical) twins. Concordance occurs when both twins express a trait. Strong environmental influence is suspected when concordance is (A) higher in monozygotic twins. (B) only observed in dizygotic twins. (C) only observed in monozygotic twins. (D) similar in monozygotic and dizygotic twins.

2022 Paper 1 Section 1 Question 20 DNA, genes and the continuity of life	A section of DNA is made up of two strands, I and II. **Base** / **Strand I composition** / **Strand II composition** adenine / / cytosine / / 25% guanine / / 14% thymine / 29% / It can be inferred that (A) strand I contains 25% cytosine. (B) strand I contains 32% adenine. (C) strand II contains 29% thymine. (D) strand II contains 71% adenine.

2021 Paper 1 Section 1 Question 1 DNA, genes and the continuity of life	In mammals, inherited mutations can cause variations in the genotype of offspring when they occur in (A) red blood cells. (B) somatic cells. (C) nerve cells. (D) sex cells.

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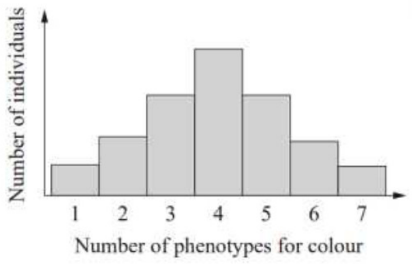
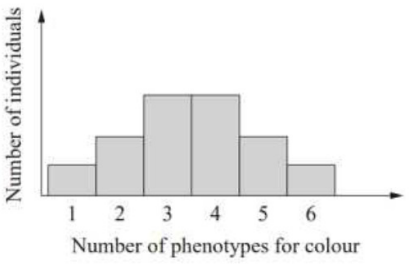
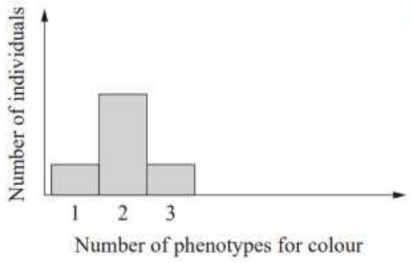
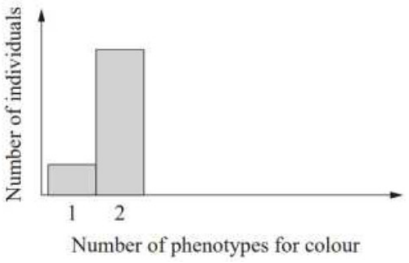
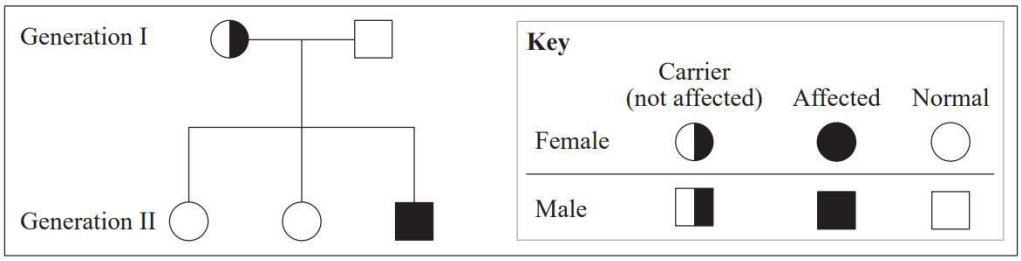
2021 Paper 1 Section 1 Question 4 DNA, genes and the continuity of life	To demonstrate polygenic inheritance of colour in wheat, a cross was performed between two intermediate parents (AaBbCc×AaBbCc). Each dominant allele adds a 'unit' of colour to the phenotype. Which graph would depict the number of individuals and number of phenotypes for the cross? (A)  (B)  (C)  (D) 

2021 Paper 1 Section 1 Question 6 DNA, genes and the continuity of life	The pedigree traces a genetic disease across two generations.  The inheritance pattern of this disease can be classified as (A) incomplete dominant. (B) autosomal dominant. (C) sex linked. (D) polygenic.

2021 Paper 1 Section 1 Question 12 DNA, genes and the continuity of life	The phenotypic expression of genes is regulated by (A) transcription factors. (B) random fertilisation. (C) DNA polymerase. (D) helicase.

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2021 Paper 1 Section 1 Question 13

DNA, genes and the continuity of life

Which combination of processes demonstrates spermatogenesis?

	Where process occurs	Outcome of process
(A)	testes	one functional gamete with 2–3 polar bodies
(B)	ovaries	four functional haploid gametes
(C)	testes	four functional haploid gametes
(D)	ovaries	one functional gamete with 2–3 polar bodies

2021 Paper 1 Section 1 Question 14

DNA, genes and the continuity of life

Which event could cause a frameshift mutation?

(A) non-disjunction during meiosis
(B) error during replication
(C) base pair substitution
(D) heat damage

2021 Paper 1 Section 1 Question 19

DNA, genes and the continuity of life

What is the role of DNA polymerase in DNA replication?

(A) breaking the hydrogen bonds that hold the complementary bases of DNA together
(B) adding complementary nucleotide bases to the exposed DNA strands
(C) sealing the sequence of DNA into two continuous double strands
(D) joining RNA primers to the lagging strand of DNA

2020 Paper 1 Section 1 Question 1

DNA, genes and the continuity of life

In prokaryotes, deoxyribonucleic acid (DNA) is found as unbound circular DNA in the

(A) mitochondria.
(B) chloroplasts.
(C) nucleus.
(D) cytosol.

2020 Paper 1 Section 1 Question 2

DNA, genes and the continuity of life

Which form of inheritance usually determines traits that display continuous phenotypic variation?

(A) polygenic
(B) sex-linked
(C) multiple allele
(D) incomplete dominance

2020 Paper 1 Section 1 Question 10

DNA, genes and the continuity of life

DNA profiling using polymerase chain reaction (PCR) and gel electrophoresis allows the comparison of

(A) genes.
(B) entire genomes.
(C) DNA fragments.
(D) specific sites of mutations.

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2020 Paper 1 Section 1 Question 12 DNA, genes and the continuity of life	In the structure of DNA, adenine pairs with which other base? (A) uracil (B) guanine (C) cytosine (D) thymine

2020 Paper 1 Section 1 Question 13 DNA, genes and the continuity of life	Which of the following molecules is involved in the transcription of DNA? (A) RNA polymerase (B) DNA helicase (C) transfer RNA (D) amino acids

2021 Paper 1 Section 1 Question 15 DNA, genes and the continuity of life	The table identifies the condition associated with a variety of ploidy changes. **Chromosome number (ploidy)** / **Condition name** Monosomy 5 / Cri du chat syndrome Trisomy 21 / Down syndrome Trisomy 23 / Klinefelter syndrome Monosomy 23 / Turner syndrome For a person who has 45 chromosomes (2n–1) due to an autosomal condition, which condition do they have? (A) Cri du chat syndrome (B) Down syndrome (C) Klinefelter syndrome (D) Turner syndrome

2020 Paper 1 Section 1 Question 3 DNA, genes and the continuity of life	A genome is defined as (A) the molecular unit of heredity. (B) all the genetic material in the chromosomes of an organism. (C) the sequence of triplets of DNA nucleotides that make up a gene. (D) the combination of alleles for a particular trait carried by an individual.

2020 Paper 1 Section 1 Question 15 DNA, genes and the continuity of life	In watermelon, skin colour is controlled by a single autosomal gene. The two phenotypic variants are green and striped. Two plants, one homozygous for the green alleles, and one homozygous for the striped alleles, were crossed. The figure shows the phenotypic frequency for the initial (F_0) generation and the subsequent (F_1) generation. A cross was then performed between members of the F_1 generation. What would be the expected frequency of striped watermelon in the next (F_2) generation? (A) 1.0 (B) 0.75 (C) 0.50 (D) 0.25

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2020 Paper 1 Section 1 Question 17

DNA, genes and the continuity of life

The table identifies the condition associated with a variety of ploidy changes.

Chromosome number ploidy	Condition name
Monosomy 5	Cri du chat syndrome
Trisomy 21	Down syndrome
Trisomy 23	Klinefelter syndrome
Monosomy 23	Turner syndrome

For a person with XXY sex chromosomes, which condition would they have?

(A) Cri du chat syndrome
(B) Down syndrome
(C) Klinefelter syndrome
(D) Turner syndrome

2020 Paper 1 Section 1 Question 19

DNA, genes and the continuity of life

The table of data shows a comparison of amino acids sequences in the same section of haemoglobin molecules from a number of different species.

From the given information, which of the following species's haemoglobin protein is most similar to human haemoglobin protein?

Species	Sequence of amino acids							
Human	Lys	Glu	His	Ile	Val	Glu	Phe	Lys
(A)	Lys	Glu	His	Lys	Val	Met	Phe	Lys
(B)	Lys	Glu	Lys	Ile	Val	Glu	Phe	Lys
(C)	Lys	Asp	His	Leu	Val	Met	Phe	Lys
(D)	Lys	Val	His	Asn	Val	Glu	Phe	Lys

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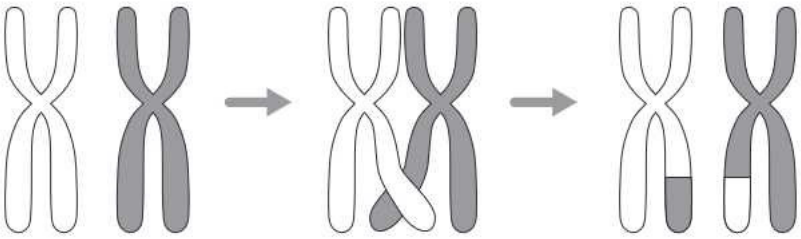
Paper 1 Section 2

2024 Paper 1 Section 2 Question 23 **DNA, genes and the continuity of life**	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. (3 marks)

2024 Paper 1 Section 2 Question 24 **DNA, genes and the continuity of life**	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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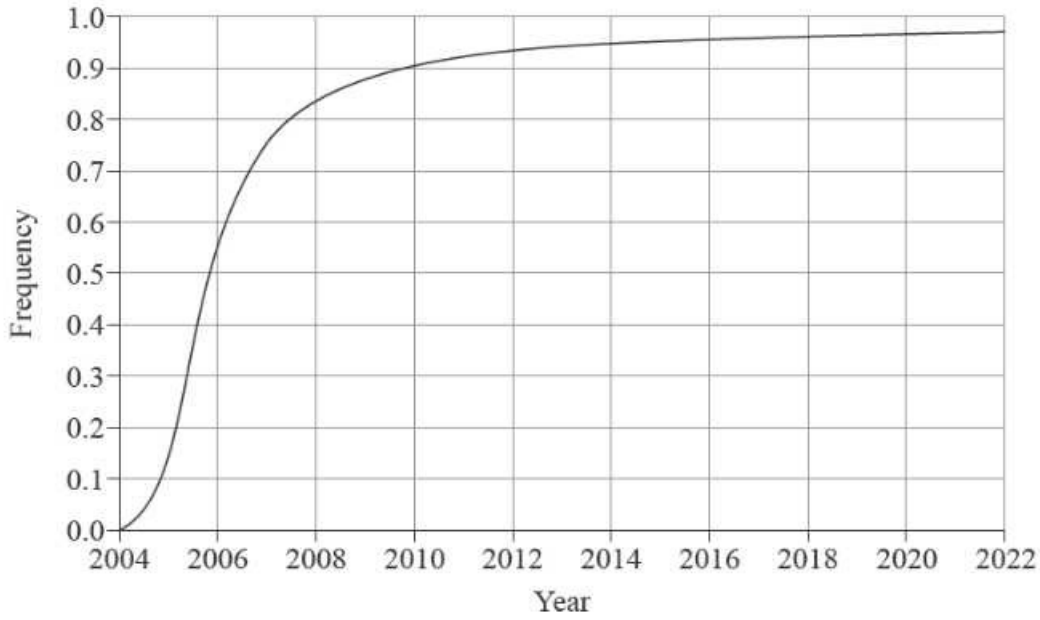
2023 Paper 1 Section 2 Question 21 **DNA, genes and the continuity of life**	The diagram represents a section of DNA. ***Copyright restrictions prohibit the release of this QCAA exam material.*** Identify the DNA components indicated by labels 1-4. [4 marks] 1. _____ 2. _____ 3. _____ 4. _____

2023 Paper 1 Section 2 Question 24 **DNA, genes and the continuity of life**	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]

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

2023 Paper 1 Section 2 Question 27 **DNA, genes and the continuity of life**	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. [3 marks]

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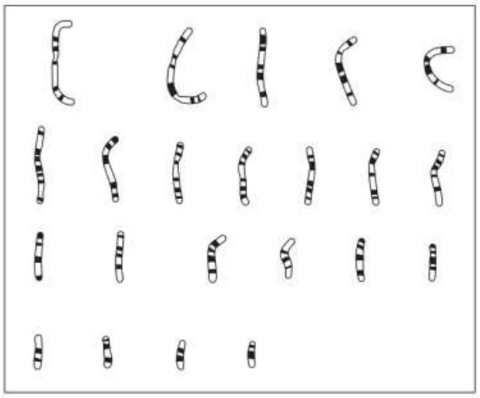
2022 Paper 1 Section 2 Question 26

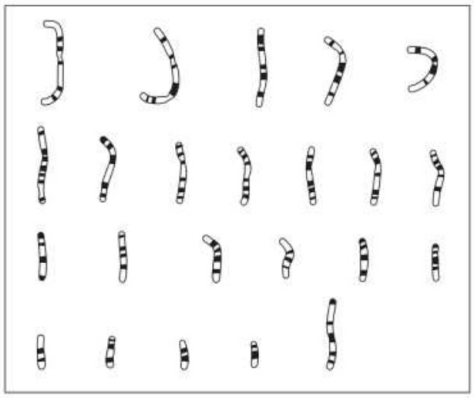
DNA, genes and the continuity of life

Karyotypes for two human gametes are shown.

Karyotype A (sperm cell)



Karyotype B (egg cell)



a) Identify which cell exhibits aneuploidy. Refer to evidence from the karyotype. [1 mark]

b) Explain how this chromosome abnormality may have occurred. [2 marks]

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This table lists some genetic conditions resulting from chromosomal abnormalities.

Genetic condition	Common name
Monosomy 5	Cri du chat syndrome
Monosomy X	Turner syndrome
Trisomy 13	Patau syndrome
Trisomy 18	Edwards syndrome
Trisomy X	Triple X syndrome

c) Predict which genetic condition would occur if the two gametes produced a zygote. [1 mark]

2022 Paper 1 Section 2 Question 27

DNA, genes and the continuity of life

Explain the purpose of gel electrophoresis in DNA profiling. [2 marks]

2021 Paper 1 Section 2 Question 25

DNA, genes and the continuity of life

In blood group inheritance in humans, three alleles (i, I^A and I^B) determine blood type, which can be type O, A, B or AB.

It is known that:
- allele I^A produces type A and is co-dominant with allele I^B, which produces type B
- allele i produces type O
- alleles I^A and I^B are dominant over allele i.

A father who is heterozygous type A and a mother who is heterozygous type B have children. Predict the likely frequency of phenotypes for their offspring. Show your working. [3 marks]

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2021 Paper 1 Section 2 Question 26 DNA, genes and the continuity of life	a) State the three components of a DNA nucleotide. [1 mark] b) Describe the steps involved in DNA profiling. [3 marks]

2020 Paper 1 Section 2 Question 24 DNA, genes and the continuity of life	a) Describe what is meant by the genotype of an organism. [1 mark] b) Inherited mutations can affect the genotype of offspring. Describe how this occurs. [2 marks]

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Paper 2 Section 1

2024 Paper 2 Section 1 Question 4 **DNA, genes and the continuity of life**	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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2024 Paper 2 Section 1 Question 6

DNA, genes and the continuity of life

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

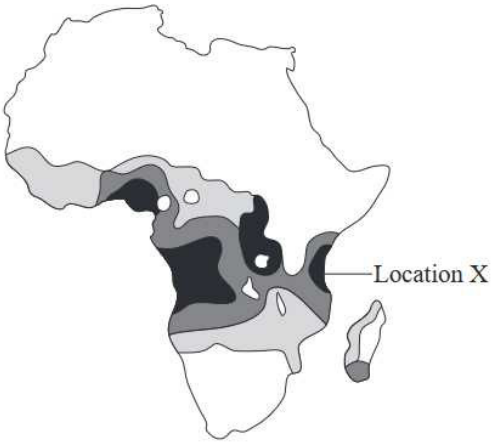
Not to scale

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

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

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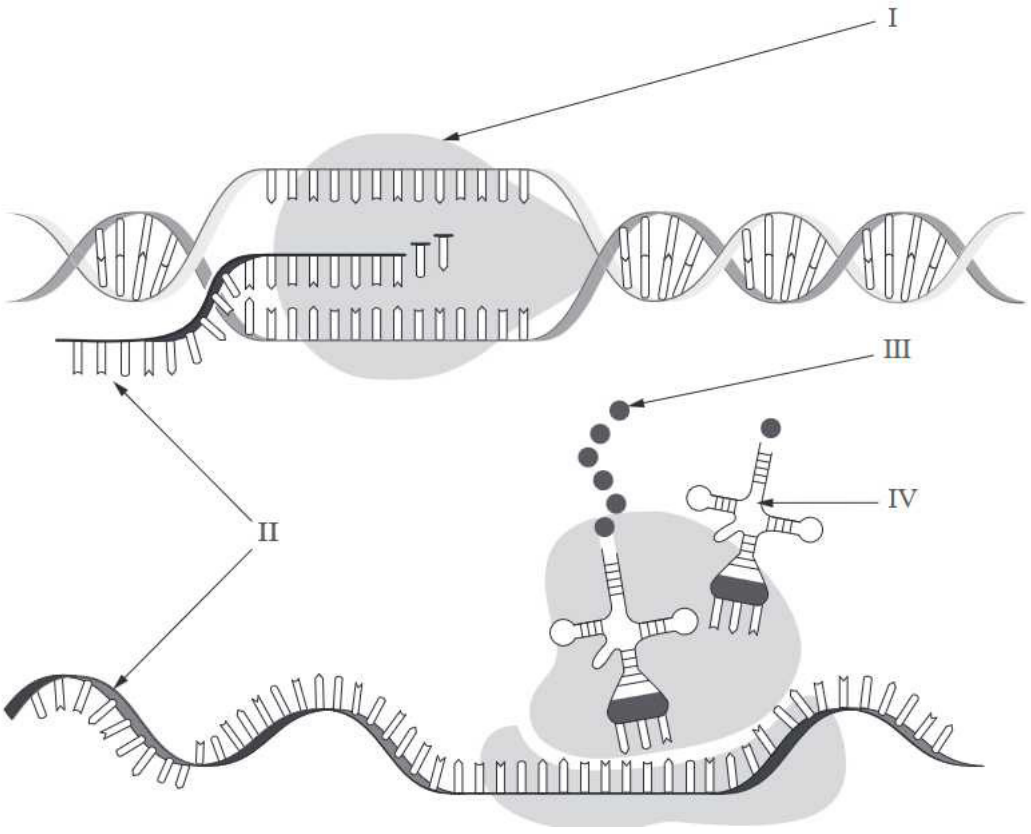
b) Identify evidence for the sickle-cell anaemia allele being advantageous for individuals living where malaria is prevalent. Explain your reasoning. [2 marks]

2024 Paper 2 Section 1 Question 9

DNA, genes and the continuity of life

The diagram shows key stages of gene expression



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

I:

II:

III:

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

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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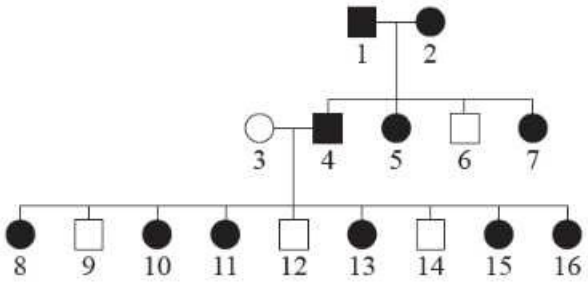
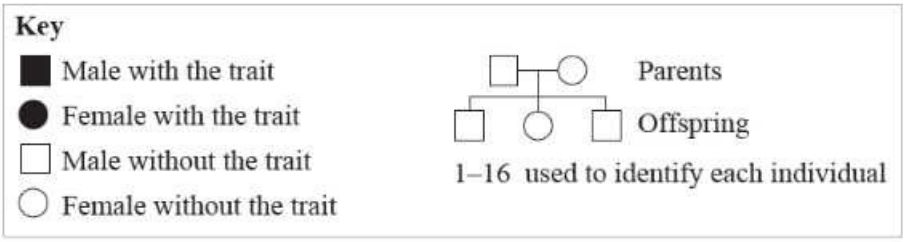
2023 Paper 2 Section 1 Question 3

DNA, genes and the continuity of life

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





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

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

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

2023 Paper 2 Section 1 Question 6 **DNA, genes and the continuity of life**	Explain how twin studies can be used to investigate the effect of the environment on gene expression. [3 marks]

2022 Paper 2 Section 1 Question 5 **DNA, genes and the continuity of life**	a) Describe the roles of messenger RNA and transfer RNA in protein synthesis. [2 marks] b) Explain how transcription factors control cell differentiation, using an example. [3 marks]

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2022 Paper 2 Section 1 Question 10 DNA, genes and the continuity of life	In fruit flies, eye colour is a sex-linked trait inherited on the X chromosome. The red-eye allele (R) is dominant over the white-eye allele (r). A red-eyed male and white-eyed female have 50 offspring. Use a Punnett square to predict the number of male and female offspring and their eye colour. [3 marks]

2021 Paper 2 Section 1 Question 2 DNA, genes and the continuity of life	a) Explain the difference between exons and introns. [2 marks] b) State a function of telomeres. [1 mark]

2021 Paper 2 Section 1 Question 4 DNA, genes and the continuity of life	Explain the purpose of the polymerase chain reaction (PCR) process and provide an example of its application. [2 marks]

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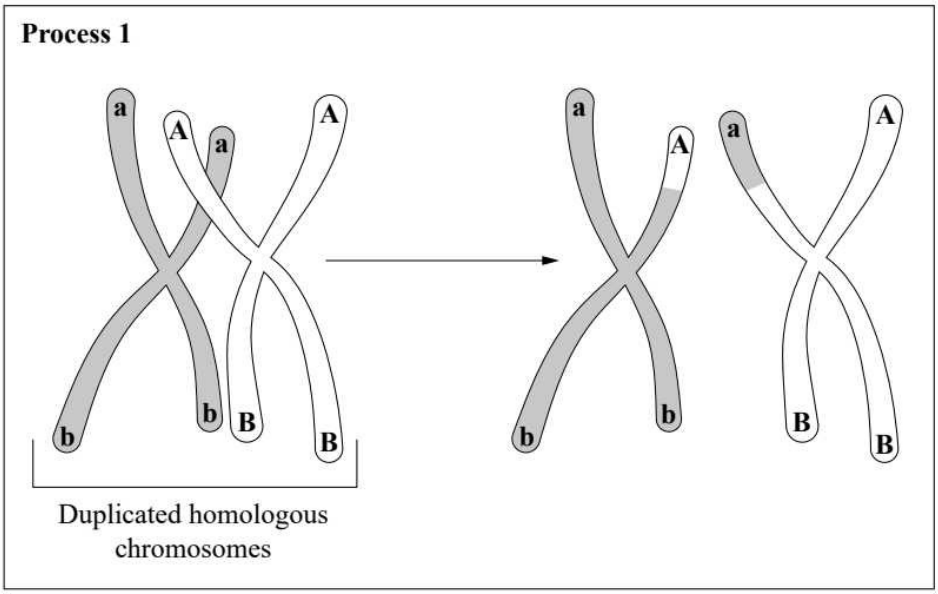
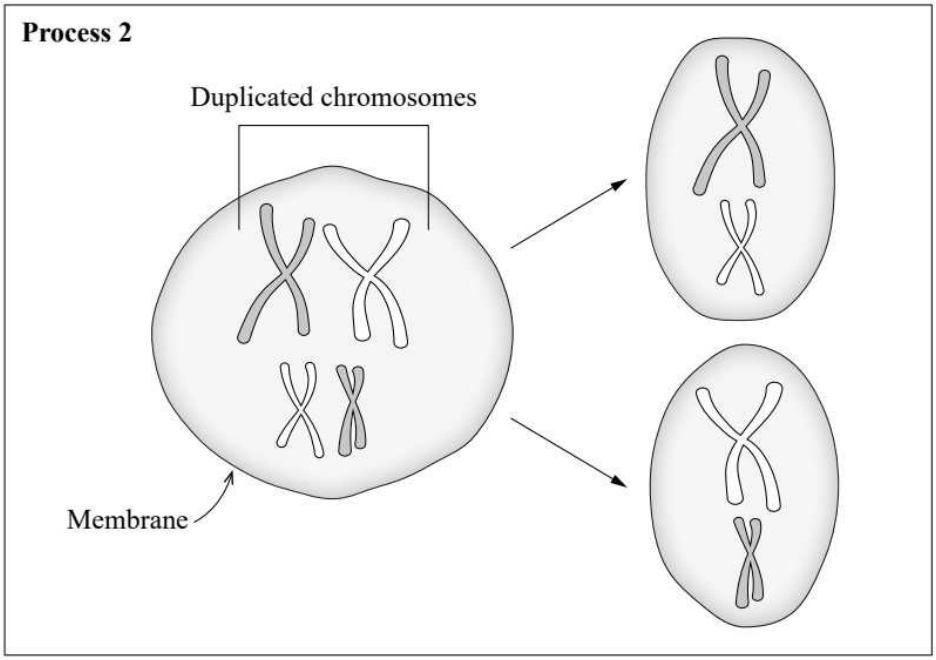
2021
Paper 2
Section 1
Question 5

DNA, genes and the continuity of life

Meiosis ensures that a wide range of genetic combinations occurs during the formation of gametes.
The diagrams show two processes that occur during meiosis.





Describe the two processes shown in the diagrams and how they contribute to genetic variation in gametes. [6 marks]

Name and description of process 1:

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	Name and description of process 2:

2021 Paper 2 Section 1 Question 10 DNA, genes and the continuity of life	Describe three ways DNA occurs in cells. [3 marks]

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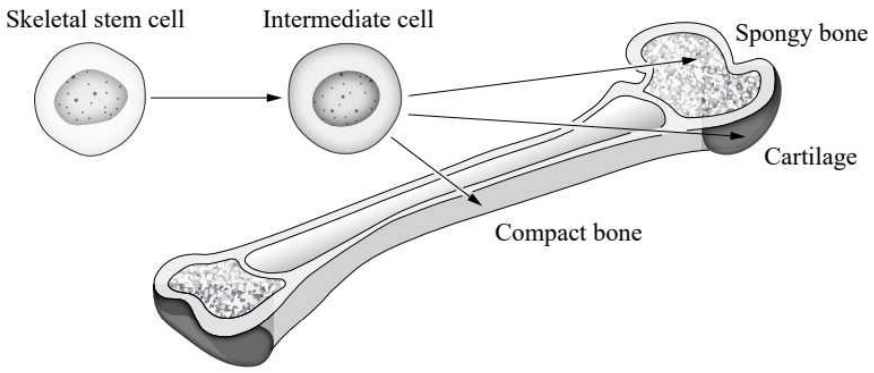
2021 Paper 2 Section 1 Question 11

DNA, genes and the continuity of life

Adult skeletal stem cells differentiate into intermediate cells and later into specialised bone tissue types.



The table shows how three transcription factors (A, B and C) affect bone tissue formation.

Transcription factor role	Intermediate cell	Cartilage	Compact bone
Activators	A	B, A	B
Repressors	—	C	A

Explain the effect of transcription factors on gene expression and tissue formation. Use an example from the table to support your answer.

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2020 Paper 2 Section 1 Question 3 **DNA, genes and the continuity of life**	Explain the role of the enzymes helicase and DNA polymerase in the process of DNA replication. [4 marks]

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2020 Paper 2 Section 1 Question 5 **DNA, genes and the continuity of life**	Explain the process of protein synthesis in terms of transcription and translation. [4 marks]

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Marking Guide – Paper 1 Section 1

2024 Paper 1 Section 1 Question 2 DNA, genes and the continuity of life	Polymerase chain reaction is a technique used in DNA profiling to (A) cut DNA at specific sites. **(B) create more copies of DNA. – Answer** (C) determine the order of nucleotides. (D) separate DNA fragments based on size.

2024 Paper 1 Section 1 Question 3 DNA, genes and the continuity of life	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. – Answer** (C) Spermatogenesis occurs throughout life, whereas oogenesis only occurs after puberty. (D) Spermatogenesis begins with haploid cells, whereas oogenesis begins with diploid cells.

2024 Paper 1 Section 1 Question 6 DNA, genes and the continuity of life	What can introduce new alleles into a population? **(A) point mutations – Answer** (B) non-disjunction (C) random fertilisation (D) independent assortment

2024 Paper 1 Section 1 Question 10 DNA, genes and the continuity of life	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. – Answer** (D) join amino acids to form a polypeptide chain during translation

2024 Paper 1 Section 1 Question 11 DNA, genes and the continuity of life	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 – Answer** (C) incomplete dominance (D) multiple allele inheritance

2024 Paper 1 Section 1 Question 17 DNA, genes and the continuity of life	Which genetic tool is **not** required to make recombinant DNA? (A) DNA ligase (B) plasmid vectors (C) restriction enzymes **(D) transcription factors – Answer**

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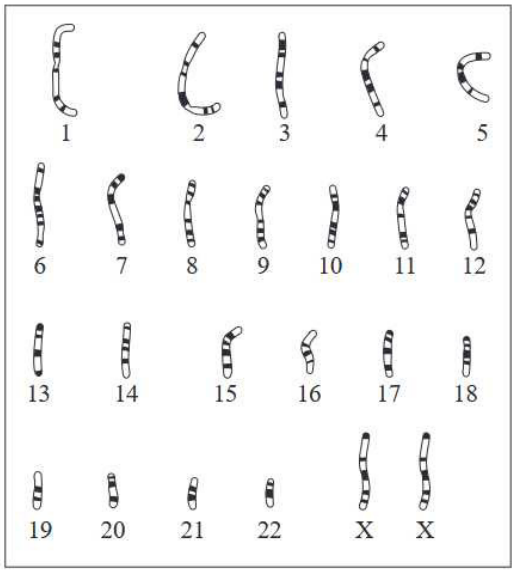
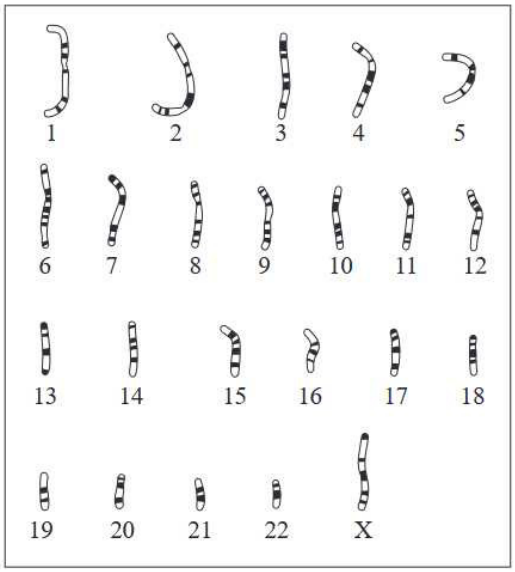
2024 Paper 1 Section 1 Question 18 DNA, genes and the continuity of life	Karyotypes for two human gametes are shown.   If the two gametes produced a zygote, the resulting embryo would be (A) male, with trisomy. **(B) female, with trisomy. – Answer** (C) male, with monosomy. (D) female, with monosomy.

2023 Paper 1 Section 1 Question 5 DNA, genes and the continuity of life	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. – Answer**

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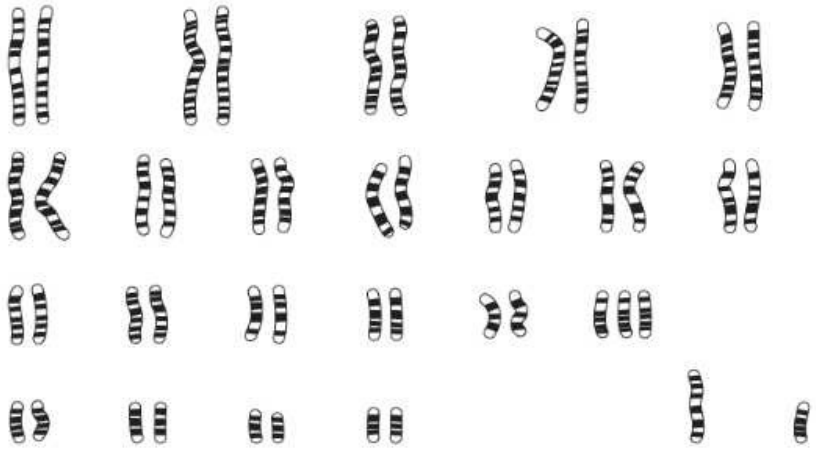
2023 Paper 1 Section 1 Question 8

DNA, genes and the continuity of life

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

Answer is C.

2023 Paper 1 Section 1 Question 11

DNA, genes and the continuity of life

Restriction enzymes

(A) join DNA into a single strand.
(B) cut DNA at specific locations. – Answer
(C) add nucleotides to a growing DNA strand.
(D) assist in the amplification of recombinant DNA.

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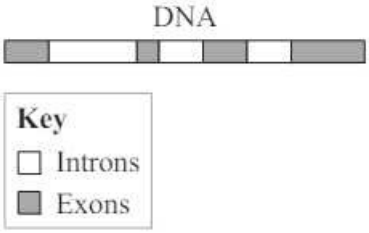
2023 Paper 1 Section 1 Question 16 DNA, genes and the continuity of life	The diagram shows a section of DNA.  Immediately following transcription and RNA splicing, the product would most closely resemble (A) mRNA: (B) tRNA: (C) mRNA: (D) tRNA: **Answer is A.**

2023 Paper 1 Section 1 Question 17 DNA, genes and the continuity of life	What is the most likely outcome of a homeobox (HOX) gene mutation? (A) slower growth rate **(B) body appendages in the incorrect location – Answer** (C) failure of sex characteristics to fully develop (D) impaired ability of red blood cells to carry oxygen

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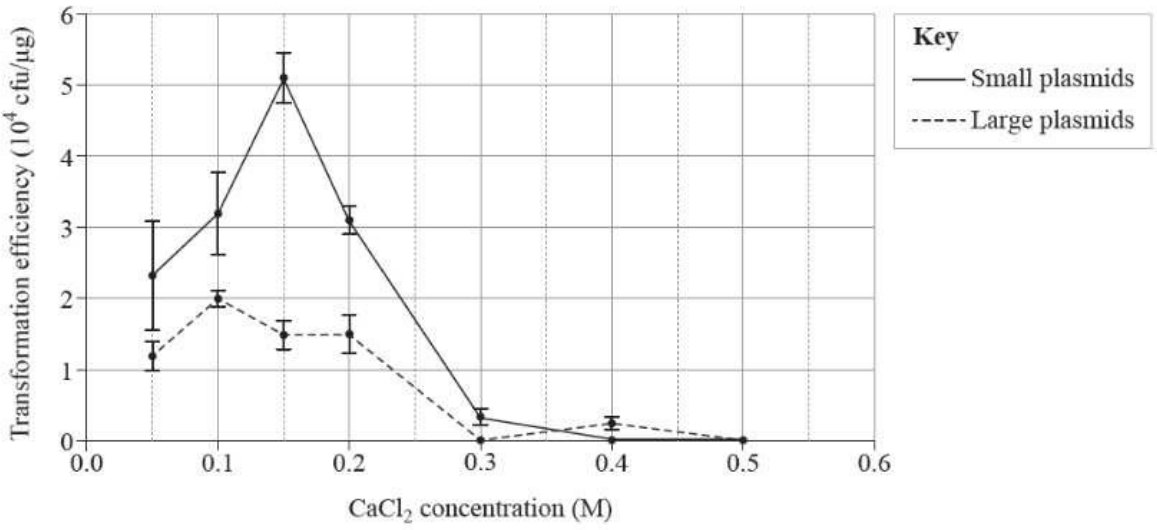
2023 Paper 1 Section 1 Question 18 **DNA, genes and the continuity of life**	Calcium chloride ($CaCl_2$) is a chemical used in bacterial transformation. An experiment was conducted to determine how the concentration of calcium chloride affects the transformation efficiency of large and small plasmids. 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. **Answer is A.**

2023 Paper 1 Section 1 Question 19 **DNA, genes and the continuity of life**	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. **Answer is B.**

2022 Paper 1 Section 1 Question 1 **DNA, genes and the continuity of life**	What is the molecular unit of heredity? **(A) gene – Answer** (B) genome (C) nucleotide (D) chromosome

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2022 Paper 1 Section 1 Question 2 DNA, genes and the continuity of life	Which stage of making recombinant DNA requires DNA ligase? (A) cutting **(B) joining – Answer** (C) isolation (D) transformation

2022 Paper 1 Section 1 Question 6 DNA, genes and the continuity of life	The role of helicase in DNA replication is to (A) initiate the process by binding to recognition sites along the template strand. (B) add complementary bases to the template strand. **(C) unwind and separate DNA strands. – Answer** (D) join DNA strands together.

2022 Paper 1 Section 1 Question 7 DNA, genes and the continuity of life	What is used directly by plants for protein synthesis? (A) nitrite, NO_2^- **(B) nitrate, NO_3^- – Answer** (C) ammonia, NH_3 (D) atmospheric nitrogen, N_2

2022 Paper 1 Section 1 Question 9 DNA, genes and the continuity of life	Polygenic inheritance involves multiple (A) alleles for a single gene. (B) genes with the same alleles. **(C) genes coding for a single characteristic. – Answer** (D) characteristics resulting from a single gene.

2022 Paper 1 Section 1 Question 13 DNA, genes and the continuity of life	An error during DNA replication resulted in the following change to mRNA transcripts. mRNA before: AUGAAGUUUGGCAUC … (continued) mRNA after: AUGAAGUUUGCAUCG … (continued) The DNA replication error most likely involved **(A) deletion of cytosine. – Answer** (B) insertion of guanine. (C) substitution of uracil with guanine. (D) substitution of guanine with cytosine.

2022 Paper 1 Section 1 Question 14 DNA, genes and the continuity of life	Prior to fertilisation, a secondary oocyte will arrest at which stage of meiosis? (A) prophase I (B) prophase II (C) metaphase I **(D) metaphase II – Answer**

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2022 Paper 1 Section 1 Question 15 DNA, genes and the continuity of life	The environment's influence on gene expression can be investigated by comparing the rate of concordance in monozygotic (identical) and dizygotic (non-identical) twins. Concordance occurs when both twins express a trait. Strong environmental influence is suspected when concordance is (A) higher in monozygotic twins. (B) only observed in dizygotic twins. (C) only observed in monozygotic twins. **(D) similar in monozygotic and dizygotic twins. – Answer**

2022 Paper 1 Section 1 Question 20 DNA, genes and the continuity of life	A section of DNA is made up of two strands, I and II. **Base** / **Strand I composition** / **Strand II composition** adenine / / cytosine / / 25% guanine / / 14% thymine / 29% / It can be inferred that (A) strand I contains 25% cytosine. **(B) strand I contains 32% adenine. – Answer** (C) strand II contains 29% thymine. (D) strand II contains 71% adenine.

2021 Paper 1 Section 1 Question 1 DNA, genes and the continuity of life	In mammals, inherited mutations can cause variations in the genotype of offspring when they occur in (A) red blood cells. (B) somatic cells. (C) nerve cells. **(D) sex cells. – Answer**

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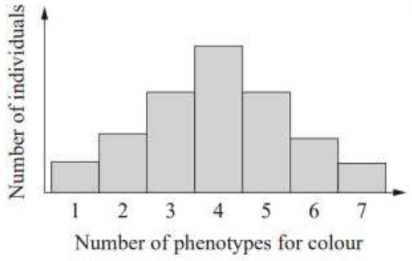
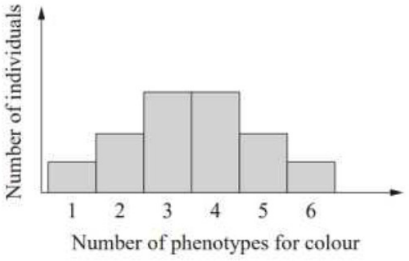
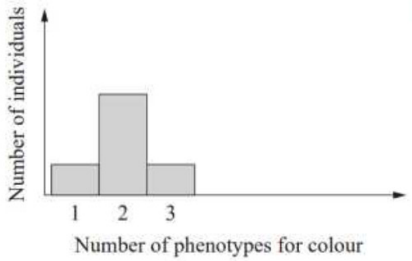
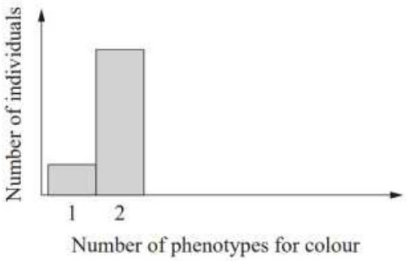
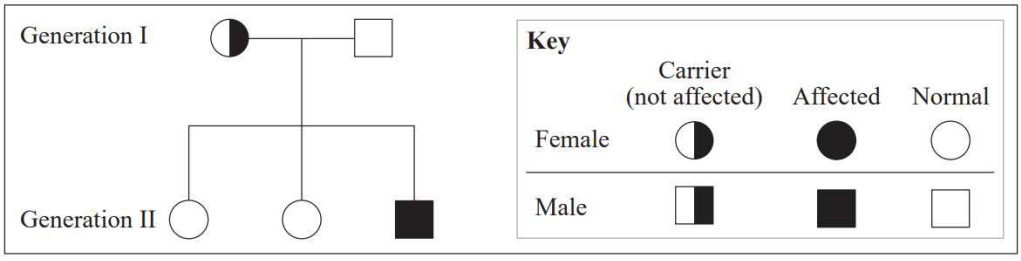
2021 Paper 1 Section 1 Question 4 DNA, genes and the continuity of life	To demonstrate polygenic inheritance of colour in wheat, a cross was performed between two intermediate parents (AaBbCc×AaBbCc). Each dominant allele adds a 'unit' of colour to the phenotype. Which graph would depict the number of individuals and number of phenotypes for the cross? (A)  (B)  (C)  (D)  **Answer is A.**
2021 Paper 1 Section 1 Question 6 DNA, genes and the continuity of life	The pedigree traces a genetic disease across two generations.  The inheritance pattern of this disease can be classified as (A) incomplete dominant. (B) autosomal dominant. **(C) sex linked. – Answer** (D) polygenic.
2021 Paper 1 Section 1 Question 12 DNA, genes and the continuity of life	The phenotypic expression of genes is regulated by **(A) transcription factors. – Answer** (B) random fertilisation. (C) DNA polymerase. (D) helicase.

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2021 Paper 1 Section 1 Question 13

DNA, genes and the continuity of life

Which combination of processes demonstrates spermatogenesis?

	Where process occurs	Outcome of process
(A)	testes	one functional gamete with 2–3 polar bodies
(B)	ovaries	four functional haploid gametes
(C)	testes	four functional haploid gametes
(D)	ovaries	one functional gamete with 2–3 polar bodies

Answer is C.

2021 Paper 1 Section 1 Question 14

DNA, genes and the continuity of life

Which event could cause a frameshift mutation?

(A) non-disjunction during meiosis
(B) error during replication – Answer
(C) base pair substitution
(D) heat damage

2021 Paper 1 Section 1 Question 19

DNA, genes and the continuity of life

What is the role of DNA polymerase in DNA replication?

(A) breaking the hydrogen bonds that hold the complementary bases of DNA together
(B) adding complementary nucleotide bases to the exposed DNA strands – Answer
(C) sealing the sequence of DNA into two continuous double strands
(D) joining RNA primers to the lagging strand of DNA

2020 Paper 1 Section 1 Question 1

DNA, genes and the continuity of life

In prokaryotes, deoxyribonucleic acid (DNA) is found as unbound circular DNA in the

(A) mitochondria.
(B) chloroplasts.
(C) nucleus.
(D) cytosol. – Answer

2020 Paper 1 Section 1 Question 2

DNA, genes and the continuity of life

Which form of inheritance usually determines traits that display continuous phenotypic variation?

(A) polygenic – Answer
(B) sex-linked
(C) multiple allele
(D) incomplete dominance

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2020 Paper 1 Section 1 Question 10 DNA, genes and the continuity of life	DNA profiling using polymerase chain reaction (PCR) and gel electrophoresis allows the comparison of (A) genes. (B) entire genomes. **(C) DNA fragments. – Answer** (D) specific sites of mutations.

2020 Paper 1 Section 1 Question 12 DNA, genes and the continuity of life	In the structure of DNA, adenine pairs with which other base? (A) uracil (B) guanine (C) cytosine **(D) thymine – Answer**

2020 Paper 1 Section 1 Question 13 DNA, genes and the continuity of life	Which of the following molecules is involved in the transcription of DNA? **(A) RNA polymerase – Answer** (B) DNA helicase (C) transfer RNA (D) amino acids

2021 Paper 1 Section 1 Question 15 DNA, genes and the continuity of life	The table identifies the condition associated with a variety of ploidy changes. **Chromosome number (ploidy)** / **Condition name** Monosomy 5 / Cri du chat syndrome Trisomy 21 / Down syndrome Trisomy 23 / Klinefelter syndrome Monosomy 23 / Turner syndrome For a person who has 45 chromosomes (2n–1) due to an autosomal condition, which condition do they have? **(A) Cri du chat syndrome – Answer** (B) Down syndrome (C) Klinefelter syndrome (D) Turner syndrome

2020 Paper 1 Section 1 Question 3 DNA, genes and the continuity of life	A genome is defined as (A) the molecular unit of heredity. **(B) all the genetic material in the chromosomes of an organism. – Answer** (C) the sequence of triplets of DNA nucleotides that make up a gene. (D) the combination of alleles for a particular trait carried by an individual.

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2020 Paper 1 Section 1 Question 15

DNA, genes and the continuity of life

In watermelon, skin colour is controlled by a single autosomal gene. The two phenotypic variants are green and striped. Two plants, one homozygous for the green alleles, and one homozygous for the striped alleles, were crossed.

The figure shows the phenotypic frequency for the initial (F_0) generation and the subsequent (F_1) generation.

A cross was then performed between members of the F_1 generation. What would be the expected frequency of striped watermelon in the next (F_2) generation?

(A) 1.0
(B) 0.75 – Answer
(C) 0.50
(D) 0.25

2020 Paper 1 Section 1 Question 17

DNA, genes and the continuity of life

The table identifies the condition associated with a variety of ploidy changes.

Chromosome number ploidy	Condition name
Monosomy 5	Cri du chat syndrome
Trisomy 21	Down syndrome
Trisomy 23	Klinefelter syndrome
Monosomy 23	Turner syndrome

For a person with XXY sex chromosomes, which condition would they have?

(A) Cri du chat syndrome
(B) Down syndrome
(C) Klinefelter syndrome – Answer
(D) Turner syndrome

2020 Paper 1 Section 1 Question 19

DNA, genes and the continuity of life

The table of data shows a comparison of amino acids sequences in the same section of haemoglobin molecules from a number of different species.

From the given information, which of the following species's haemoglobin protein is most similar to human haemoglobin protein?

Species	Sequence of amino acids							
Human	Lys	Glu	His	Ile	Val	Glu	Phe	Lys
(A)	Lys	Glu	His	Lys	Val	Met	Phe	Lys
(B)	Lys	Glu	Lys	Ile	Val	Glu	Phe	Lys
(C)	Lys	Asp	His	Leu	Val	Met	Phe	Lys
(D)	Lys	Val	His	Asn	Val	Glu	Phe	Lys

Answer is B.

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2024 Paper 1 Section 2 Question 23

DNA, genes and the continuity of life

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.

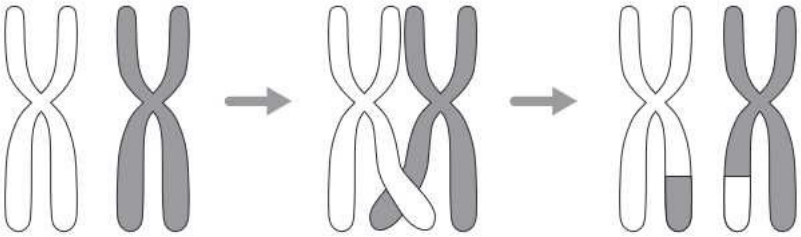
Predict the number of offspring with white fur. Justify your response using a Punnett square. (3 marks)

Sample response	The response
<table><tr><th></th><th>B</th><th>b</th></tr><tr><th>b</th><td>Bb</td><td>bb</td></tr><tr><th>b</th><td>Bb</td><td>bb</td></tr></table> 50% Bb: heterozygous black fur 50% bb: white fur 0.5 x 12 offspring = 6 white rabbits	• identifies parental genotypes **[1 mark]** • provides an appropriate Punnett square **[1 mark]** • predicts number of offspring with white fur **[1 mark]**

2024 Paper 1 Section 2 Question 24

DNA, genes and the continuity of life

The diagram shows a process that occurs during meiosis.



a) Identify the process. [1 mark]

Sample response	The response
Crossing over	• identifies crossing over **[1 mark]**

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

Sample response	The response
Crossing over involves homologous chromosomes exchanging portions of their DNA. Because homologous chromosomes have the same genes but (usually) different alleles, this results in chromosomes with new combinations of genetic information/alleles.	• describes crossing over **[1 mark]** • explains how crossing over contributes to genetic variation **[1 mark]**

2023 Paper 1 Section 2 Question 21

DNA, genes and the continuity of life

The diagram represents a section of DNA.

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Identify the DNA components indicated by labels 1-4. [4 marks]

Sample response	The response
1: hydrogen bonds 2: nitrogenous base 3: sugar 4: phosphate	• identifies 1 as hydrogen bonds **[1 mark]** • identifies 2 as nitrogenous base **[1 mark]** • identifies 3 as sugar **[1 mark]** • identifies 4 as phosphate **[1 mark]**

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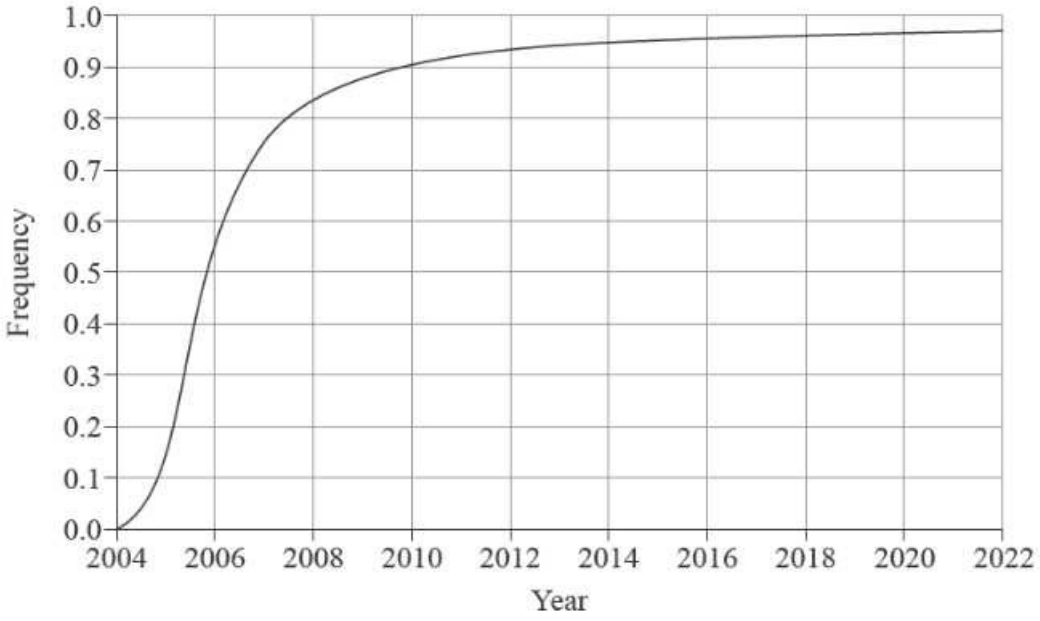
2023 Paper 1 Section 2 Question 24

DNA, genes and the continuity of life

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]

Sample response	The response
Advantageous. There was a rapid increase in the frequency of the new allele between 2004 and 2008 (0–84%). The frequency then continued to increase until 2022, when approximately 97% of the population had the allele. This indicates positive selection for the allele has occurred, suggesting the trait is advantageous.	• infers the allele is advantageous **[1 mark]** • justifies response using evidence from the graph **[1 mark]**

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

Sample response	The response
If mutations occur in coding regions of DNA, they may create new alleles. If new alleles occur in sex cells, they can be passed to the next generation and may become more common in the population (particularly if they're advantageous), causing changes to allele frequencies.	• explains that mutations can create new alleles **[1 mark]** • recognises the mutation must occur in sex cells **[1 mark]** • explains how mutations contribute to microevolutionary change **[1 mark]**

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2023 Paper 1 Section 2 Question 27

DNA, genes and the continuity of life

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. [3 marks]

Sample response	The response
When homologous chromosomes pair up at metaphase 1 of meiosis, the orientation of maternal and paternal chromosomes is random, so each daughter cell (gamete) has a 50% chance of receiving the maternal homologue and a 50% chance of receiving the paternal homologue. This leads to 2^{24} possible chromosome combinations for each egg and sperm. In addition to this, any of the millions of sperm created by each male fish could fertilise an egg. This leads to a high number of possible chromosome combinations for the offspring, even before crossing over is considered.	• explains – the process of independent assortment **[1 mark]** – the process of random fertilisation **[1 mark]** – how independent assortment and random fertilisation contribute to genetic variation **[1 mark]**

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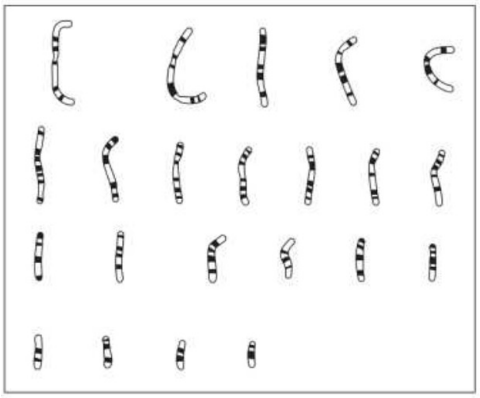
2022 Paper 1 Section 2 Question 26

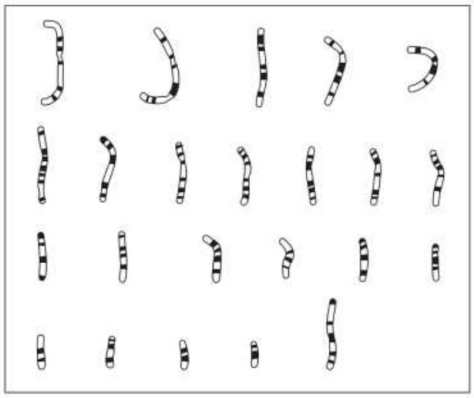
DNA, genes and the continuity of life

Karyotypes for two human gametes are shown.

Karyotype A (sperm cell)



Karyotype B (egg cell)



a) Identify which cell exhibits aneuploidy. Refer to evidence from the karyotype. [1 mark]

Sample Response	The response
The sperm cell is missing a sex chromosome.	• identifies the sperm cell is missing a chromosome [1 mark]

b) Explain how this chromosome abnormality may have occurred. [2 marks]

Sample Response	The response
The abnormality may have occurred due to nondisjunction during meiosis, where the sex chromosomes failed to separate at anaphase and ended up in the same daughter cell. This results in the daughter cells (gametes) containing either two copies of the sex chromosome/s or no copies, as is the case for karyotype A.	• identifies the abnormality may be due to nondisjunction [1 mark] • explains that non-disjunction occurs when chromosomes fail to separate during meiosis [1 mark]

This table lists some genetic conditions resulting from chromosomal abnormalities.

Genetic condition	Common name
Monosomy 5	Cri du chat syndrome
Monosomy X	Turner syndrome
Trisomy 13	Patau syndrome
Trisomy 18	Edwards syndrome
Trisomy X	Triple X syndrome

c) Predict which genetic condition would occur if the two gametes produced a zygote. [1 mark]

Sample Response	The response
Turner syndrome.	• predicts Turner syndrome [1 mark]

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2022 Paper 1 Section 2 Question 27

DNA, genes and the continuity of life

Explain the purpose of gel electrophoresis in DNA profiling. [2 marks]

Sample Response	The response
Gel electrophoresis separates DNA segments based on size to produce characteristic banding patterns.	• identifies that gel electrophoresis is used to separate DNA fragments based on size [1 mark] • explains that this produces characteristic banding patterns [1 mark]

2021 Paper 1 Section 2 Question 25

DNA, genes and the continuity of life

In blood group inheritance in humans, three alleles (i, I^A and I^B) determine blood type, which can be type O, A, B or AB.

It is known that:
• allele I^A produces type A and is co-dominant with allele I^B, which produces type B
• allele i produces type O
• alleles I^A and I^B are dominant over allele i.

A father who is heterozygous type A and a mother who is heterozygous type B have children. Predict the likely frequency of phenotypes for their offspring. Show your working. [3 marks]

Sample Response	The response
The genotypes of the parents are I^Ai and I^Bi Potential crosses I^A | i I^B | I^AI^B | I^Bi i | I^Ai | ii ¼ type AB, ¼ type A, ¼ type B, ¼ type O	• identifies parents as IAi and IBi [1 mark] • shows appropriate working [1 mark] • states a consequentially correct frequency for each blood type [1 mark]

2021 Paper 1 Section 2 Question 26

DNA, genes and the continuity of life

a) State the three components of a DNA nucleotide. [1 mark]

Sample Response	The response
Phosphate, deoxyribose sugar and a nitrogenous base.	• states phosphate, sugar and a base [1 mark]

b) Describe the steps involved in DNA profiling. [3 marks]

Sample Response	The response
DNA samples are taken from two or more individuals and short sequences/STRs are identified and separated. The short fragments of DNA are then amplified using polymerase chain reaction (PCR). Results are compared by gel electrophoresis, so DNA similarities and differences between the samples and/or a known DNA profile can be determined.	• describes - one step [1 mark] - a second step [1 mark] - a third step [1 mark]

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2020 Paper 1 Section 2 Question 24

DNA, genes and the continuity of life

a) Describe what is meant by the genotype of an organism. [1 mark]

Sample Response	The response
Genotype refers to the combination of alleles that an organism has.	• states combination of alleles [1 mark]

b) Inherited mutations can affect the genotype of offspring. Describe how this occurs. [2 marks]

Sample Response	The response
The parent of the offspring would have a mutation that is inheritable (in sex organs) and creates a new allele (variation of a gene). The genotype of an offspring may then be affected as it would contain new alleles if the mutated gene from an egg or sperm is present in the zygote at fertilisation. This will then affect the genotype of the offspring.	• states a description of the mutation being a new allele of a gene [1 mark] • states genotype contains new alleles if/when inherited [1 mark]

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2024 Paper 2 Section 1 Question 4

DNA, genes and the continuity of life

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

Sample response	The response
Helicase unwinds the double helix and separates the strands. Polymerase adds nucleotides to the new strand.	• describes the role of helicase **[1 mark]** • describes the role of DNA polymerase **[1 mark]**

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

Sample response	The response
The weak nature of hydrogen bonds makes it easy for helicase to separate strands. Complementary base pairing allows DNA polymerase to be guided by the template strand.	• explains one way the structure of DNA aids replication **[1 mark]** • explains a second way the structure of DNA aids replication **[1 mark]**

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

Sample response	The response
Mutations occur when DNA polymerase makes an error by inserting, removing or adding an incorrect nucleotide. Substitution reactions involve A, T, C or G being swapped for a different nucleotide, and result in point mutations. Because of the way that codons work, these mutations will only affect one amino acid. Additions or deletions cause frameshift mutations, where all codons after the mutation will be affected.	• explains how errors in DNA replication cause point mutations **[1 mark]** • explains how errors in DNA replication cause frameshift mutations **[1 mark]**

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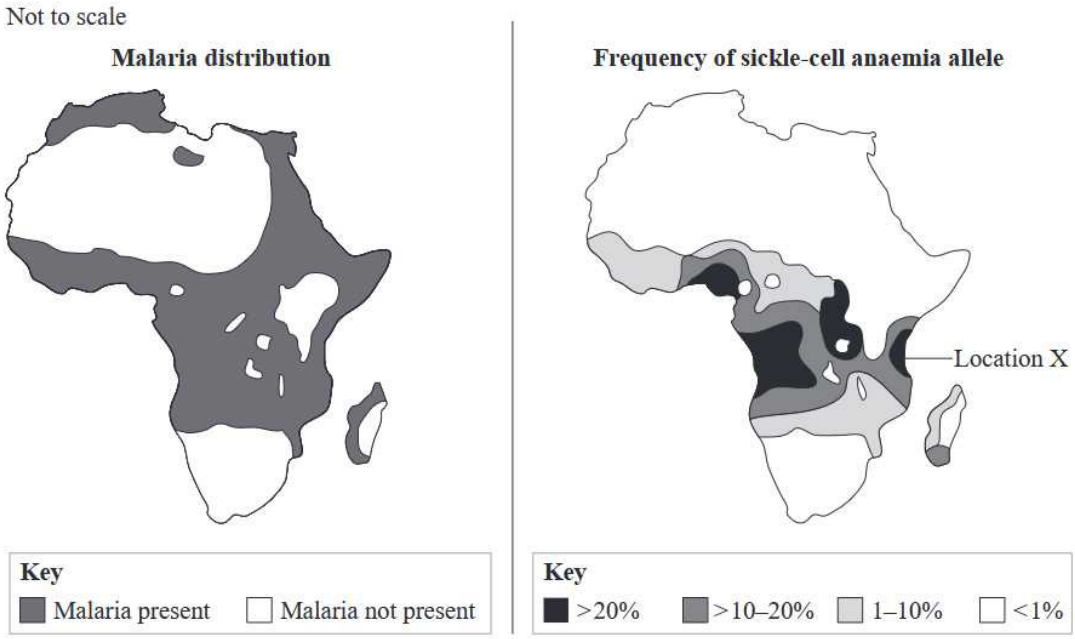
2024 Paper 2 Section 1 Question 6

DNA, genes and the continuity of life

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



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

Genotype	Number of individuals
AA	830
Aa	540
aa	23

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

Sample response	The response
$\text{Frequency (a)} = \frac{(2\times 23)+540}{2\times(830+540+23)}$ $= 0.21$	• calculates frequency of allele a **[1 mark]** • provides appropriate working **[1 mark]**

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

Sample response	The response
Frequencies of the sickle-cell anaemia allele are high (1–20%) in the middle of the continent, where malaria is present, but low (<1%) in other areas. This suggests positive selection for the allele has occurred in these areas, causing it to become more prevalent. This is characteristic of an allele that is advantageous.	• identifies appropriate evidence **[1 mark]** • explains their reasoning **[1 mark]**

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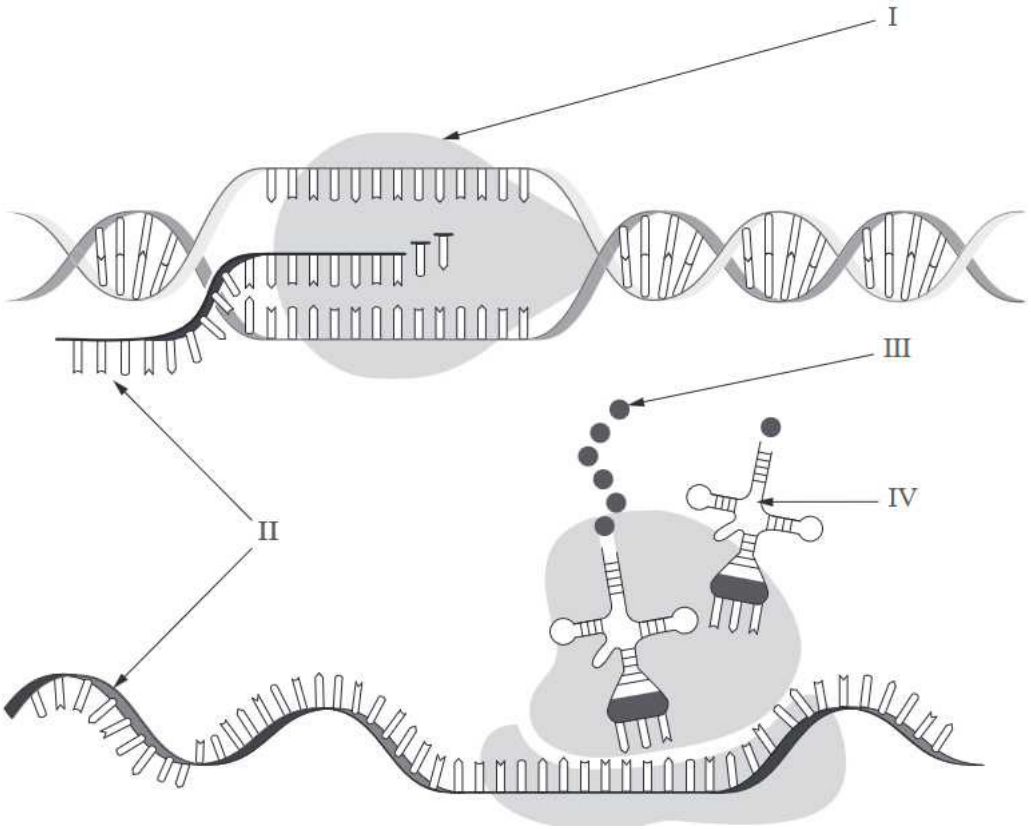
2024
Paper 2
Section 1
Question 9

DNA, genes and the continuity of life

The diagram shows key stages of gene expression



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

Sample response	The response
I. RNA polymerase II. mRNA III. polypeptide	• identifies I as RNA polymerase **[1 mark]** • identifies II as mRNA **[1 mark]** • identifies III as polypeptide **[1 mark]**

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

Sample response	The response
The role of tRNA is to transport amino acids from the cytoplasm to the ribosome in the order specified by the mRNA. Each tRNA carries a specific amino acid, based on its anticodon sequence. The anticodon recognises and binds to its complementary sequence on the mRNA molecule. This allows amino acids to be connected in the order specified by the mRNA sequence.	• describes – the role of tRNA **[1 mark]** – the role of anticodons **[1 mark]** – tRNA-amino acid specificity **[1 mark]**

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

Sample response	The response
Transcription factors bind to sections of DNA near the gene being expressed and either promote or inhibit the binding of RNA polymerase. Epigenetic tags affect the degree of DNA coiling. Genes in sections of DNA that are tightly bound are usually not expressed because the enzymes involved in transciption can't access them.	• describes one way gene expression is regulated **[1 mark]** • describes a second way gene expression is regulated **[1 mark]**

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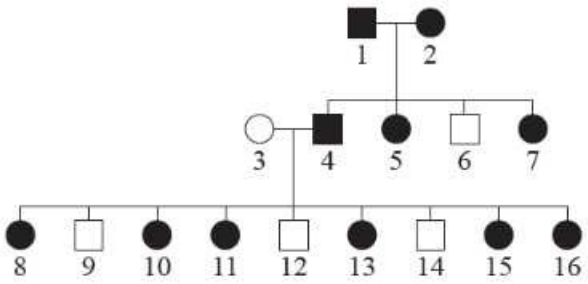
d) Explain two reasons why genetic mutations do not always affect the phenotype of an individual. [2 marks]

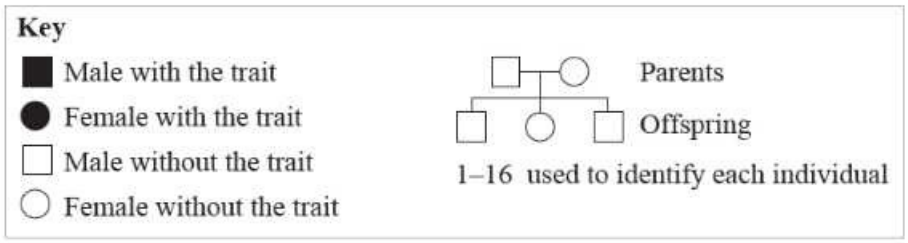
Sample response	The response
Mutations may occur in non-coding sections of DNA (introns), meaning the resulting polypeptide will not be affected. Point mutations may not change the amino acid the triplet codes for, meaning the resulting polypeptide is unaffected (silent mutation).	• provides one reason **[1 mark]** • provides a second reason **[1 mark]**

2023 Paper 2 Section 1 Question 3

DNA, genes and the continuity of life

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





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

Sample response	The response
3	• states 3 **[1 mark]**

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

Sample response	The response
Individual 4 has passed the trait on to all his daughters (who would inherit his X chromosome) but none of his sons (who would inherit his Y chromosome). This shows that if an affected male (X^AY) mates with an unaffected female (X^aX^a), all of their daughters will be affected, but none of their sons. This matches the chart, as individual 4 has six daughters with the trait, but none of his three sons have it.	• identifies appropriate evidence from the chart **[1 mark]** • identifies appropriate genotypes for the Punnett square **[1 mark]** • constructs a Punnett square **[1 mark]** • uses the Punnett square to determine expected frequencies for offspring phenotypes **[1 mark]**

	X^A	Y
X^a	X^AX^a	X^aY
X^a	X^AX^a	X^aY

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

Sample response	The response
X^aY Individual 6 is a male without the trait, so he must have inherited a recessive allele.	• infers X^aY **[1 mark]** • provides appropriate reasoning **[1 mark]**

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2023 Paper 2 Section 1 Question 6

DNA, genes and the continuity of life

Explain how twin studies can be used to investigate the effect of the environment on gene expression. [3 marks]

Sample response	The response
Twin studies involve collecting data on the rate of concordance/discordance in monozygotic twin pairs. Because identical twins form from a single egg, they share the same DNA, so any differences in phenotype can be attributed to the environment. By comparing the rate of discordance in monozygotic twin pairs, scientists can quantify the degree to which the environment influences gene expression and look for differences in the epigenome that may explain the observed differences.	• describes a twin methodology **[1 mark]** • recognises that monozygotic twins have the same genome **[1 mark]** • explains how data can be used to investigate the effect of the environment on gene expression **[1 mark]**

2022 Paper 2 Section 1 Question 5

DNA, genes and the continuity of life

a) Describe the roles of messenger RNA and transfer RNA in protein synthesis. [2 marks]

Sample Response	The response
Messenger RNA (or mRNA) provides copies of the gene from the DNA template strand.	• describes the role of messenger RNA in protein synthesis [1 mark]
Transfer RNA (or tRNA) decodes mRNA sequences by matching amino acids to codons of the mRNA.	• describes the role of transfer RNA in protein synthesis [1 mark]

b) Explain how transcription factors control cell differentiation, using an example. [3 marks]

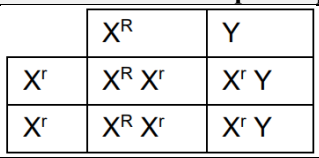
Sample Response	The response
Transcription factors are proteins that turn specific genes on or off by binding to nearby sections of DNA. This allows different genes to be expressed in different cell types. For example, the SRY gene on the Y chromosome promotes the development of testes by producing a protein that regulates the expression of genes (production of proteins) required by Sertoli cells.	• recognises that transcription factors regulate gene expression by binding to specific DNA sequences [1 mark] • explains that this allows for differential gene expression [1 mark] • provides an example [1 mark]

2022 Paper 2 Section 1 Question 10

DNA, genes and the continuity of life

In fruit flies, eye colour is a sex-linked trait inherited on the X chromosome. The red-eye allele (R) is dominant over the white-eye allele (r). A red-eyed male and white-eyed female have 50 offspring.

Use a Punnett square to predict the number of male and female offspring and their eye colour. [3 marks]

Sample Response	The response
	• provides working using a Punnett square [1 mark]
Approximately 25 red-eyed females and 25 white-eyed males.	• predicts 25 females with red eyes [1 mark] • predicts 25 males with white eyes [1 mark]

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2021 Paper 2 Section 1 Question 2

DNA, genes and the continuity of life

a) Explain the difference between exons and introns. [2 marks]

Sample Response	The response
Exons are sequences of coding DNA, which is transcribed into mRNA and then translated into proteins. Introns are sequences of non-coding DNA and have a variety of other functions. They are spliced out of the mRNA prior to translation.	• states that exons are coding DNA and introns are non-coding DNA [1 mark] • explains that exons are transcribed into mRNA and then translated into proteins, whereas introns are spliced out of mRNA and have other functions [1 mark]

b) State a function of telomeres. [1 mark]

Sample Response	The response
Telomeres protect the ends of chromosomes from being degraded, prolonging their life.	• states a function of telomeres [1 mark]

2021 Paper 2 Section 1 Question 4

DNA, genes and the continuity of life

Explain the purpose of the polymerase chain reaction (PCR) process and provide an example of its application. [2 marks]

Sample Response	The response
Polymerase chain reaction is used to amplify (i.e. make many copies) of a DNA template because usually only a small amount of DNA is available for analysis. For example, crime scene DNA is sometimes found only at trace levels. PCR amplifies this small amount to allow analysis to be carried out.	• explains purpose of PCR as amplifying a DNA sample for further analysis [1 mark] • provides an example [1 mark]

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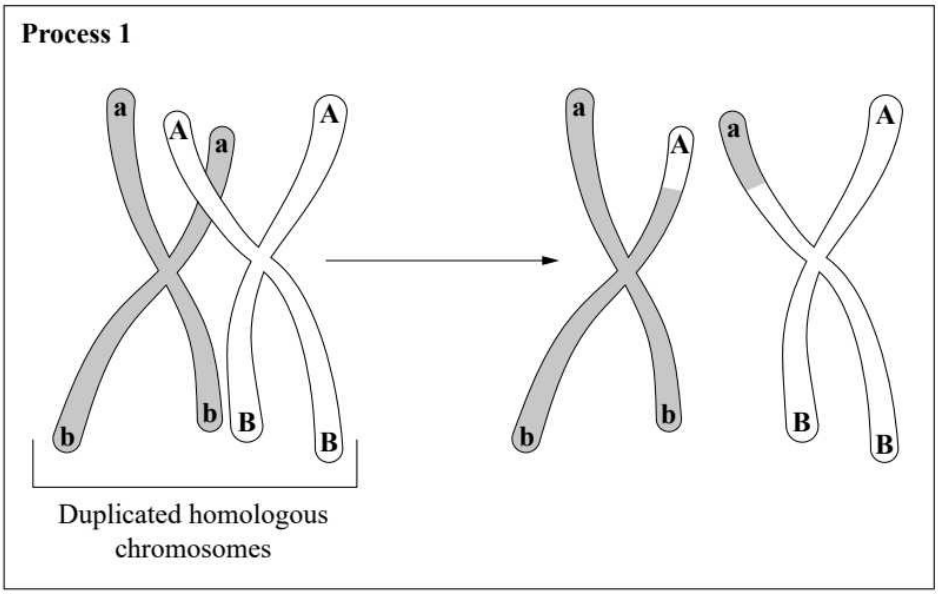
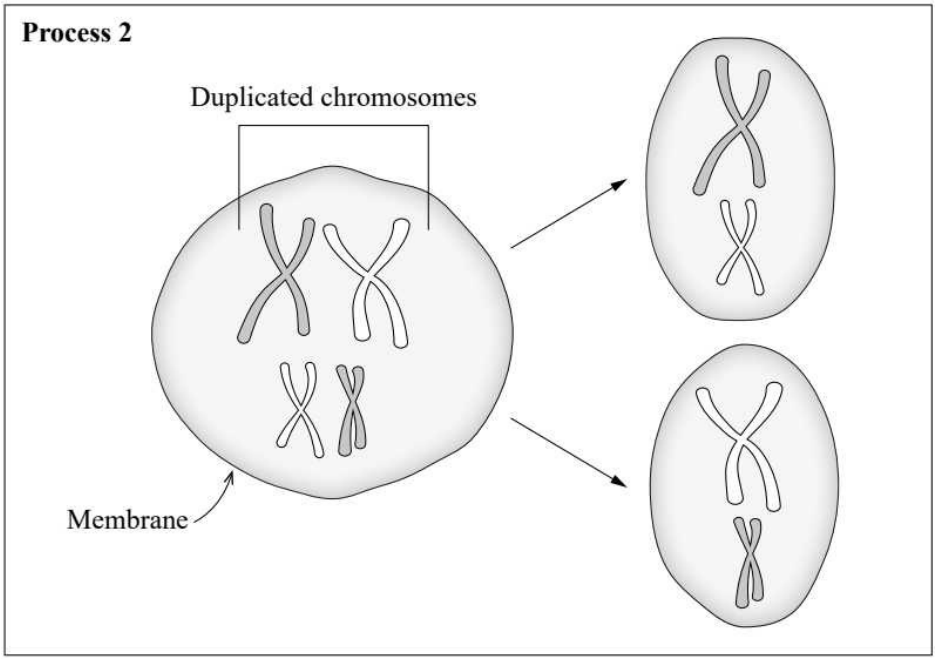
2021 Paper 2 Section 1 Question 5

DNA, genes and the continuity of life

Meiosis ensures that a wide range of genetic combinations occurs during the formation of gametes. The diagrams show two processes that occur during meiosis.





Describe the two processes shown in the diagrams and how they contribute to genetic variation in gametes. [6 marks]

Sample Response	The response
Crossing over: When segments of maternal and paternal chromosomes are exchanged during the process of meiosis, resulting in chromosomes containing DNA from each parent — new genetic combinations are produced at the chromosome level.	• for crossing over - provides the name of the process [1 mark] - describes the process [1 mark] - states how the process contributes to genetic variation in gametes [1 mark]
Independent assortment: Maternal and paternal chromosomes do not separate together; instead, each haploid gamete cell will contain a mixture of chromosomes from each parent, providing new genetic combinations.	• for independent assortment - provides the name of the process [1 mark] - describes the process [1 mark] - states how the process contributes to genetic variation in gametes [1 mark]

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2021 Paper 2 Section 1 Question 10

DNA, genes and the continuity of life

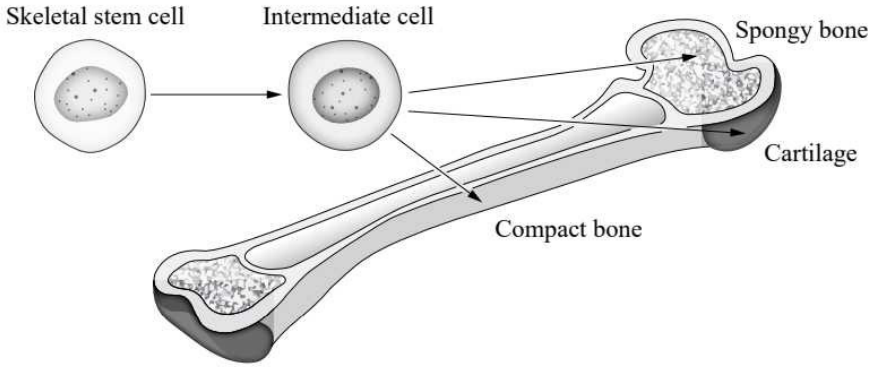
Describe three ways DNA occurs in cells. [3 marks]

Sample Response	The response
In eukaryotes, DNA occurs bound to histone proteins in chromosomes in the nucleus of eukaryotes or as unbound circular DNA in the mitochondria. It can also occur as unbound circular DNA in the cytosol of prokaryotic cells.	• describes one way DNA occurs in cells [1 mark] • describes a second way DNA occurs in cells [1 mark] • describes a third way DNA occurs in cells [1 mark]

2021 Paper 2 Section 1 Question 11

DNA, genes and the continuity of life

Adult skeletal stem cells differentiate into intermediate cells and later into specialised bone tissue types.



The table shows how three transcription factors (A, B and C) affect bone tissue formation.

Transcription factor role	Intermediate cell	Cartilage	Compact bone
Activators	A	B, A	B
Repressors	—	C	A

Explain the effect of transcription factors on gene expression and tissue formation. Use an example from the table to support your answer.

Sample Response	The response
Transcription factors either increase (activator) or decrease (repressor) the rate of transcription of a particular gene. For example, transcription factor A increases transcription for the intermediate cells to form, whereas it reduces the rate of or prevents compact bone formation.	• states that transcription factors can both increase and decrease transcription rates [1 mark] • provides a suitable example from the table [1 mark]

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2020 Paper 2 Section 1 Question 3

DNA, genes and the continuity of life

Explain the role of the enzymes helicase and DNA polymerase in the process of DNA replication. [4 marks]

Sample Response	The response
Helicase unzips the DNA molecule by breaking the weak hydrogen bonds between the two complementary strands. This creates a replication fork region so that bases are exposed. DNA polymerase uses each original strand as a template to produce a copy of the DNA molecule, and adds complementary nucleotides to the exposed bases. DNA polymerase also proofreads the newly synthesised strand.	• states helicase's role in -unzipping DNA [1 mark] -exposing bases [1 mark] • states DNA polymerase's role in -adding complementary nucleotides to the exposed bases [1 mark] • states another role of helicase, polymerase, or suitable feature of the process [1 mark]

2020 Paper 2 Section 1 Question 5

DNA, genes and the continuity of life

Explain the process of protein synthesis in terms of transcription and translation. [4 marks]

Sample Response	The response
Transcription involves copying a gene's DNA sequence to make an RNA molecule. This is performed by enzymes called RNA polymerases, which link nucleotides to form an mRNA strand. In the translation process, the mRNA formed in transcription is transported out of the nucleus to the ribosome. Here, it directs protein synthesis. The mRNA passes through the ribosome and tRNA interacts with it, adding amino acids together to make a protein chain.	• states that in transcription - DNA is copied [1 mark] - mRNA is formed [1 mark] • states that in translation - mRNA is transported to ribosome [1 mark] - tRNA adds amino acids to form a protein chain [1 mark]

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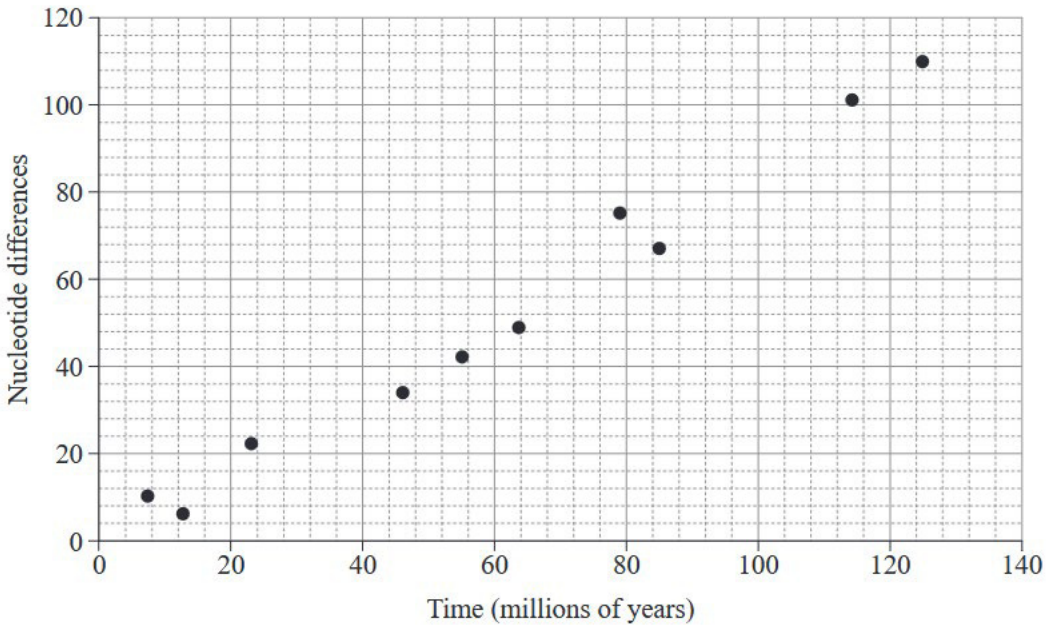
Unit 4 – Topic 2: Continuity of life on Earth

Paper 1 Section 1

2024 Paper 1 Section 1 Question 19 Continuity of life on Earth	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

2024 Paper 1 Section 1 Question 20 Continuity of life on Earth	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.

2023 Paper 1 Section 1 Question 4 Continuity of life on Earth	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.

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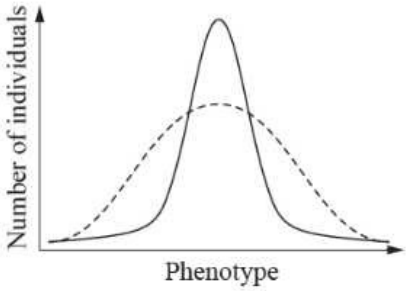
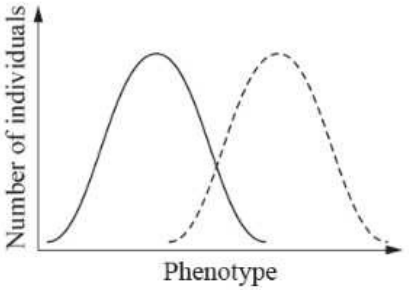
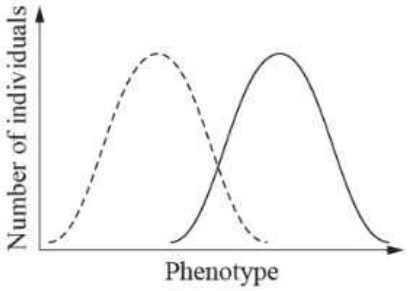
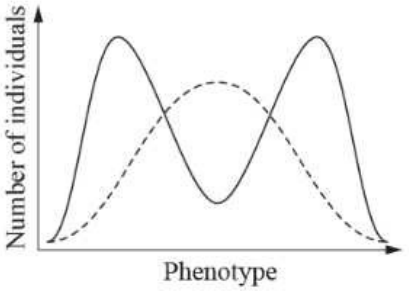
2023 Paper 1 Section 1 Question 6 Continuity of life on Earth	The phylogenetic tree shows evolutionary relationships between seven species of Himalayan songbird and the elevations they inhabit. ***Copyright restrictions prohibit the release of this QCAA exam material.*** The data shows that (A) the most 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.

2023 Paper 1 Section 1 Question 7 Continuity of life on Earth	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) 

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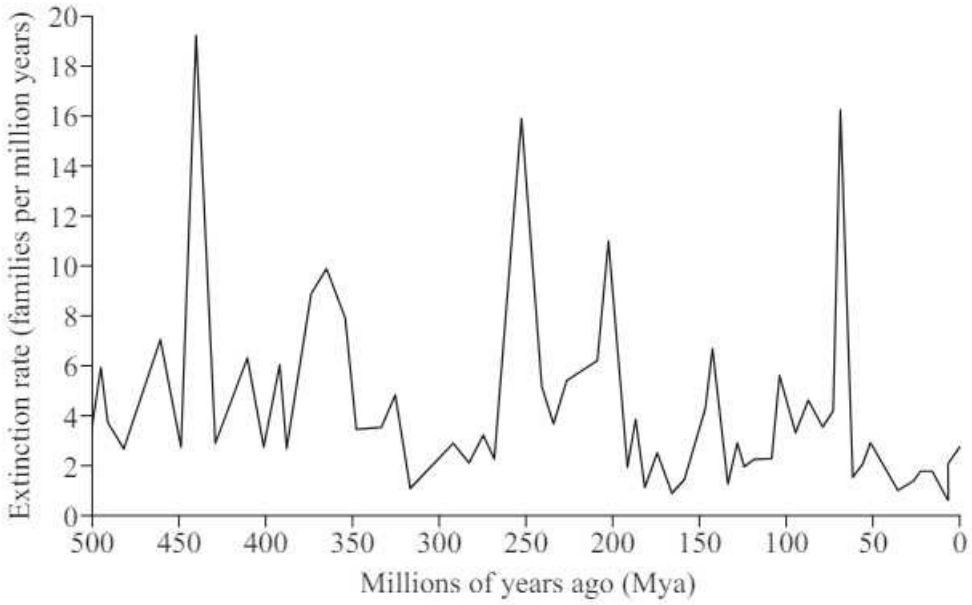
2023 Paper 1 Section 1 Question 10 Continuity of life on Earth	The graph shows extinction rates over time.  How many times in the past 500 million years has the extinction rate exceeded 14 families per million years? (A) 3 (B) 4 (C) 5 (D) 6

2023 Paper 1 Section 1 Question 13 Continuity of life on Earth	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.

2023 Paper 1 Section 1 Question 15 Continuity of life on Earth	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.

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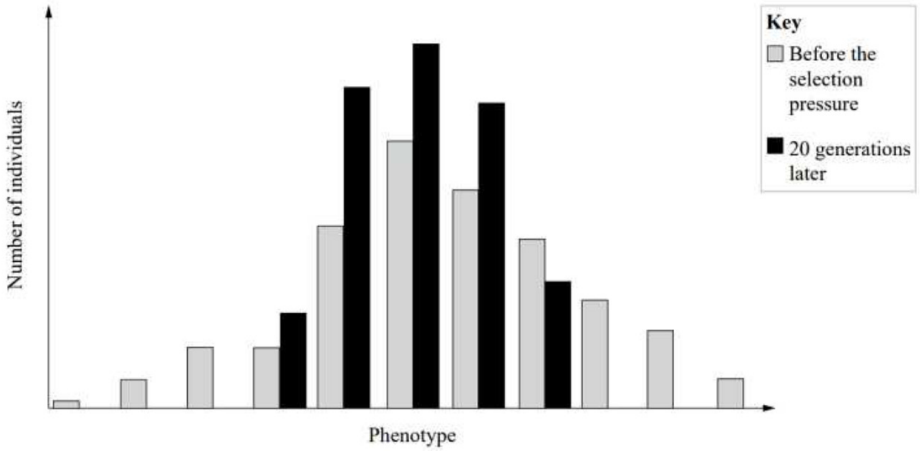
2022 Paper 1 Section 1 Question 4

Continuity of life on Earth

The graph shows the effect of a selection pressure on a hypothetical population.



Which mode of phenotypic selection corresponds with the data?

(A) negative
(B) disruptive
(C) stabilising
(D) directional

2022 Paper 1 Section 1 Question 10

Continuity of life on Earth

Wings in birds, bats and pterosaurs are phenotypically similar, though they belong to different families and do not have a common ancestor with the trait. While the general morphology is similar, the structure and organisation of each wing is different.

This is an example of

(A) coevolution.
(B) parallel evolution.
(C) divergent evolution.
(D) convergent evolution.

2022 Paper 1 Section 1 Question 11

Continuity of life on Earth

Evolutionary relationships were investigated by sequencing a section of protein from five different species. Each letter represents an amino acid.

Species I	D	E	V	G	W	E	A	L	G	R	L	V	S
Species II	D	E	V	G	W	E	G	L	G	R	A	V	S
Species III	D	E	A	G	S	E	G	L	A	R	L	E	S
Species IV	D	E	V	G	S	E	G	L	G	R	L	E	S
Species V	D	E	V	G	W	E	A	L	A	R	L	V	S

It can be inferred that Species I is most closely related to

(A) Species II.
(B) Species III.
(C) Species IV.
(D) Species V.

2022 Paper 1 Section 1 Question 12

Continuity of life on Earth

Speciation occurs when

(A) the gene pool of an existing species becomes too small to support a viable population.
(B) selection pressures cause significant changes to the allele frequencies of a population.
(C) genetic drift is no longer occurring within populations.
(D) gene flow is no longer occurring between populations.

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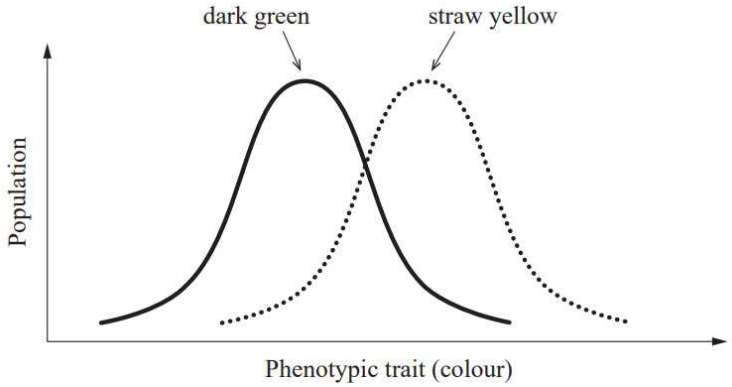
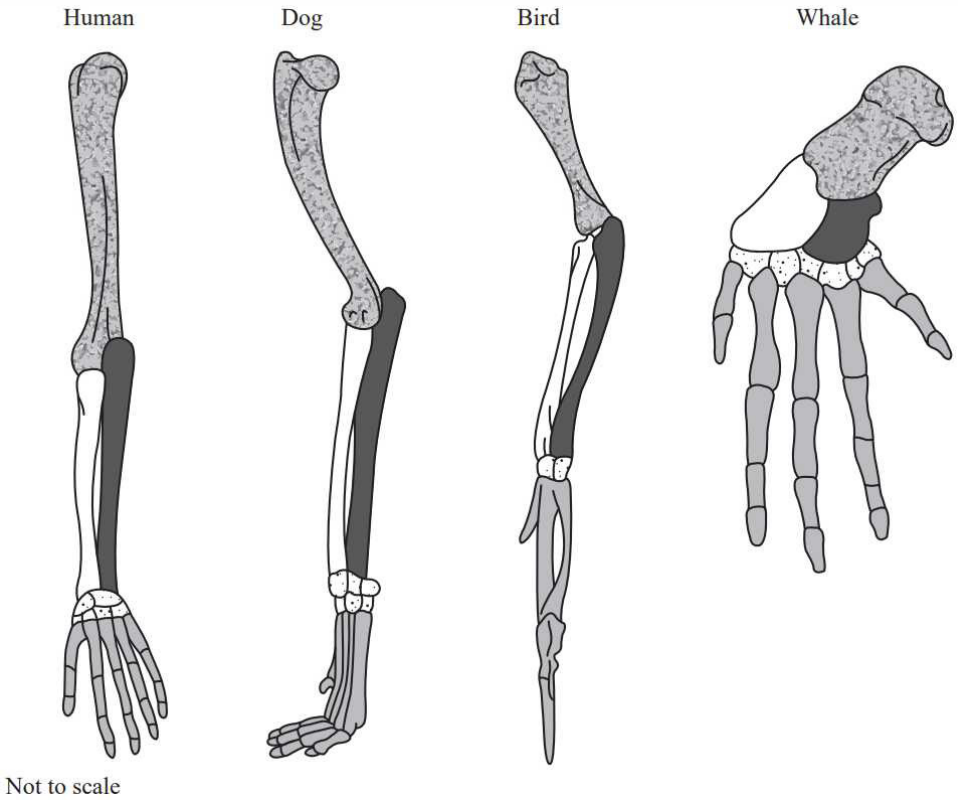
2021 Paper 1 Section 1 Question 7 Continuity of life on Earth	In a long-term study of grasshopper colour in a grassland ecosystem, it was found that the most abundant phenotype changed from dark green to straw yellow.  This change in the phenotype is an example of (A) diversifying selection. (B) directional selection. (C) stabilising selection. (D) disruptive selection.

2021 Paper 1 Section 1 Question 10 Continuity of life on Earth	The forelimbs of humans, dogs, birds and whales have a very similar pattern of bones.  Not to scale The similarity of these structures is best explained by which pattern of evolution? (A) convergent evolution (B) divergent evolution (C) parallel evolution (D) coevolution

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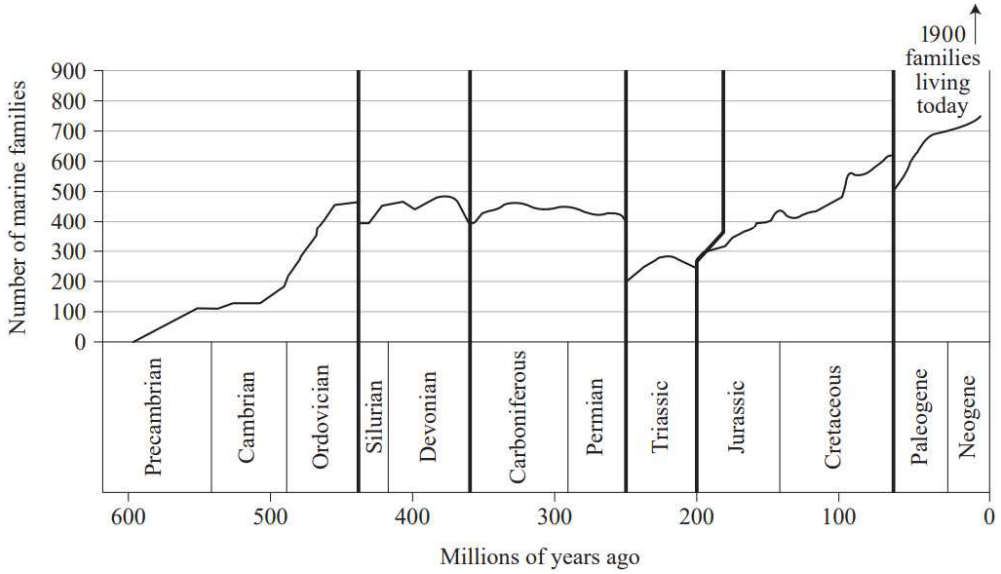
2021 **Paper 1** **Section 1** **Question 16** **Continuity of life on Earth**	A small group of dingoes migrated to a new area and established a population. After several generations, the new population showed a different genetic composition from the original population. This is an example of (A) microevolution and gene flow. (B) macroevolution and gene flow. (C) microevolution and genetic drift. (D) macroevolution and genetic drift.

2021 **Paper 1** **Section 1** **Question 18** **Continuity of life on Earth**	Which scenario would create a selection pressure on a given population? (A) change in fur colour (B) change in weather patterns (C) greater resistance to disease (D) improved ability to locate food sources

2020 **Paper 1** **Section 1** **Question 5** **Continuity of life on Earth**	The figure shows the diversity of marine animals since the late Precambrian time. The data is from marine animal families that have been reliably preserved in the fossil record.  Which of the following time periods saw the greatest evolutionary radiation of the marine families? (A) Ordovician (B) Cretaceous (C) Devonian (D) Permian

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2020 Paper 1 Section 1 Question 18

Continuity of life on Earth

The diagram shows the abundance (n) of phenotypic and genotypic variation for the colour trait of a species of butterfly.

AA
n = 400

Aa
n = 500

aa
n = 1000

If these butterflies were placed in an environment with light-coloured trees, which option from the table would be the most likely effect on the allelic frequencies?

	Frequency of allele/genotype			
	A	**a**	**AA**	**aa**
(A)	increase	decrease		
(B)			increase	no change
(C)	decrease	increase		
(D)			no change	increase

2020 Paper 1 Section 1 Question 20

Continuity of life on Earth

Which of the following are features of both microevolution and macroevolution?

(A) mutations only
(B) mutations and gene flow only
(C) gene flow and genetic drift only
(D) mutations, gene flow and genetic drift

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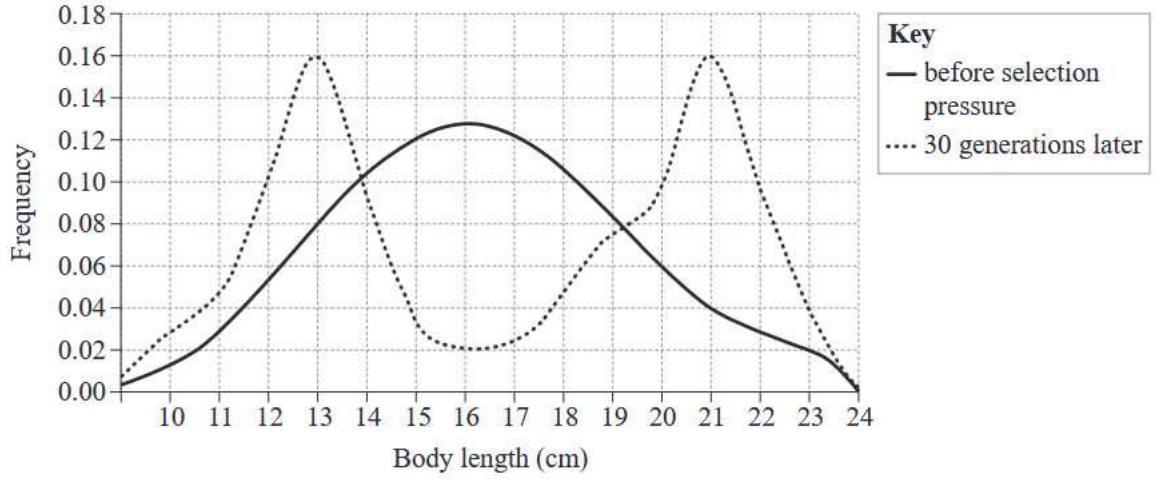
2024 Paper 1 Section 2 Question 22

Continuity of life on Earth

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]

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2022 Paper 1 Section 2 Question 23

Continuity of life on Earth

Compare microevolution and macroevolution. [3 marks]

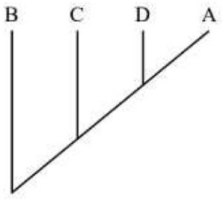
2021 Paper 1 Section 2 Question 27

Continuity of life on Earth

The table shows the percentage sequence similarity for three different parts of a gene found in four different eukaryotic species. The data was obtained by comparing DNA from one member of each species to Species A.

From this data, a proposed phylogenetic tree was produced.

Species	Gene region 1	Gene region 2	Gene region 3
A	100%	100%	100%
B	98%	96%	82%
C	99%	92%	96%
D	99%	99%	92%



Determine whether the phylogenetic tree has been drawn correctly based on the DNA comparison. Explain your reasoning. [3 marks]

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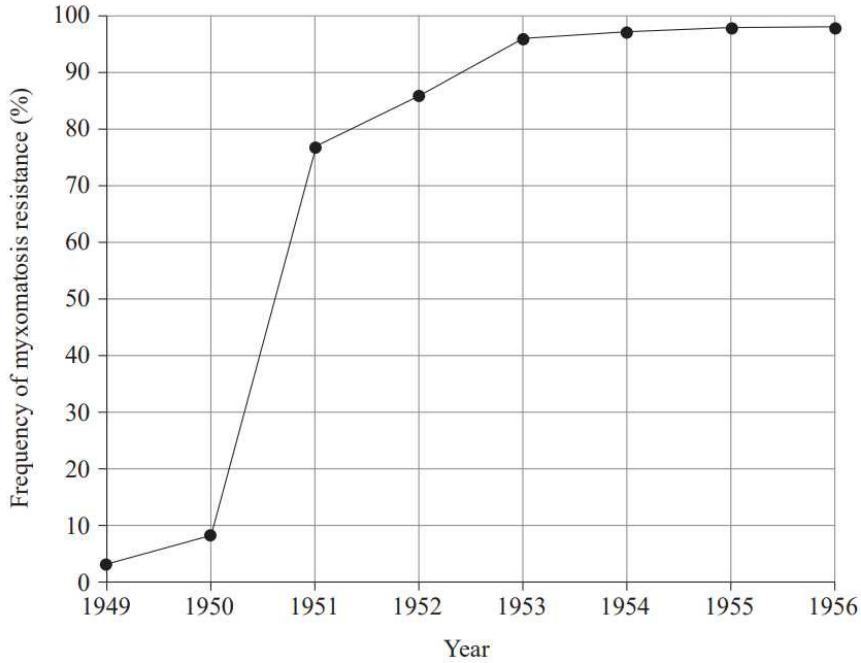
2022
Paper 1
Section 2
Question 28

Continuity of life on Earth

In 1950, the myxoma virus was released into Australian pest rabbit populations to reduce their numbers. The resulting disease, myxomatosis, initially wiped out 95% of the rabbit population; however, it quickly became less effective as a population control measure.

This graph shows the frequency of myxomatosis resistance in Australia's rabbit population from 1949 to 1956.



Use evidence from the graph and the principles of natural selection to explain how myxomatosis became ineffective as a population control measure. [3 marks]

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2020 Paper 1 Section 2 Question 26 Continuity of life on Earth	Define microevolution. [1 mark]

2020 Paper 1 Section 2 Question 27 Continuity of life on Earth	In a freshwater lake in Africa, a species of crab and its snail prey species both exhibit specialisations that are unusual for freshwater species. The crabs possess strong claws with characteristics of marine crabs that crush and peel shells, and the snail prey have thick, strong shells that resist crushing. a) Identify which pattern of evolution this example represents. [1 mark] b) Describe how the two species may have evolved these characteristics. [3 marks]

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Paper 2 Section 1

2024 Paper 2 Section 1 Question 5 Continuity of life on Earth	a) Describe a population bottleneck b) Explain why populations affected by bottlenecks face increased risk of extinction. [2 marks]

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2024 Paper 2 Section 1 Question 7 Continuity of life on Earth	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]

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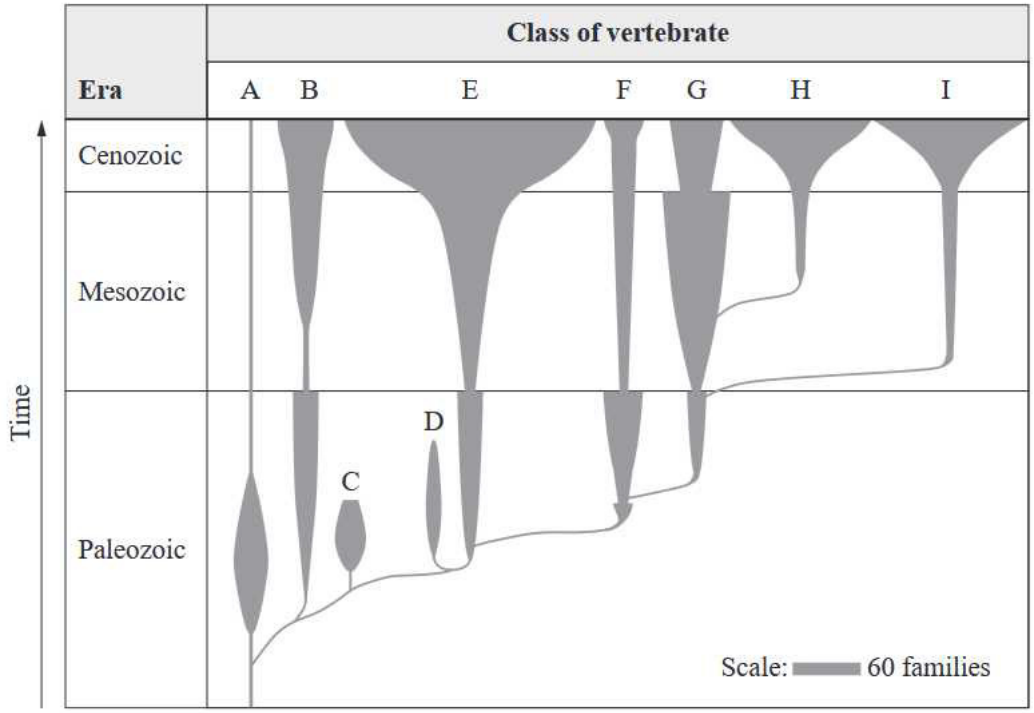
2024 Paper 2 Section 1 Question 10

Continuity of life on Earth

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]

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]

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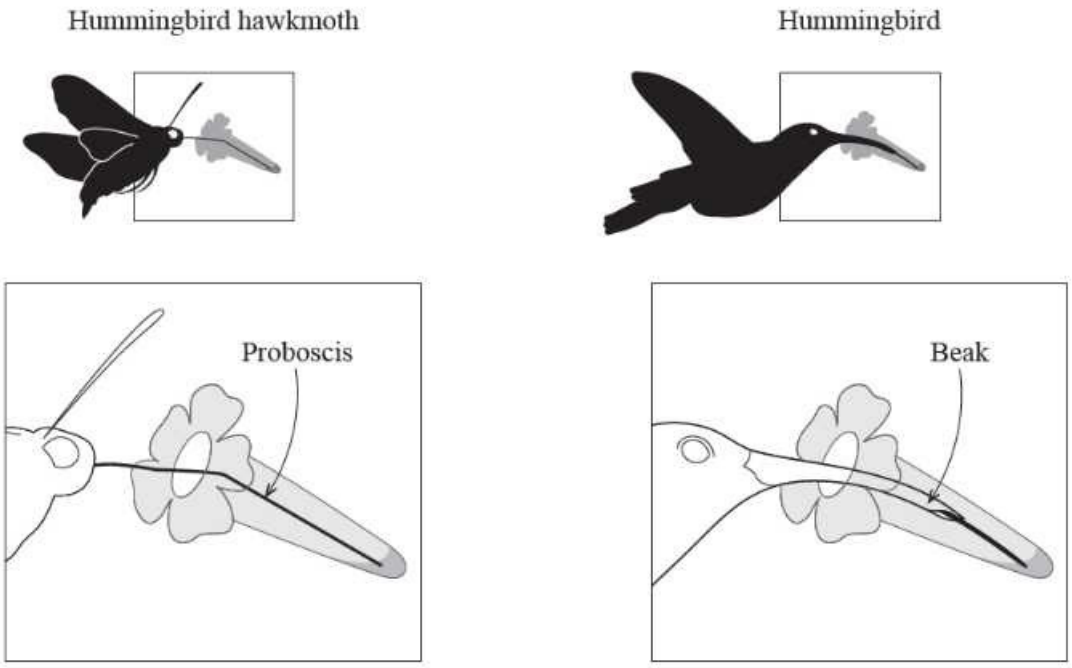
2023 Paper 2 Section 1 Question 4

Continuity of life on Earth

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.



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

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

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	c) Explain how coevolution of the hummingbird hawkmoth and tube-shaped flowers may have occurred. P2 marks]

2023 Paper 2 Section 1 Question 8 **Continuity of life on Earth**	Explain how temporal isolation can lead to speciation. [3 marks]

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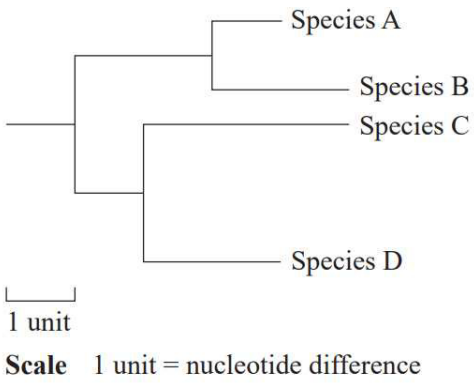
2022 Paper 2 Section 1 Question 1 Continuity of life on Earth	This phylogenetic tree uses horizontal distance to represent genetic difference.  **Scale** 1 unit = nucleotide difference a) Infer which species is most closely related to species B. Explain your reasoning. [2 marks] b) Determine the genetic difference between species A and D. [1 mark]

2022 Paper 2 Section 1 Question 8 Continuity of life on Earth	Over time, the South African cheetah population has suffered drastic reduction due to periodic droughts, disease and hunting. Currently, only small, isolated populations of cheetahs exist in the wild. Explain, in terms of genetic diversity, why cheetah populations are now on the verge of extinction. [3 marks]

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2022 Paper 2 Section 1 Question 11

Continuity of life on Earth

Allele frequencies were monitored in two large populations of field mice from neighbouring forests over a 10-year period. Results are shown.

Forest X

Year	Genotype			Allele frequency	
	AA	Aa	aa	A	a
2013	52	146	102	0.42	0.58
2014	48	144	108	0.40	0.60
2015	55	147	98	0.43	0.57
2016	60	150	90	0.45	0.55
2017	58	142	100	0.43	0.57
2018	58	148	94	0.44	0.56
2019	59	152	89	0.45	0.55
2020	60	148	92	0.45	0.55
2021	65	149	86	0.46	0.54
2022	66	149	85	0.47	0.53

Forest Y

Year	Genotype			Allele frequency	
	AA	Aa	aa	A	a
2013	0	0	300	0.00	1.00
2014	0	0	300	0.00	1.00
2015	0	0	300	0.00	1.00
2016	0	15	285	0.03	0.98
2017	3	46	251	0.09	0.91
2018	14	60	226		
2019	31	91	178	0.26	0.75
2020	48	104	148	0.33	0.67
2021	60	122	118	0.40	0.60
2022	66	137	97	0.45	0.55

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a) Calculate the allele frequencies for forest Y in 2018. Show your working. [2 marks]

b) Identify temporal trends in allele frequency for forests X and Y and infer reasons for the observed differences. [6 marks]

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2021 Paper 2 Section 1 Question 7 Continuity of life on Earth	Koalas were once widespread in Australia. Due to a variety of factors, their population decreased and fragmented into small pockets, forcing them to inbreed. They have recently been hit by devastating epidemic diseases. Explain why koalas face an increased extinction risk from disease. [3 marks]

2021 Paper 2 Section 1 Question 8 Continuity of life on Earth	Australia has many bird species that have evolved to be largely dependent on mangroves. These species are patchy in their distribution because of: • the island-like distribution of their habitat • exclusion by possible competitors • geographical barriers. Identify and describe the mode of speciation that may have caused diversity in mangrove bird species. [3 marks]

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2021 Paper 2 Section 1 Question 9

Continuity of life on Earth

A computer simulation was used to observe genotypic changes in the gene pool of 20 randomly selected rabbits. The simulation was set with these parameters:

- each rabbit's coat colour was either black or white
- black alleles were dominant; white alleles were recessive
- the number of rabbits was constant in each generation and breeding was random throughout the population
- an environmental factor was chosen in the simulation to provide selection pressure.

The table shows the results of the simulation at the start and after 20 generations.

Initial population genotypes	Population genotypes after 20 generations
BB BB BB BB BB BB Bb Bb Bb Bb Bb Bb Bb Bb Bb Bb bb bb bb bb	BB BB Bb Bb Bb Bb Bb Bb Bb Bb bb bb bb bb bb bb bb bb bb bb

Contrast the initial allele frequency with the allele frequency after 20 generations to draw a conclusion about the effect of the selection pressure on the rabbit population.

2020 Paper 2 Section 1 Question 9

Continuity of life on Earth

Fossil evidence seems to show that the morphology of the Queensland lung fish has remained relatively unchanged for the past 100 million years.

Describe the features of the theory of natural selection to explain how this may have occurred. [3 marks]

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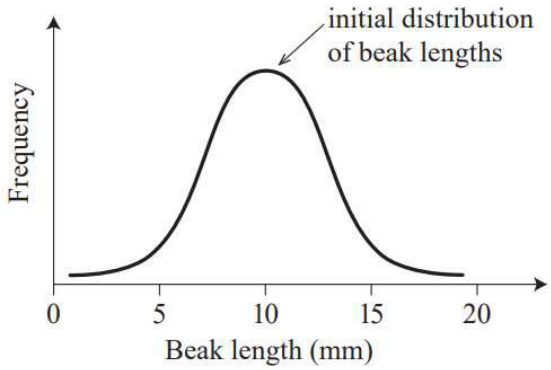
2020 Paper 2 Section 1 Question 10 Continuity of life on Earth	Researchers measured the adult beak lengths of an entire population of a species of bird and plotted their results on the graph. After many generations, the lengths of the adult beaks were again measured. By comparing this new data to the original data, the researchers concluded that the average length of beaks had increased as a result of directional selection. [3 marks]  a) Describe directional selection. [2 marks] b) On the graph provided, sketch a representation of directional selection for the beak length scenario. [1 mark] Note: If you make a mistake on the graph, cancel it by ruling a single diagonal line through your work and use the additional graph on page 17 of this question and response book.

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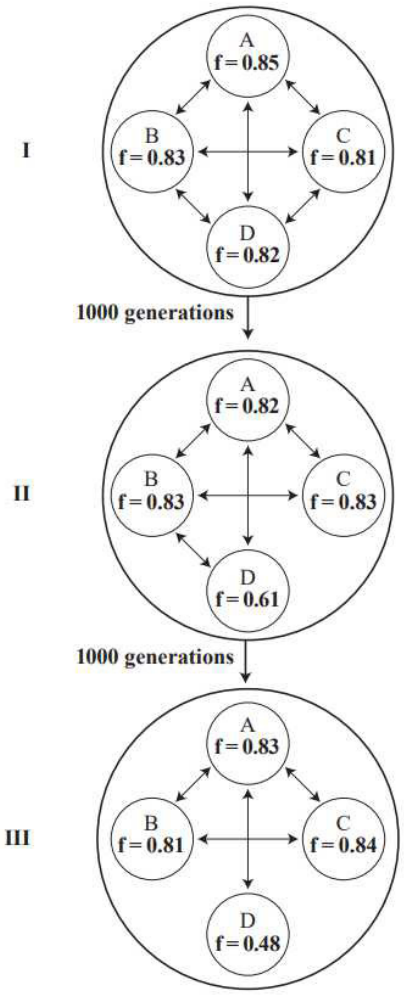
2020
Paper 2
Section 1
Question 11

Continuity of life on Earth

The image shows changes in the frequency of a particular gene in a single species of bird, leading to a speciation event. These changes have occurred over a period of successive time points (i.e. I, II and III) each separated by approximately 1000 generations.

- The letters A, B, C and D represent separate niches inhabited by the birds.
- The arrows depict gene flow between the niches.
- The allelic frequency for the gene is shown as f in each niche.



Draw a conclusion about the type of speciation that has occurred in this population. Explain your reasoning by referring to the information provided in each of the time points. [6 marks]

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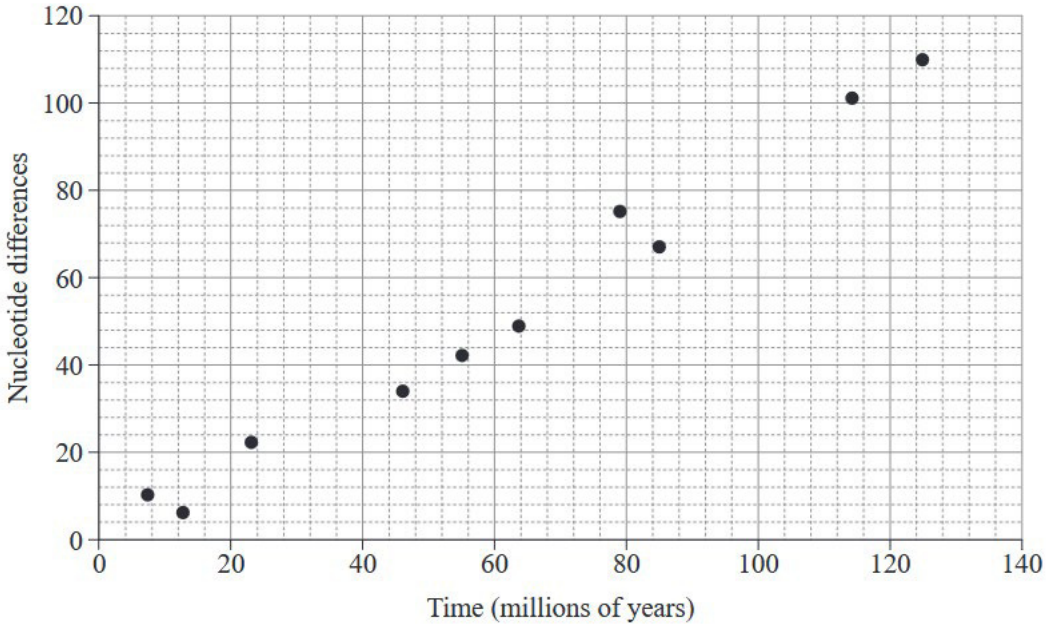
Marking Guide – Paper 1 Section 1

2024 Paper 1 Section 1 Question 19 Continuity of life on Earth	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 – Answer**

2024 Paper 1 Section 1 Question 20 Continuity of life on Earth	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. – Answer** (D) 120 million years ago.

2023 Paper 1 Section 1 Question 4 Continuity of life on Earth	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. – Answer** (D) contain a larger proportion of heterozygous individuals.

2023 Paper 1 Section 1 Question 6 Continuity of life on Earth	The phylogenetic tree shows evolutionary relationships between seven species of Himalayan songbird and the elevations they inhabit. ***Copyright restrictions prohibit the release of this QCAA exam material.*** The data shows that **(A) the most closely related species occupy different elevations. – Answer** (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.

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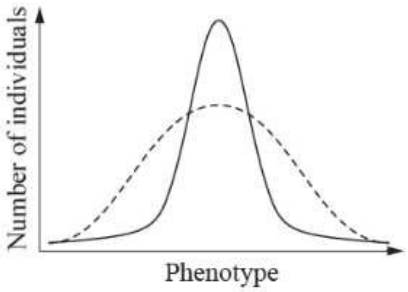
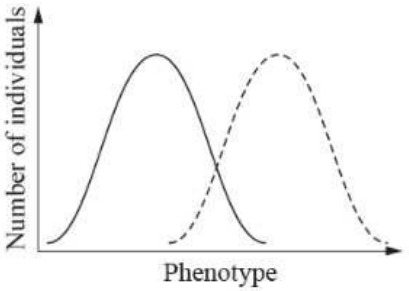
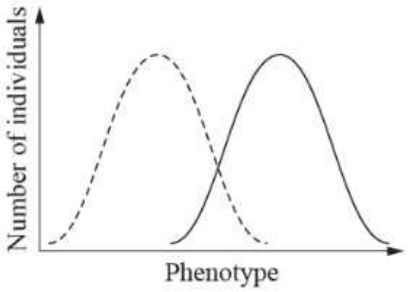
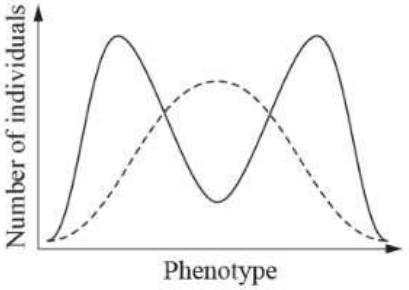
2023 Paper 1 Section 1 Question 7 Continuity of life on Earth	The distributions of phenotypes before and after a selection pressure acted on a population are shown. Which graph shows disruptive selection? **Key** ------- Before selection pressure ——— 25 generations later (A)  (B)  (C)  (D)  **Answer is D.**

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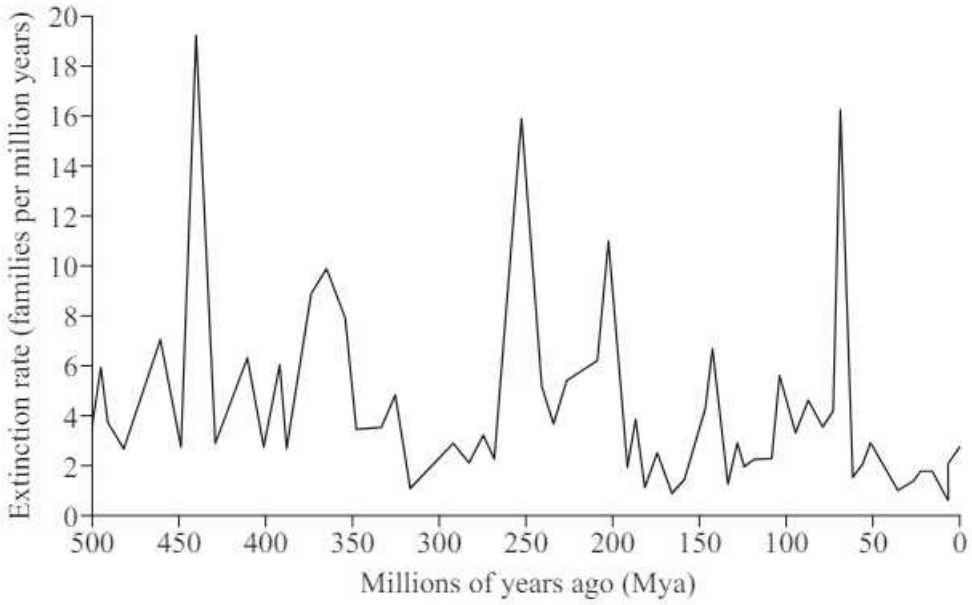
2023 Paper 1 Section 1 Question 10 Continuity of life on Earth	The graph shows extinction rates over time.  How many times in the past 500 million years has the extinction rate exceeded 14 families per million years? **(A) 3 – Answer** (B) 4 (C) 5 (D) 6

2023 Paper 1 Section 1 Question 13 Continuity of life on Earth	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. – Answer** (D) A small group of organisms becomes separated from their parent population by physical barriers.

2023 Paper 1 Section 1 Question 15 Continuity of life on Earth	Allele frequencies are most likely to stay constant in **(A) large populations with low levels of migration. – Answer** (B) small populations with low levels of migration. (C) large populations with high levels of migration. (D) small populations with high levels of migration.

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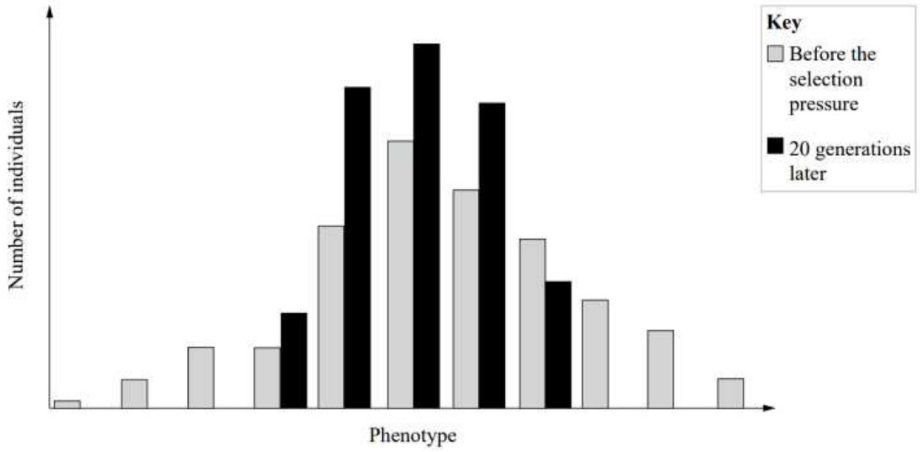
2022 Paper 1 Section 1 Question 4

Continuity of life on Earth

The graph shows the effect of a selection pressure on a hypothetical population.



Which mode of phenotypic selection corresponds with the data?

(A) negative
(B) disruptive
(C) stabilising – Answer
(D) directional

2022 Paper 1 Section 1 Question 10

Continuity of life on Earth

Wings in birds, bats and pterosaurs are phenotypically similar, though they belong to different families and do not have a common ancestor with the trait. While the general morphology is similar, the structure and organisation of each wing is different.

This is an example of

(A) coevolution.
(B) parallel evolution.
(C) divergent evolution.
(D) convergent evolution. – Answer

2022 Paper 1 Section 1 Question 11

Continuity of life on Earth

Evolutionary relationships were investigated by sequencing a section of protein from five different species. Each letter represents an amino acid.

Species I	D	E	V	G	W	E	A	L	G	R	L	V	S
Species II	D	E	V	G	W	E	G	L	G	R	A	V	S
Species III	D	E	A	G	S	E	G	L	A	R	L	E	S
Species IV	D	E	V	G	S	E	G	L	G	R	L	E	S
Species V	D	E	V	G	W	E	A	L	A	R	L	V	S

It can be inferred that Species I is most closely related to

(A) Species II.
(B) Species III.
(C) Species IV.
(D) Species V. – Answer

2022 Paper 1 Section 1 Question 12

Continuity of life on Earth

Speciation occurs when

(A) the gene pool of an existing species becomes too small to support a viable population.
(B) selection pressures cause significant changes to the allele frequencies of a population.
(C) genetic drift is no longer occurring within populations.
(D) gene flow is no longer occurring between populations. – Answer

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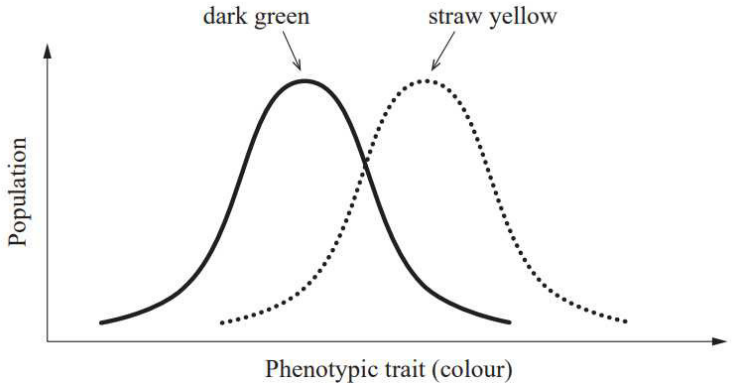
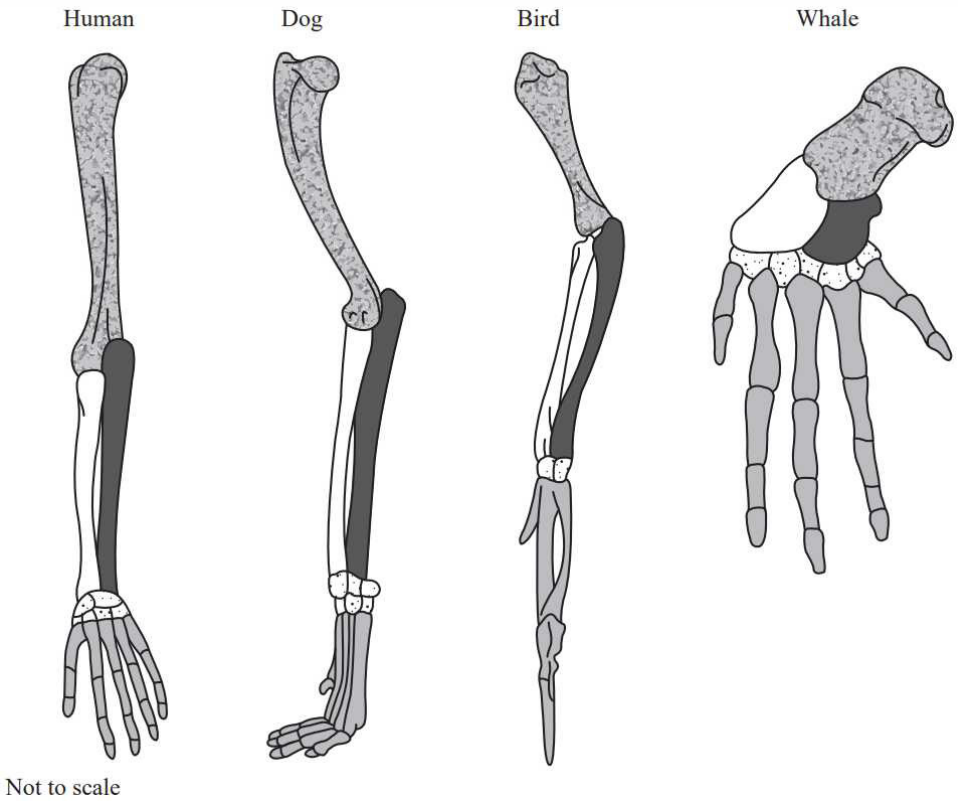
2021 Paper 1 Section 1 Question 7 Continuity of life on Earth	In a long-term study of grasshopper colour in a grassland ecosystem, it was found that the most abundant phenotype changed from dark green to straw yellow.  This change in the phenotype is an example of (A) diversifying selection. **(B) directional selection. – Answer** (C) stabilising selection. (D) disruptive selection.

2021 Paper 1 Section 1 Question 10 Continuity of life on Earth	The forelimbs of humans, dogs, birds and whales have a very similar pattern of bones.  The similarity of these structures is best explained by which pattern of evolution? (A) convergent evolution **(B) divergent evolution – Answer** (C) parallel evolution (D) coevolution

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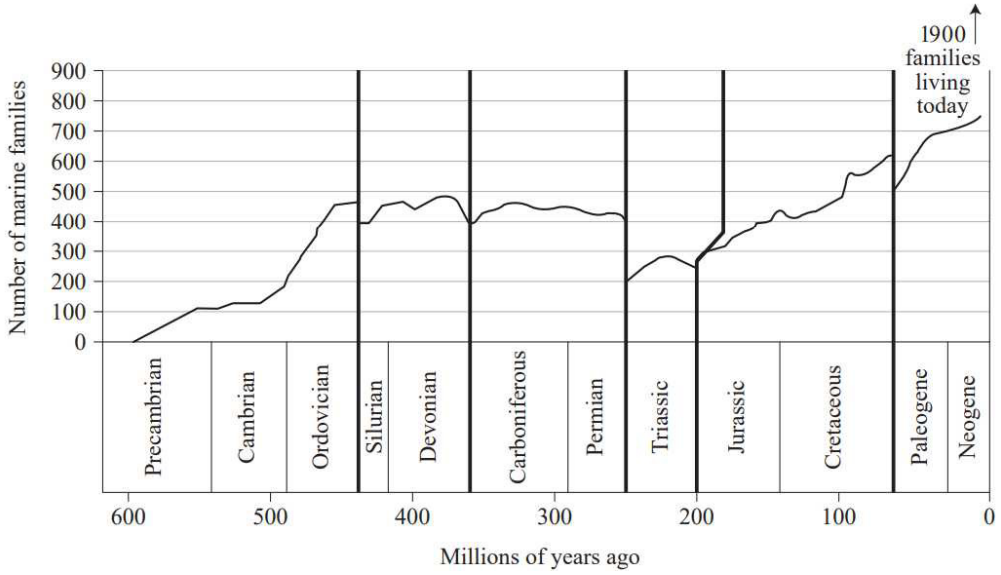
2021 **Paper 1** **Section 1** **Question 16** **Continuity of life on Earth**	A small group of dingoes migrated to a new area and established a population. After several generations, the new population showed a different genetic composition from the original population. This is an example of (A) microevolution and gene flow. (B) macroevolution and gene flow. **(C) microevolution and genetic drift. – Answer** (D) macroevolution and genetic drift.

2021 **Paper 1** **Section 1** **Question 18** **Continuity of life on Earth**	Which scenario would create a selection pressure on a given population? (A) change in fur colour **(B) change in weather patterns – Answer** (C) greater resistance to disease (D) improved ability to locate food sources

2020 **Paper 1** **Section 1** **Question 5** **Continuity of life on Earth**	The figure shows the diversity of marine animals since the late Precambrian time. The data is from marine animal families that have been reliably preserved in the fossil record.  Which of the following time periods saw the greatest evolutionary radiation of the marine families? **(A) Ordovician – Answer** (B) Cretaceous (C) Devonian (D) Permian

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2020
Paper 1
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Question 18

Continuity of life on Earth

The diagram shows the abundance (n) of phenotypic and genotypic variation for the colour trait of a species of butterfly.

AA
n = 400

Aa
n = 500

aa
n = 1000

If these butterflies were placed in an environment with light-coloured trees, which option from the table would be the most likely effect on the allelic frequencies?

	Frequency of allele/genotype			
	A	**a**	**AA**	**aa**
(A)	increase	decrease		
(B)			increase	no change
(C)	decrease	increase		
(D)			no change	increase

Answer is C.

2020
Paper 1
Section 1
Question 20

Continuity of life on Earth

Which of the following are features of both microevolution and macroevolution?

(A) mutations only
(B) mutations and gene flow only
(C) gene flow and genetic drift only
(D) mutations, gene flow and genetic drift

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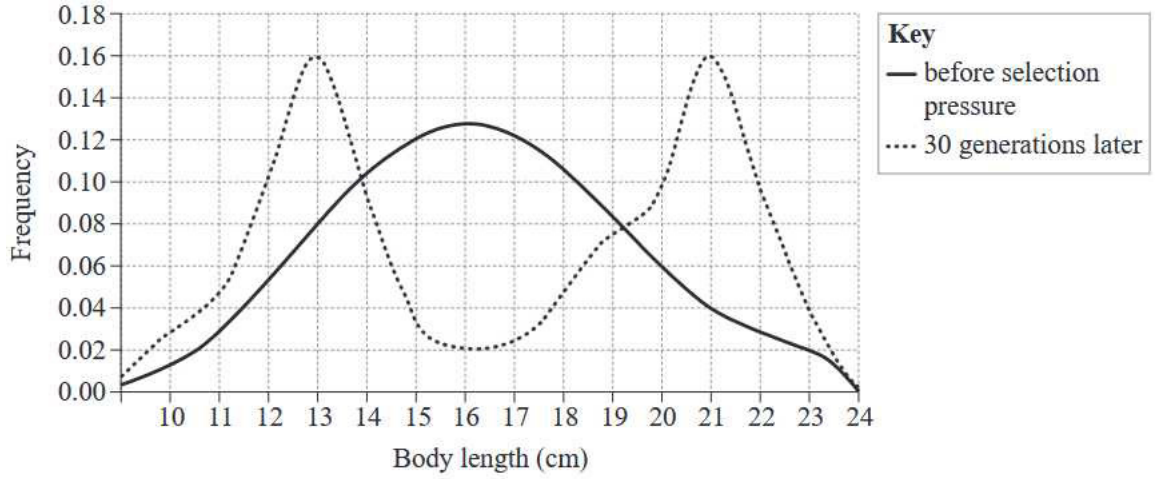
2024 Paper 1 Section 2 Question 22

Continuity of life on Earth

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]

Sample response	The response
Disruptive selection	• determines disruptive selection **[1 mark]**

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

Sample response	The response
The selection pressure provided a selective advantage to fish with body lengths around 13 cm and 21 cm. These fish had an increased chance of surviving to reproduce and pass on the trait, leading to an increase in these phenotypes from ~8% and ~4% before the selection pressure to ~16% after. Fish with intermediate phenotypes (~15–18 cm) were selected against, causing their relative frequencies to decrease over time.	• explains the observed trends, referring to – phenotypic variation **[1 mark]** – differential survival and reproduction **[1 mark]** – change over time **[1 mark]**

2022 Paper 1 Section 2 Question 23

Continuity of life on Earth

Compare microevolution and macroevolution. [3 marks]

Sample Response	The response
Both involve changes in allele frequencies, but in microevolution, this change occurs within a species, whereas for macroevolution, the change is at or above the species level. This means that in microevolution, the descendant is in the same taxonomic group as the ancestor, whereas in macroevolution, the descendant is in a different taxonomic group.	• provides a similarity [1 mark] • provides a difference [1 mark] • states the significance [1 mark]

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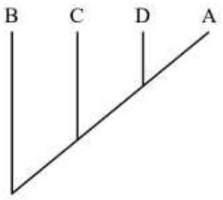
2021 Paper 1 Section 2 Question 27

Continuity of life on Earth

The table shows the percentage sequence similarity for three different parts of a gene found in four different eukaryotic species. The data was obtained by comparing DNA from one member of each species to Species A.

From this data, a proposed phylogenetic tree was produced.

Species	Gene region 1	Gene region 2	Gene region 3
A	100%	100%	100%
B	98%	96%	82%
C	99%	92%	96%
D	99%	99%	92%



Determine whether the phylogenetic tree has been drawn correctly based on the DNA comparison. Explain your reasoning. [3 marks]

Sample Response	The response
The phylogenetic tree is correct. In order of percentage differences compared to A, D is 10% different across the three gene regions, C is 13% different and B is 24% different.	• determines that the tree is correct [1 mark] • describes the order of percentage differences between species [1 mark] • provides relevant data from the table [1 mark]

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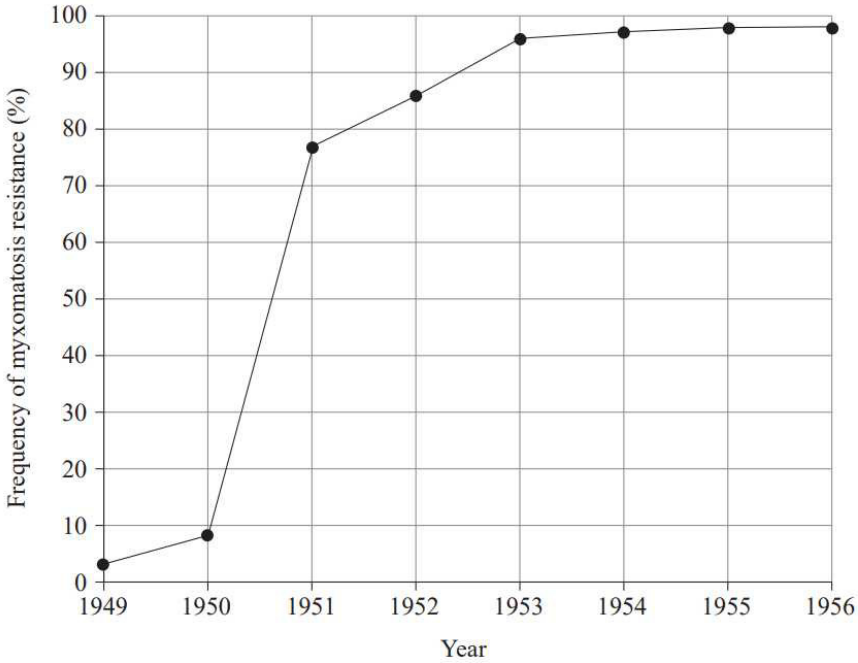
2022 Paper 1 Section 2 Question 28

Continuity of life on Earth

In 1950, the myxoma virus was released into Australian pest rabbit populations to reduce their numbers. The resulting disease, myxomatosis, initially wiped out 95% of the rabbit population; however, it quickly became less effective as a population control measure.

This graph shows the frequency of myxomatosis resistance in Australia's rabbit population from 1949 to 1956.



Use evidence from the graph and the principles of natural selection to explain how myxomatosis became ineffective as a population control measure. [3 marks]

Sample Response	The response
The introduction of the myxoma virus conferred a selective advantage on the myxomatosis-resistant phenotype. Myxomatosis-resistant rabbits had an increased chance of surviving to reproduce and pass on the trait. This led to an increase in the frequency of this phenotype in the population from approximately 9% in 1950 to approximately 96% in 1953. After 1953, most of the remaining rabbits possessed the myxomatosis-resistant phenotype, so the disease was no longer effective at reducing rabbit numbers.	• recognises that the myxomatosis-resistant phenotype provided a selective advantage [1 mark] • uses evidence from the graph to establish that this caused myxomatosis resistance to increase in the population [1 mark] • concludes that myxomatosis became less effective as the percentage of myxomatosis resistant rabbits increased [1 mark]

2020 Paper 1 Section 2 Question 26

Continuity of life on Earth

Define microevolution. [1 mark]

Sample Response	The response
Microevolution is the small-scale variation of allele frequencies within a species or population, in which the descendant is of the same taxonomic group as the ancestor.	• states small-scale variation of allele frequencies within a species or population, in which the descendant is of the same taxonomic group as the ancestor [1 mark]

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2020 Paper 1 Section 2 Question 27

Continuity of life on Earth

In a freshwater lake in Africa, a species of crab and its snail prey species both exhibit specialisations that are unusual for freshwater species. The crabs possess strong claws with characteristics of marine crabs that crush and peel shells, and the snail prey have thick, strong shells that resist crushing.

a) Identify which pattern of evolution this example represents. [1 mark]

Sample Response	The response
Coevolution	• states coevolution [1 mark]

b) Describe how the two species may have evolved these characteristics. [3 marks]

Sample Response	The response
The increased ability for crabs to crush shells acts as a selection pressure on the prey and the stronger shells on the snails acts as a selection pressure on the crabs. Within the crab population, some will have stronger claws and be more successful in preying on the snails, and within the snail population, some will have stronger shells and resist predation — these are both selection advantages. This means that the population will gain a higher proportion of the genes that lead to claw strength or shell strength and, therefore, the population gains phenotypic resistance.	• states the selection pressures [1 mark] • describes variation in claw strength and shell strength occurring in both populations [1 mark] • describes the individuals with the selection advantage surviving and passing on the genes/traits to the next generation [1 mark]

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Marking Guide – Paper 2 Section 1

2024 Paper 2 Section 1 Question 5

Continuity of life on Earth

a) Describe a population bottleneck

Sample response	The response
A population bottleneck is an event that drastically reduces the size of a population.	• describes a population bottleneck **[1 mark]**

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

Sample response	The response
A population bottleneck may lead to lower genetic variation because individuals who survive usually do so by chance. Allele frequencies of the remaining population may not reflect the original population, and some (potentially fitter) alleles may be lost altogether. Lower genetic diversity means a population is less likely to have favourable alleles that allow them to respond effectively to environmental changes, increasing the risk of extinction.	• recognises population bottlenecks reduce genetic diversity **[1 mark]** • explains why lower genetic diversity increases the risk of extinction **[1 mark]**

2024 Paper 2 Section 1 Question 7

Continuity of life on Earth

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

Sample response	The response
Habitat fragmentation can lead to geographic isolation, where populations that were previously able to interbreed can no longer reach each other to do so. This disruption to gene flow can result in two populations evolving independently to the point that they are too genetically dissimilar to interbreed.	• recognises that habitat fragmentation can cause populations to become isolated **[1 mark]** • identifies that this disrupts gene flow **[1 mark]** • explains how disruption to gene flow can lead to speciation **[1 mark]**

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

Sample response	The response
Allopatric speciation	• identifies allopatric speciation **[1 mark]**

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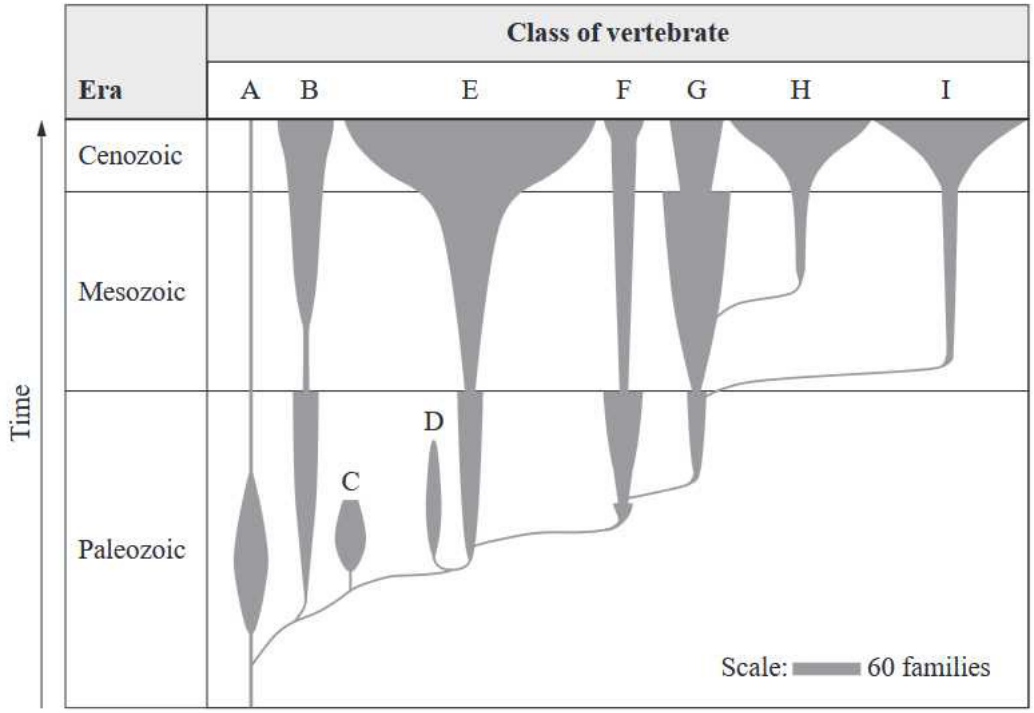
2024 Paper 2 Section 1 Question 10

Continuity of life on Earth

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]

Sample response	The response
Vertebrate biodiversity has increased over geological time. While the number of different classes has remained about the same in each era (7), the number of families has gradually increased from ~110 at the end of the Palaeozoic era to ~220 at the end of the Mesozoic era and ~610 in the Cenozoic era.	• identifies an appropriate trend **[1 mark]** • provides data to support response **[1 mark]**

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

Sample response	The response
Classes C and D became extinct during the Palaeozoic era.	• identifies C and D **[1 mark]** • identifies Palaeozoic era **[1 mark]**

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

Sample response	The response
Class G	• identifies G **[1 mark]**

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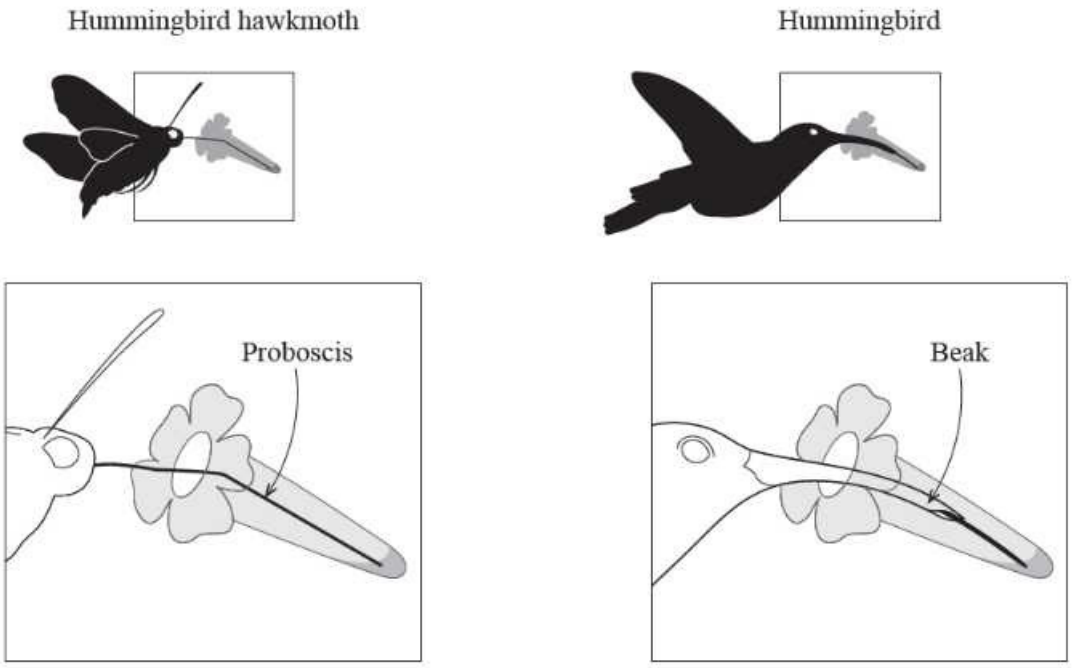
2023 Paper 2 Section 1 Question 4

Continuity of life on Earth

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.



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

Sample response	The response
Convergent evolution	• identifies convergent evolution **[1 mark]**

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

Sample response	The response
As both species live in similar environments, they experience similar selection pressures, so natural selection will favour similar features. In this example, a longer beak/proboscis increases the chance of accessing food, and therefore survival, long enough to reproduce and pass on the trait. This results in the trait becoming more common in both populations over time.	• recognises the two species are exposed to similar selection pressures **[1 mark]** • explains how natural selection favours similar features **[1 mark]**

c) Explain how coevolution of the hummingbird hawkmoth and tube-shaped flowers may have occurred. P2 marks]

Sample response	The response
The hummingbird hawkmoth and tube-shaped flowers place selection pressures on each other, resulting in complementary characteristics (the proboscis length matches the flower depth). This gives the hawkmoth an advantage over species with shorter proboscises (access to food) and advantages the flower because the hawkmoth is more likely to distribute pollen to other flowers of the same species. Coevolution has most likely resulted in longer proboscises and deeper flowers.	• explains that – the two species impose selection pressures on each other **[1 mark]** – this results in complementary characteristics **[1 mark]**

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2023 Paper 2 Section 1 Question 8

Continuity of life on Earth

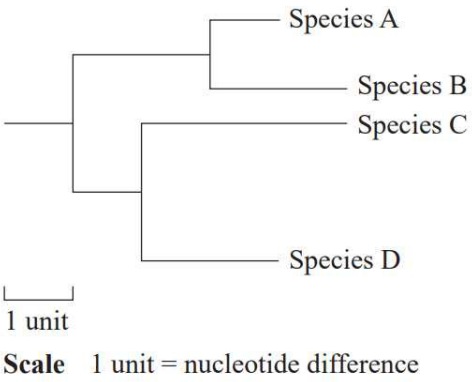
Explain how temporal isolation can lead to speciation. [3 marks]

Sample response	The response
Temporal isolation occurs when populations differ in their periods of reproductive activity, so genes are no longer exchanged. This disruption to gene flow can result in two populations evolving independently to the point that they are no longer able to interbreed.	• explains that temporal isolation occurs when populations differ in their periods of reproductive activity **[1 mark]** • identifies that this disrupts gene flow **[1 mark]** • explains how disruption to gene flow can lead to speciation **[1 mark]**

2022 Paper 2 Section 1 Question 1

Continuity of life on Earth

This phylogenetic tree uses horizontal distance to represent genetic difference.



a) Infer which species is most closely related to species B. Explain your reasoning. [2 marks]

Sample Response	The response
Species A. Species A and B have the least genetic difference, suggesting there has been less time since they diverged for mutations to occur.	• infers species A is most closely related to species B [1 mark] • provides appropriate reasoning [1 mark]

b) Determine the genetic difference between species A and D. [1 mark]

Sample Response	The response
6 nucleotides	• states 6 nucleotides [1 mark]

2022 Paper 2 Section 1 Question 8

Continuity of life on Earth

Over time, the South African cheetah population has suffered drastic reduction due to periodic droughts, disease and hunting. Currently, only small, isolated populations of cheetahs exist in the wild. Explain, in terms of genetic diversity, why cheetah populations are now on the verge of extinction. [3 marks]

Sample Response	The response
The cheetah population has suffered a severe bottleneck. This means that (by chance) certain alleles may be over- or under-represented in the surviving population, and some (potentially 'fitter') alleles may have been lost altogether. This reduces genetic variability and means that the small surviving population's gene pool is not representative of the original population. If the environment suddenly changes, the selection pressures on the cheetahs will also change. Having a limited gene pool may mean the population cannot adapt to the changing conditions and are therefore at increased risk of extinction.	• explains that - the reduction in population has reduced genetic variability [1 mark] - some alleles may have been eliminated from the gene pool [1 mark] - a population with limited genetic variability may not be able to evolve in response to changing conditions [1 mark]

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2022 Paper 2 Section 1 Question 11

Continuity of life on Earth

Allele frequencies were monitored in two large populations of field mice from neighbouring forests over a 10-year period. Results are shown.

Forest X

Year	Genotype			Allele frequency	
	AA	Aa	aa	A	a
2013	52	146	102	0.42	0.58
2014	48	144	108	0.40	0.60
2015	55	147	98	0.43	0.57
2016	60	150	90	0.45	0.55
2017	58	142	100	0.43	0.57
2018	58	148	94	0.44	0.56
2019	59	152	89	0.45	0.55
2020	60	148	92	0.45	0.55
2021	65	149	86	0.46	0.54
2022	66	149	85	0.47	0.53

Forest Y

Year	Genotype			Allele frequency	
	AA	Aa	aa	A	a
2013	0	0	300	0.00	1.00
2014	0	0	300	0.00	1.00
2015	0	0	300	0.00	1.00
2016	0	15	285	0.03	0.98
2017	3	46	251	0.09	0.91
2018	14	60	226		
2019	31	91	178	0.26	0.75
2020	48	104	148	0.33	0.67
2021	60	122	118	0.40	0.60
2022	66	137	97	0.45	0.55

a) Calculate the allele frequencies for forest Y in 2018. Show your working. [2 marks]

Sample Response	The response
Frequency (a) = [(2 x 226) + 60] / 600 = 0.85 Frequency (A) = [(2 x 14) + 60] / 600 = 0.15	• provides appropriate working [1 mark] • calculates the frequencies of both alleles [1 mark]

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b) Identify temporal trends in allele frequency for forests X and Y and infer reasons for the observed differences. [6 marks]

Sample Response	The response
Allele frequencies remained relatively constant in forest X over the 10-year period, with a slight increase in allele A over time. This suggests genetic drift is occurring and the changes are likely due to chance rather than the environment favouring a particular phenotype. This contrasts with forest Y, where the frequency of allele A increases significantly over time after it first appears in 2016. The allele may have been introduced to forest Y due to migration (mice moving in from a neighbouring forest) or mutation. Either way, it is evident that the allele A provided a selective advantage to mice in forest Y, resulting in its frequency increasing over time.	• identifies allele frequencies remain relatively constant in forest X over time [1 mark] • infers a reason for the temporal change in forest X [1 mark] • identifies allele A first appeared in forest Y in 2016 [1 mark] • infers this is due to migration (gene flow) or mutation [1 mark] • identifies the frequency of allele A increases over time in forest Y [1 mark] • infers allele A provides a selective advantage to mice in forest Y [1 mark]

2021 Paper 2 Section 1 Question 7

Continuity of life on Earth

Koalas were once widespread in Australia. Due to a variety of factors, their population decreased and fragmented into small pockets, forcing them to inbreed. They have recently been hit by devastating epidemic diseases.
Explain why koalas face an increased extinction risk from disease. [3 marks]

Sample Response	The response
High genetic diversity may allow for some members of the population to survive diseases and later reproduce and pass on their resistance to increase the survivability of the population. However, inbreeding creates low genetic diversity, which makes koalas vulnerable to extinction due to disease.	• · explains how genetic diversity can prevent extinction during rapid environmental change, e.g. disease [1 mark] • describes why koalas have low genetic diversity (inbreeding) [1 mark] • states that koalas are more vulnerable to extinction due to low genetic diversity [1 mark]

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2021 Paper 2 Section 1 Question 8

Continuity of life on Earth

Australia has many bird species that have evolved to be largely dependent on mangroves.

These species are patchy in their distribution because of:
• the island-like distribution of their habitat
• exclusion by possible competitors
• geographical barriers.

Identify and describe the mode of speciation that may have caused diversity in mangrove bird species. [3 marks]

Sample Response	The response
This is allopatric speciation, where populations of the same species are separated by barriers (island-like distribution, exclusion by competitors, geographical barriers) meaning that no exchange of genetic material is possible and gene flow is halted. Over many generations, mutation, natural selection and genetic drift result in genetic and phenotypic divergence until a new species is formed.	• identifies the mode as allopatric speciation [1 mark] • describes two elements of allopatric speciation - cessation of gene flow due to a barrier between population groups [1 mark] - genetic drift over time until divergence [1 mark]

2021 Paper 2 Section 1 Question 9

Continuity of life on Earth

A computer simulation was used to observe genotypic changes in the gene pool of 20 randomly selected rabbits. The simulation was set with these parameters:

• each rabbit's coat colour was either black or white
• black alleles were dominant; white alleles were recessive
• the number of rabbits was constant in each generation and breeding was random throughout the population
• an environmental factor was chosen in the simulation to provide selection pressure.

The table shows the results of the simulation at the start and after 20 generations.

Initial population genotypes	Population genotypes after 20 generations
BB BB BB BB BB BB Bb Bb Bb Bb Bb Bb Bb Bb Bb Bb bb bb bb bb	BB BB Bb Bb Bb Bb Bb Bb Bb Bb bb bb bb bb bb bb bb bb bb bb

Contrast the initial allele frequency with the allele frequency after 20 generations to draw a conclusion about the effect of the selection pressure on the rabbit population.

Sample Response	The response
Initial allelic frequencies were B 0.55 and b 0.45. Allelic frequencies after 20 generations were B 0.3 and b 0.7. B decreased (from 0.55 to 0.3) and b increased (from 0.45 to 0.7). This selection pressure was in favour of white rabbits as both genotype and allelic frequencies shifted toward the white phenotype and the white allele.	• provides the correct initial and final allele frequencies [1 mark] • identifies consequentially correct change in allele frequency [1 mark] • states a consequentially valid conclusion [1 mark]

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2020 Paper 2 Section 1 Question 9

Continuity of life on Earth

Fossil evidence seems to show that the morphology of the Queensland lung fish has remained relatively unchanged for the past 100 million years.

Describe the features of the theory of natural selection to explain how this may have occurred. [3 marks]

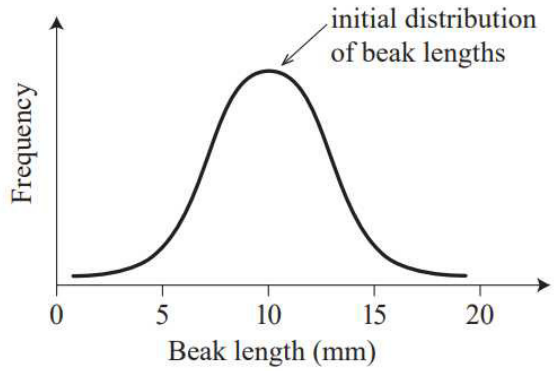
Sample Response	The response
In a population, some individuals will have inherited traits that help them survive and reproduce. Because the helpful traits are heritable, and because organisms with these traits leave more offspring, the population will become adapted to its environment. In the case of the lung fish, if the environment remains relatively unchanged (i.e. no new predators or competitors, still a water-dwelling organism), there is no environmental selection pressure to select for any new mutations in morphology, so there is minimal change in the species.	• describes natural selection in terms of -natural variation in a population includes traits that may be positive for survival in a given environment [1 mark] -states that these traits survive in the population if there is a selection pressure [1 mark] • with reference to the lung fish -states that the environment must have been relatively unchanged as no new morphological traits have been selected [1 mark]

2020 Paper 2 Section 1 Question 10

Continuity of life on Earth

Researchers measured the adult beak lengths of an entire population of a species of bird and plotted their results on the graph.

After many generations, the lengths of the adult beaks were again measured. By comparing this new data to the original data, the researchers concluded that the average length of beaks had increased as a result of directional selection. [3 marks]



a) Describe directional selection. [2 marks]

Sample Response	The response
Directional selection is a mode of natural selection in which an extreme phenotype is favoured over other phenotypes, causing the allele frequency to shift over time in the direction of that phenotype.	• states directional selection as when -an extreme phenotype is favoured in a population [1 mark] -population shifts to have more individuals with the phenotype [1 mark]

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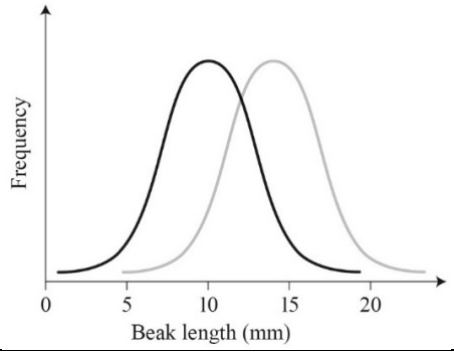
b) On the graph provided, sketch a representation of directional selection for the beak length scenario. [1 mark]
Note: If you make a mistake on the graph, cancel it by ruling a single diagonal line through your work and use the additional graph on page 17 of this question and response book.

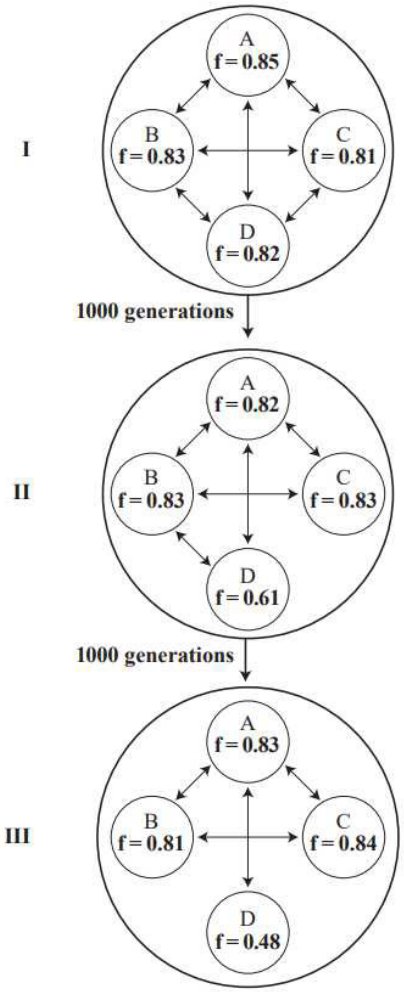
Sample Response	The response
	• sketch indicates shift to longer beak length [1 mark]

2020
Paper 2
Section 1
Question 11

Continuity of life on Earth

The image shows changes in the frequency of a particular gene in a single species of bird, leading to a speciation event. These changes have occurred over a period of successive time points (i.e. I, II and III) each separated by approximately 1000 generations.

- The letters A, B, C and D represent separate niches inhabited by the birds.
- The arrows depict gene flow between the niches.
- The allelic frequency for the gene is shown as f in each niche.



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Draw a conclusion about the type of speciation that has occurred in this population. Explain your reasoning by referring to the information provided in each of the time points. [6 marks]

Sample Response	The response	
At time point I, there is equal gene flow and equal allelic frequency in all niches, indicating a high degree of interbreeding between all niches. Trends show that the niche labelled as D has a progressive decrease in allelic frequency of the gene from time point I to time point III. This is supported by gene flow halting between C and D at time point II and then further from B to D at time point III. Gene flow between niches A, B and C remains constant throughout all time points, as shown by the arrows and also by the constant allelic frequency. This evidence supports a potential speciation event at niche D. Niche D however is not totally isolated as there remains some gene flow to the other populations (through niche A). This excludes allopatric speciation as the mode of proposed speciation. There is however an element of population isolation through niches, which supports parapatric speciation over sympatric speciation.	• identifies 3 pieces of evidence of speciation • infers that speciation is not allopatric because D is not isolated, e.g. at III, there is still gene flow with niche A • concludes that parapatric speciation occurred at D	6 marks
	• identifies 3 pieces of evidence of speciation • concludes that parapatric speciation occurred at D	5 marks
	• identifies 2 pieces of evidence of speciation • concludes that parapatric speciation occurred	4 marks
	• identifies 2 pieces of evidence of speciation • concludes that speciation occurred at D OR • identifies 3 pieces of evidence of speciation	3 marks
	• identifies 2 pieces of evidence of speciation	2 marks
	• concludes that parapatric speciation has occurred OR • concludes that speciation occurred at D	1 mark
	• does not satisfy any of the descriptors above.	0 marks

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