Essential Insight Exam Guide

Biology

Year 12 WACE

Western Australian Curriculum

2025 Edition

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Biology
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Acknowledgements
School Curriculum and Standards Authority. (2019-2023). ATAR Examinations and Marking Keys. The School Curriculum and Standards Authority does not endorse this publication or product.

Contents

Notes	• Section 3 questions feature question content from both topics within each unit for both Unit 3 and Unit 4. Section 3 questions have been placed in their own topic category for both Unit 3 and Unit 4. • Science Inquiry Skills are embedded within many questions that focus primarily on specific topics. Some questions largely focus on Science Inquiry Skills rather than a specific topic. These Science Inquiry Skill questions have been placed in their own topic category. • Some question material has not been released by SCSA 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 SCSA exams on the SCSA website.

Unit 3 – Continuity of species

Unit 3 – Heredity

Section 1

2023 Section 1 Question 4 **Heredity**	Which of the following are broken as a normal part of DNA replication? (a) hydrogen bonds between complementary bases (b) nitrogen bonds between complementary bases (c) phosphodiester bonds between adjacent nucleotides (d) phosphate bonds between adjacent nucleotides

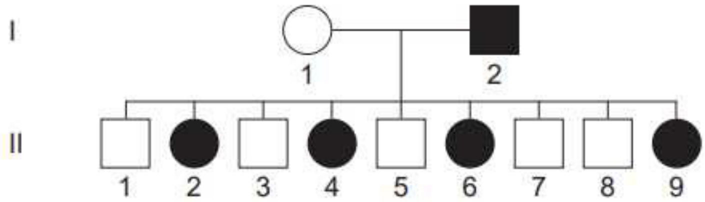
2023 Section 1 Question 7 **Heredity**	Which of the following is a type of physical mutagen? (a) alkylating agent (b) base analogue (c) UV light (d) transposable element

2023 Section 1 Question 10 **Heredity**	Polymerase chain reaction (PCR) is a laboratory procedure used in DNA sequencing. PCR mimics cellular (a) DNA replication. (b) DNA repair. (c) transcription. (d) translation.

2023 Section 1 Question 12 **Heredity**	Crossing-over is the exchange of (a) genes between homologous chromosomes. (b) genes between autosomal chromosomes. (c) alleles between homologous chromosomes. (d) alleles between autosomal chromosomes.

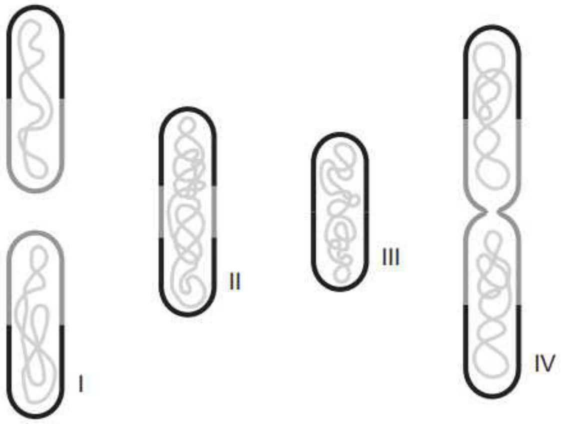
2023 Section 1 Question 21 **Heredity**	In watermelons, fruit bitterness is determined by two alleles at a gene where the allele for bitter fruit is dominant to the allele for sweet fruit. What is the probability that a cross between two plants that are heterozygous for these alleles will produce an offspring with bitter fruit? (a) 0.25 (b) 0.50 (c) 0.75 (d) 1.00

2023 Section 1 Question 28 **Heredity**	In snapdragons, flower colour is determined by the alleles at a gene. Crosses between plants with white flowers and plants with red flowers yield plants with pink flowers. Crosses between plants with pink flowers yield some plants with red flowers, some with pink and some with white. On this basis, how many alleles are involved in determining flower colour in snapdragons at this gene? (a) 4 (b) 3 (c) 2 (d) 1

2023 Section 1 Question 29-30 **Heredity**	The following pedigree chart shows the inheritance of nephritis in dogs. A filled symbol indicates that the dog has nephritis. Use the pedigree chart to answer questions 29 and 30.  Individual (a) II2 is a female that does not have nephritis. (b) II4 is a female with nephritis. (c) II6 inherited nephritis from its mother. (d) II8 inherited nephritis from its father. The information in the pedigree chart suggests that nephritis in dogs is **most** likely caused by a (a) dominant autosomal allele. (b) dominant sex-linked allele. (c) recessive autosomal allele. (d) recessive sex-linked allele.

2022 Section 1 Question 1 **Heredity**	If 28% of the bases in a DNA molecule are cytosine, what percentage will be adenine? (a) 22 (b) 28 (c) 44 (d) 56

2022 Section 1 Question 5 **Heredity**	In a plant cell, DNA occurs in the (a) nucleus only. (b) nucleus and chloroplasts only. (c) nucleus, chloroplasts and mitochondria only. (d) nucleus, chloroplasts, mitochondria and ribosomes.

2022 Section 1 Question 10-11 **Heredity**	The diagram below shows four steps in the division of a bacterial cell. The steps I to IV are not labelled in the correct order. Use this information to answer Questions 10 and 11.  10. The process shown in the diagram is (a) mitosis. (b) independent assortment. (c) binary fission. (d) fertilisation. 11. Which of the following lists the steps in the diagram in the order in which they occur in the division of the bacterial cell? (a) III, II, IV, I (b) II, III, I, IV (c) IV, III, II, I (d) I, IV, II, III

2022 Section 1 Question 16 **Heredity**	The haploid number of chromosomes in an orangutan is 24. How many chromosomes will be present in the sperm cell of an orangutan? (a) 12 (b) 24 (c) 48 (d) 60

2022 Section 1 Question 17 **Heredity**	Which of the following statements about meiosis is correct? (a) Both crossing over and independent assortment of chromosomes occur during meiosis I. (b) Both crossing over and independent assortment of chromosomes occur during meiosis II. (c) Crossing over occurs during meiosis I and independent assortment of chromosomes occurs during meiosis II. (d) Crossing over occurs during meiosis II and independent assortment of chromosomes occurs during meiosis I.

2022 Section 1 Question 26 **Heredity**	The table below shows the mRNA codons for four amino acids. Use this information to answer Question 26. <table><tr><th>Amino acid</th><th>mRNA codon</th></tr><tr><td>Methionine</td><td>AUG</td></tr><tr><td>Histidine</td><td>CAU</td></tr><tr><td>Asparagine</td><td>GAU</td></tr><tr><td>Valine</td><td>GUA</td></tr></table> Which amino acid is specified by the DNA codon GTA? (a) valine (b) asparagine (c) methionine (d) histidine

2022 Section 1 Question 27 **Heredity**	Plant breeders sometimes expose plant seeds to X-rays. This is done to (a) remove the seed coat to stimulate seed germination. (b) induce mutations to create different plant varieties. (c) activate hormones to improve seedling growth. (d) preserve seeds for long-term storage in seed banks.

2022 Section 1 Question 29 **Heredity**	A dog has an extra chromosome in all its cells. The mutation that caused this most likely occurred in a (a) cell undergoing meiosis in the dog. (b) cell undergoing mitosis in the dog. (c) germ cell in one of the dog's parents. (d) somatic cell in one of the dog's parents.

2021 Section 1 Question 4 **Heredity**	The nucleotide sequence of a DNA template is 5'-CCAGTTCCA-3'. The nucleotide sequence of the corresponding mRNA transcript is (a) 5'-GGUCAAGGU-3'. (b) 3'-GGUCAAGGU-5'. (c) 5'-GGTCUUGGT-3'. (d) 3'-GGTCUUGGT-5'.

2021 Section 1 Question 5 **Heredity**	Random assortment of chromosomes occurs in (a) binary fission. (b) fertilisation. (c) mitosis. (d) meiosis.

2021 Section 1 Question 9 **Heredity**	The figure below shows the structure of DNA. Use this figure to answer questions 9 and 10. 9. What type of chemical bond is indicated by X? (a) oxygen (b) carbon (c) hydrogen (d) nitrogen 10. The structure indicated by Y is a (a) deoxyribose sugar. (b) phosphate group. (c) nitrogenous base. (d) nucleotide.

2021 Section 1 Question 19 **Heredity**	Chromosomes in the nucleus are usually (a) linear and contain a DNA molecule that is shorter than the chromosome. (b) linear and contain a DNA molecule that is longer than the chromosome. (c) circular and contain a DNA molecule that is shorter than the chromosome. (d) circular and contain a DNA molecule that is longer than the chromosome.

2021 Section 1 Question 21-23

Heredity

A type of pea plant can have red or purple flowers. The table below shows the flower colour of parental plants and their offspring for five different crosses. Use this information to answer questions 21 to 23.

Cross	Male Parent	Female Parent	Offspring
1	red	red	all red
2	red	purple	all purple
3	purple	red	all purple
4	purple	red	some with red and some with purple
5	?	purple	some with red and some with purple

21. What type of trait is red flower colour in the pea plants?

(a) autosomal dominant
(b) sex-linked dominant
(c) autosomal recessive
(d) sex-linked recessive

22. Which of the following most likely represents the number of plants with red flowers and the number of plants with purple flowers in the offspring of Cross 4?

(a) 60 red and 24 purple
(b) 36 red and 38 purple
(c) 22 red and 62 purple
(d) 8 red and 72 purple

23. Which of the following statements about Cross 5 is correct?

(a) The female parent could be a homozygote for the dominant allele.
(b) The male parent could be a heterozygote with red flowers.
(c) The male parent could be a homozygote with purple flowers.
(d) The male parent could be a homozygote with red flowers.

2020 Section 1 Question 11

Heredity

A mRNA molecule has the following sequence – CUUUCUGAAAUU. The number of codons in this molecule is

(a) 0.
(b) 3.
(c) 4.
(d) 12.

2020 Section 1 Question 12-14

Heredity

The table below shows the amino acid that corresponds to each mRNA codon. Use this code to answer Questions 12 to 14.

1st position	2nd position U	2nd position C	2nd position A	2nd position G	3rd position
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	stop	stop	A
	Leu	Ser	stop	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G
	Amino Acids				

Ala: Alanine	Gln: Glutamine	Leu: Leucine	Ser: Serine
Arg: Arginine	Glu: Glutamic acid	Lys: Lysine	Thr: Threonine
Asn: Asparagine	Gly: Glycine	Met: Methionine	Trp: Tryptophane
Asp: Aspartic acid	His: Histidine	Phe: Phenylalanine	Tyr: Tyrosine
Cys: Cysteine	Ile: Isoleucine	Pro: Proline	Val: Valine

12. The sequence of amino acids in a protein that is made from the mRNA molecule in Question 11 is

(a) leucine, serine, glutamic acid, isoleucine.
(b) leucine, proline, histidine, arginine.
(c) phenylalanine, serine, tyrosine, cysteine.
(d) phenylalanine, leucine, methionine, valine.

13. Which of the following anticodons on a tRNA molecule would add the amino acid 'histidine' to a protein?

(a) CAU
(b) CAG
(c) GUA
(d) GUU

14. A mutation changes the sequence of a DNA molecule from GAA AGA CTT TAA to GAA AGA CTC TAA. This mutation will change

(a) the sequence of nucleotides in the mRNA molecule and of amino acids in the protein.
(b) the sequence of nucleotides in the mRNA molecule but not of amino acids in the protein.
(c) the sequence of amino acids in the protein but not of nucleotides in the mRNA.
(d) neither the sequence of nucleotides in the mRNA nor amino acids in the protein.

2020 Section 1 Question 16 **Heredity**	Muscular dystrophy in golden retriever dogs is caused by a mutation of the dystrophin gene. It is much more common in male golden retrievers than females. On this basis, what type of condition is muscular dystrophy in golden retrievers? (a) sex-linked dominant (b) sex-linked recessive (c) autosomal dominant (d) autosomal recessive

2020 Section 1 Question 23 **Heredity**	Which of the following processes generates genetic variation in bacteria and viruses? (a) binary fission (b) fertilisation (c) meiosis (d) mutation

2020 Section 1 Question 27 **Heredity**	The genetic material of a virus contains 1996 adenine, 2131 guanine, 1642 uracil and 2365 cytosine bases. This suggests that the genetic material of the virus is (a) single-stranded DNA. (b) single-stranded RNA. (c) double-stranded DNA. (d) double-stranded RNA.

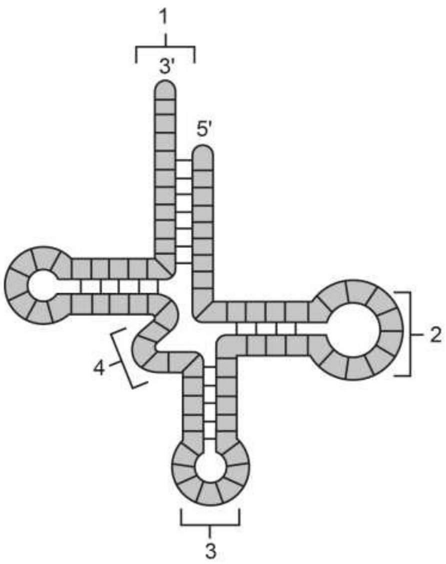
2020 Section 1 Question 28-29 **Heredity**	Two alleles, *Y1* and *Y2*, are present for the agouti gene in mice. Mice that are homozygous for the *Y1* allele have black fur, mice that have both the *Y1* and *Y2* alleles (i.e. heterozygotes) have yellow fur, and mice that are homozygous for the *Y2* allele die before being born. Two yellow mice were mated repeatedly to produce multiple litters. Use this information to answer Questions 28 and 29. 28. The proportion of offspring that die before being born is expected to be (a) 0.25. (b) 0.33. (c) 0.50. (d) 0.67. 29. The proportion of surviving offspring that have yellow fur is expected to be (a) 0.25. (b) 0.33. (c) 0.50. (d) 0.67.

2019 Section 1 Question 2 **Heredity**	A strand of DNA has the nucleotide sequence AGGTCT. The nucleotide sequence of the complementary strand of DNA is (a) AGGTCT. (b) AGGUCU. (c) TCCUGU. (d) TCCAGA.

2019 Section 1 Question 5 **Heredity**	Circular DNA that is not bound to proteins is typically found in (a) mitochondria. (b) nuclei. (c) ribosomes. (d) vacuoles.

2019 Section 1 Question 8 **Heredity**	Which of the following statements about the movement of DNA fragments through an agarose gel is correct? (a) Larger fragments move faster than smaller fragments because it is easier for them to move through the gel. (b) Larger fragments move faster than smaller fragments because they have a higher negative charge. (c) Smaller fragments move faster than larger fragments because it is easier for them to move through the gel. (d) Smaller fragments move faster than larger fragments because they have a lower negative charge.

2019 Section 1 Question 10 **Heredity**	Like mammals, the fruit fly *Drosophila* has an XY system of sex determination. *Drosophila* usually have large, round eyes, but a dominant allele at the Bar gene on the X chromosome causes small, narrow eyes, called 'Bar eyes'. If a male with Bar eyes is crossed with a female with normal eyes, then (a) half of the female offspring will have Bar eyes but none of the males. (b) half of the male offspring will have Bar eyes but none of the females. (c) all of the male and female offspring will have Bar eyes. (d) all of the female offspring will have Bar eyes but none of the males.

2019 Section 1 Question 11-12 **Heredity**	Questions 11 and 12 relate to the diagram of a RNA molecule below.  11. The structure at location 3 is (a) a ribose sugar. (b) mRNA. (c) an anticodon. (d) a codon. 12. An amino acid will attach to this molecule at location (a) 1. (b) 2. (c) 3. (d) 4.

2019 Section 1 Question 17 **Heredity**	The early evolution and diversification of eukaryotes required increasing amounts of which of the following gases in the atmosphere? (a) oxygen (b) carbon dioxide (c) hydrogen (d) nitrogen

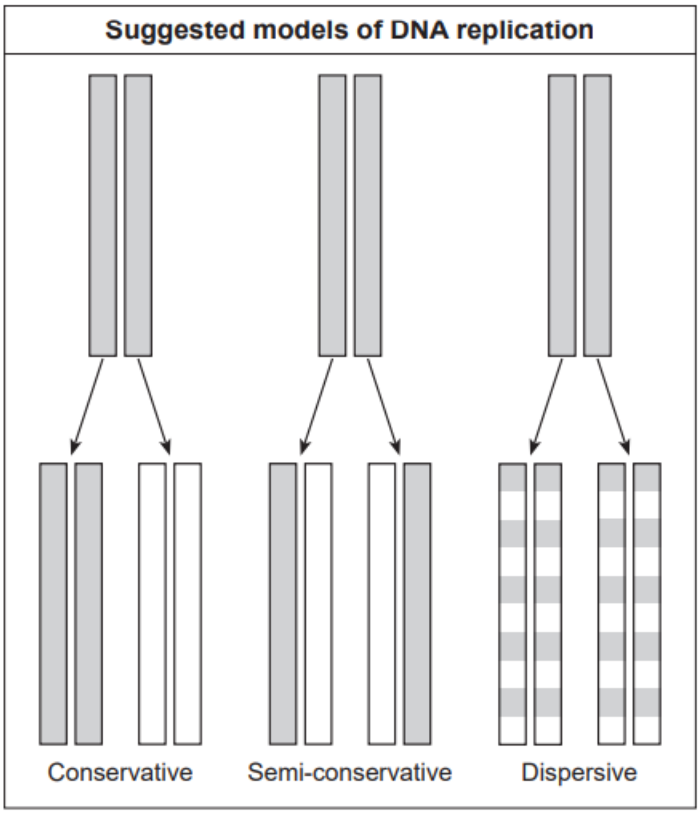
2019 Section 1 Question 22 **Heredity**	22. A mutation in a DNA sequence results in the substitution of one amino acid for another in a protein product. This mutation has produced a new (a) allele. (b) chromosome. (c) gene. (d) species.

2019 Section 1 Question 23 **Heredity**	Variation in the height of pea plants is discontinuous. Variation in the height of wheat plants is continuous. This suggests that height in pea plants is controlled by (a) a recessive allele, whereas height in wheat plants is controlled by a dominant allele. (b) a dominant allele, whereas height in wheat plants is controlled by a recessive allele. (c) multiple genes, whereas height in wheat plants is controlled by a single gene. (d) a single gene, whereas height in wheat plants is controlled by multiple genes.

Section 2

2023 Section 2 Question 32 **Heredity**	(a) DNA occurs in three organelles in plant cells. Identify these organelles. (3 marks) One: __________ Two: __________ Three: __________ (b) (i) Identify the process by which bacterial cells reproduce. (1 mark) __________ (ii) List the four main steps in the process in part (b)(i) above. (4 marks) One: __________ Two: __________ Three: __________ Four: __________

After DNA was discovered, three models of DNA replication (conservative, semi-conservative and dispersive) were proposed. These three models are shown in the diagram below, where the original DNA is shown in grey and newly synthesised DNA is shown in white.



(c) (i) Distinguish between the three different models of DNA replication. (3 marks)

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(ii) Ultimately one of the models was shown to be correct. Identify the correct model. (1 mark)

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A biologist analysed the base composition of a DNA molecule and a mRNA molecule. The analysis showed that the number of cytosine bases was the same as the number of guanine bases in the DNA molecule but not in the mRNA molecule.

(d) Explain why the number of cytosine bases was the same as the number of guanine bases in the DNA molecule but not in the mRNA molecule. (4 marks)

Rabbits with a coat colour pattern called Himalayan have white fur on their body and black fur on their paws and ears if they are exposed to cold temperature when born. However, the same rabbits would be all white if they had not been exposed to cold temperatures.

(e) Explain the reasons for this difference in colouring. (5 marks)

2023
Section 2
Question 33

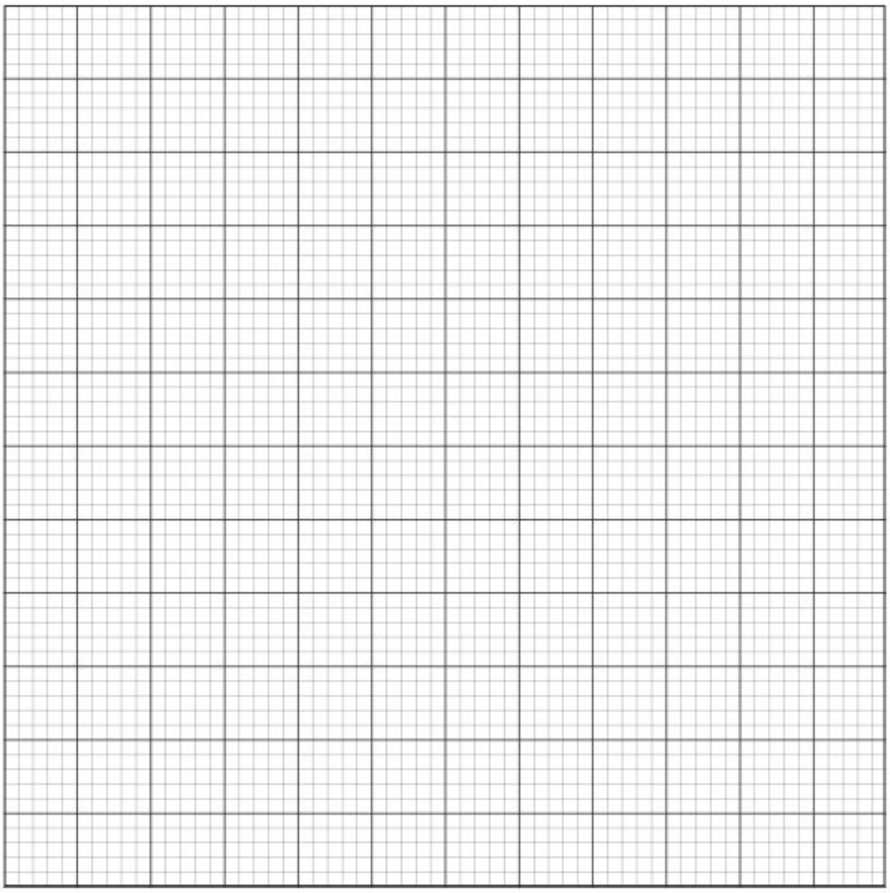
Heredity

Biologists measured the duration of meiosis (in minutes) at different environmental temperatures in two plant species. The results are given in the table below.

Duration of meiosis in the common bluebell and red trillium at different environmental temperatures

A '-' indicates that no data are available for the species at that temperature.

(a) Graph the duration of meiosis against environmental temperature for both species. (6 marks)



(b) (i) Using your graph, estimate the duration of meiosis in the common bluebell at 2 °C. (1 mark)

(ii) Using your graph, estimate the duration of meiosis in red trillium at 20 °C. (1 mark)

(iii) State which estimate you have the most confidence in. Justify your response. (2 marks)

(c) (i) List **two** similarities between meiosis and mitosis. (2 marks)

One: ____

____

Two: ____

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(ii) Outline **one** difference between meiosis I and meiosis II. (2 marks)

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(d) The haploid number of chromosomes in the Musk ox is 24. Indicate how many chromosomes will occur in a skin cell of a Musk ox. Justify your response. (3 marks)

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(e) Most Banksia plants have a chromosome number of 2n = 28. Explain how an error in meiosis could generate an individual with 29 chromosomes. (4 marks)

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2022 Section 2 Question 31 **Heredity**	Some biologists believe that RNA, rather than DNA, played a critical role in the evolution of life on Earth. (a) (i) Approximately when did life first evolve on Earth? (1 mark) (ii) List three structural properties of an RNA molecule. (3 marks) All living organisms essentially use the same genetic code. (b) (i) Define the term 'genetic code'. (1 mark) (ii) Outline how the fact that all living organisms use essentially the same genetic code provides evidence for evolution. (2 marks) All cells need to synthesise proteins to function and reproduce (c) State the role that each of the following plays in protein synthesis. (5 marks) RNA polymerase: Transcription: Anticodon:

Ribosome:

Amino acid:

Life on Earth has diversified and changed over time. Mutation has played an important role in this evolution.

(d) (i) Define the term ‘mutation’. (1 mark)

(ii) List **three** distinctly different causes of mutation. (3 marks)

(e) Explain the role that mutation has played in diversifying life on Earth. (4 marks)

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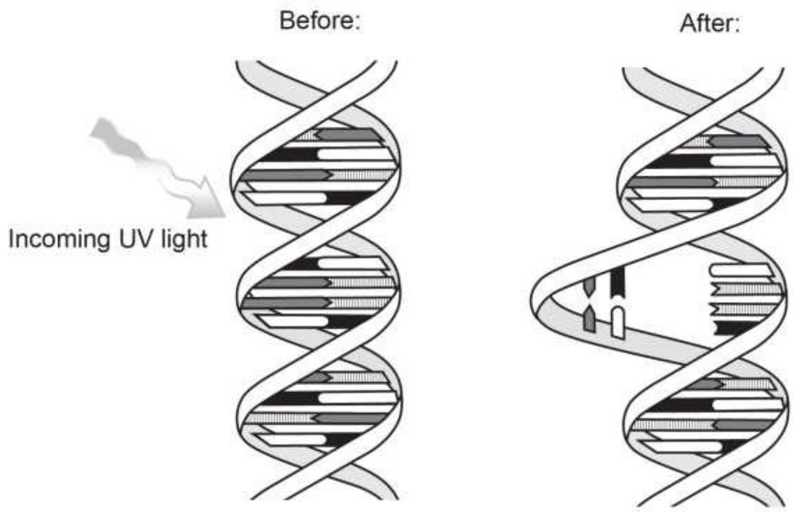
(ii) List **three** distinctly different causes of mutation. (3 marks)

(e) Explain the role that mutation has played in diversifying life on Earth. (4 marks)

2019 Section 2 Question 35 Heredity	(a) (i) State **two** similarities between binary fission and mitosis. (2 marks) One: ______ Two: ______ (ii) State **two** differences between binary fission and mitosis. (2 marks) One: ______ Two: ______ (b) Explain the role of fertilisation in sexual reproduction. (4 marks) (c) (i) Outline how crossing over creates genotypic variation. (2 marks) (ii) Outline how independent assortment creates genotypic variation. (2 marks)

The following diagram shows the structure of a DNA molecule before and after exposure to ultraviolet (UV) light.



(d) Describe the effect that UV light has on DNA structure. (4 marks)

(e) Explain why mutation is the ultimate source of genetic variation. (4 marks)

Marking Guide – Section 1

2023 Section 1 Question 4 **Heredity**	Which of the following are broken as a normal part of DNA replication? **(a) hydrogen bonds between complementary bases – Answer** (b) nitrogen bonds between complementary bases (c) phosphodiester bonds between adjacent nucleotides (d) phosphate bonds between adjacent nucleotides

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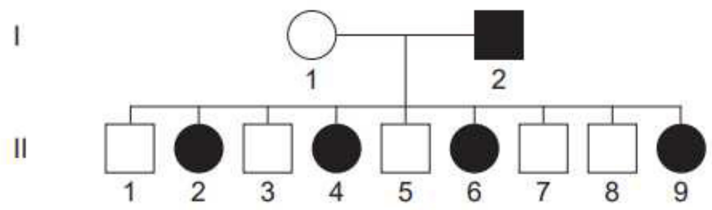
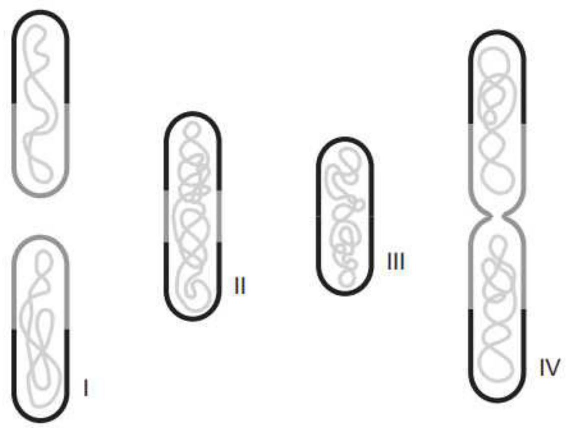
2023 Section 1 Question 28 **Heredity**	In snapdragons, flower colour is determined by the alleles at a gene. Crosses between plants with white flowers and plants with red flowers yield plants with pink flowers. Crosses between plants with pink flowers yield some plants with red flowers, some with pink and some with white. On this basis, how many alleles are involved in determining flower colour in snapdragons at this gene? (a) 4 (b) 3 **(c) 2 – Answer** (d) 1

2023 Section 1 Question 29-30 **Heredity**	The following pedigree chart shows the inheritance of nephritis in dogs. A filled symbol indicates that the dog has nephritis. Use the pedigree chart to answer questions 29 and 30.  Individual (a) II2 is a female that does not have nephritis. **(b) II4 is a female with nephritis. – Answer** (c) II6 inherited nephritis from its mother. (d) II8 inherited nephritis from its father. The information in the pedigree chart suggests that nephritis in dogs is **most** likely caused by a (a) dominant autosomal allele. **(b) dominant sex-linked allele. – Answer** (c) recessive autosomal allele. (d) recessive sex-linked allele.

2022 Section 1 Question 1 **Heredity**	If 28% of the bases in a DNA molecule are cytosine, what percentage will be adenine? **(a) 22 – Answer** (b) 28 (c) 44 (d) 56

2022 Section 1 Question 5 **Heredity**	In a plant cell, DNA occurs in the (a) nucleus only. (b) nucleus and chloroplasts only. **(c) nucleus, chloroplasts and mitochondria only. – Answer** (d) nucleus, chloroplasts, mitochondria and ribosomes.

2022 Section 1 Question 10-11 **Heredity**	The diagram below shows four steps in the division of a bacterial cell. The steps I to IV are not labelled in the correct order. Use this information to answer Questions 10 and 11.  10. The process shown in the diagram is (a) mitosis. (b) independent assortment. **(c) binary fission. – Answer** (d) fertilisation. 11. Which of the following lists the steps in the diagram in the order in which they occur in the division of the bacterial cell? **(a) III, II, IV, I – Answer** (b) II, III, I, IV (c) IV, III, II, I (d) I, IV, II, III

2022 Section 1 Question 16 **Heredity**	The haploid number of chromosomes in an orangutan is 24. How many chromosomes will be present in the sperm cell of an orangutan? (a) 12 **(b) 24 – Answer** (c) 48 (d) 60

2022 Section 1 Question 17 **Heredity**	Which of the following statements about meiosis is correct? **(a) Both crossing over and independent assortment of chromosomes occur during meiosis I. – Answer** (b) Both crossing over and independent assortment of chromosomes occur during meiosis II. (c) Crossing over occurs during meiosis I and independent assortment of chromosomes occurs during meiosis II. (d) Crossing over occurs during meiosis II and independent assortment of chromosomes occurs during meiosis I.

2022 Section 1 Question 26

Heredity

The table below shows the mRNA codons for four amino acids. Use this information to answer Question 26.

Amino acid	mRNA codon
Methionine	AUG
Histidine	CAU
Asparagine	GAU
Valine	GUA

Which amino acid is specified by the DNA codon GTA?
(a) valine
(b) asparagine
(c) methionine
(d) histidine – Answer

2022 Section 1 Question 27

Heredity

Plant breeders sometimes expose plant seeds to X-rays. This is done to

(a) remove the seed coat to stimulate seed germination.
(b) induce mutations to create different plant varieties. – Answer
(c) activate hormones to improve seedling growth.
(d) preserve seeds for long-term storage in seed banks.

2022 Section 1 Question 29

Heredity

A dog has an extra chromosome in all its cells. The mutation that caused this most likely occurred in a

(a) cell undergoing meiosis in the dog.
(b) cell undergoing mitosis in the dog.
(c) germ cell in one of the dog's parents. – Answer
(d) somatic cell in one of the dog's parents.

2021 Section 1 Question 4

Heredity

The nucleotide sequence of a DNA template is 5'-CCAGTTCCA-3'. The nucleotide sequence of the corresponding mRNA transcript is

(a) 5'-GGUCAAGGU-3'.
(b) 3'-GGUCAAGGU-5'. – Answer
(c) 5'-GGTCUUGGT-3'.
(d) 3'-GGTCUUGGT-5'.

2021 Section 1 Question 5

Heredity

Random assortment of chromosomes occurs in

(a) binary fission.
(b) fertilisation.
(c) mitosis.
(d) meiosis. – Answer

2021 Section 1 Question 9 **Heredity**	The figure below shows the structure of DNA. Use this figure to answer questions 9 and 10. 9. What type of chemical bond is indicated by X? (a) oxygen (b) carbon **(c) hydrogen – Answer** (d) nitrogen 10. The structure indicated by Y is a **(a) deoxyribose sugar. – Answer** (b) phosphate group. (c) nitrogenous base. (d) nucleotide.

2021 Section 1 Question 19 **Heredity**	Chromosomes in the nucleus are usually (a) linear and contain a DNA molecule that is shorter than the chromosome. **(b) linear and contain a DNA molecule that is longer than the chromosome. – Answer** (c) circular and contain a DNA molecule that is shorter than the chromosome. (d) circular and contain a DNA molecule that is longer than the chromosome.

2021 Section 1 Question 21-23

Heredity

A type of pea plant can have red or purple flowers. The table below shows the flower colour of parental plants and their offspring for five different crosses. Use this information to answer questions 21 to 23.

Cross	Male Parent	Female Parent	Offspring
1	red	red	all red
2	red	purple	all purple
3	purple	red	all purple
4	purple	red	some with red and some with purple
5	?	purple	some with red and some with purple

21. What type of trait is red flower colour in the pea plants?

(a) autosomal dominant
(b) sex-linked dominant
(c) autosomal recessive – Answer
(d) sex-linked recessive

22. Which of the following most likely represents the number of plants with red flowers and the number of plants with purple flowers in the offspring of Cross 4?

(a) 60 red and 24 purple
(b) 36 red and 38 purple – Answer
(c) 22 red and 62 purple
(d) 8 red and 72 purple

23. Which of the following statements about Cross 5 is correct?

(a) The female parent could be a homozygote for the dominant allele.
(b) The male parent could be a heterozygote with red flowers.
(c) The male parent could be a homozygote with purple flowers.
(d) The male parent could be a homozygote with red flowers. – Answer

2020 Section 1 Question 11

Heredity

A mRNA molecule has the following sequence – CUUUCUGAAAUU. The number of codons in this molecule is

(a) 0.
(b) 3.
(c) 4. – Answer
(d) 12.

2020 Section 1 Question 12-14

Heredity

The table below shows the amino acid that corresponds to each mRNA codon. Use this code to answer Questions 12 to 14.

1st position	2nd position U	2nd position C	2nd position A	2nd position G	3rd position
U	Phe Phe Leu Leu	Ser Ser Ser Ser	Tyr Tyr stop stop	Cys Cys stop Trp	U C A G
C	Leu Leu Leu Leu	Pro Pro Pro Pro	His His Gln Gln	Arg Arg Arg Arg	U C A G
A	Ile Ile Ile Met	Thr Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G
G	Val Val Val Val	Ala Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G
	Amino Acids				

Ala: Alanine	Gln: Glutamine	Leu: Leucine	Ser: Serine
Arg: Arginine	Glu: Glutamic acid	Lys: Lysine	Thr: Threonine
Asn: Asparagine	Gly: Glycine	Met: Methionine	Trp: Tryptophane
Asp: Aspartic acid	His: Histidine	Phe: Phenylalanine	Tyr: Tyrosine
Cys: Cysteine	Ile: Isoleucine	Pro: Proline	Val: Valine

12. The sequence of amino acids in a protein that is made from the mRNA molecule in Question 11 is

(a) leucine, serine, glutamic acid, isoleucine. – Answer
(b) leucine, proline, histidine, arginine.
(c) phenylalanine, serine, tyrosine, cysteine.
(d) phenylalanine, leucine, methionine, valine.

13. Which of the following anticodons on a tRNA molecule would add the amino acid 'histidine' to a protein?

(a) CAU
(b) CAG
(c) GUA – Answer
(d) GUU

14. A mutation changes the sequence of a DNA molecule from GAA AGA CTT TAA to GAA AGA CTC TAA. This mutation will change

(a) the sequence of nucleotides in the mRNA molecule and of amino acids in the protein.
(b) the sequence of nucleotides in the mRNA molecule but not of amino acids in the protein. – Answer
(c) the sequence of amino acids in the protein but not of nucleotides in the mRNA.
(d) neither the sequence of nucleotides in the mRNA nor amino acids in the protein.

2020 Section 1 Question 16 **Heredity**	Muscular dystrophy in golden retriever dogs is caused by a mutation of the dystrophin gene. It is much more common in male golden retrievers than females. On this basis, what type of condition is muscular dystrophy in golden retrievers? (a) sex-linked dominant **(b) sex-linked recessive – Answer** (c) autosomal dominant (d) autosomal recessive

2020 Section 1 Question 23 **Heredity**	Which of the following processes generates genetic variation in bacteria and viruses? (a) binary fission (b) fertilisation (c) meiosis **(d) mutation – Answer**

2020 Section 1 Question 27 **Heredity**	The genetic material of a virus contains 1996 adenine, 2131 guanine, 1642 uracil and 2365 cytosine bases. This suggests that the genetic material of the virus is (a) single-stranded DNA. **(b) single-stranded RNA. – Answer** (c) double-stranded DNA. (d) double-stranded RNA.

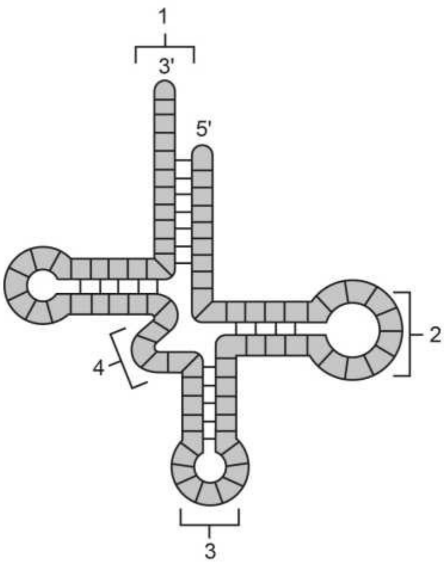
2020 Section 1 Question 28-29 **Heredity**	Two alleles, *Y1* and *Y2*, are present for the agouti gene in mice. Mice that are homozygous for the *Y1* allele have black fur, mice that have both the *Y1* and *Y2* alleles (i.e. heterozygotes) have yellow fur, and mice that are homozygous for the *Y2* allele die before being born. Two yellow mice were mated repeatedly to produce multiple litters. Use this information to answer Questions 28 and 29. 28. The proportion of offspring that die before being born is expected to be **(a) 0.25. – Answer** (b) 0.33. (c) 0.50. (d) 0.67. 29. The proportion of surviving offspring that have yellow fur is expected to be (a) 0.25. (b) 0.33. (c) 0.50. **(d) 0.67. – Answer**

2019 Section 1 Question 2 **Heredity**	A strand of DNA has the nucleotide sequence AGGTCT. The nucleotide sequence of the complementary strand of DNA is (a) AGGTCT. (b) AGGUCU. (c) TCCUGU. **(d) TCCAGA. – Answer**

2019 Section 1 Question 5 **Heredity**	Circular DNA that is not bound to proteins is typically found in **(a) mitochondria. – Answer** (b) nuclei. (c) ribosomes. (d) vacuoles.

2019 Section 1 Question 8 **Heredity**	Which of the following statements about the movement of DNA fragments through an agarose gel is correct? (a) Larger fragments move faster than smaller fragments because it is easier for them to move through the gel. (b) Larger fragments move faster than smaller fragments because they have a higher negative charge. **(c) Smaller fragments move faster than larger fragments because it is easier for them to move through the gel. – Answer** (d) Smaller fragments move faster than larger fragments because they have a lower negative charge.

2019 Section 1 Question 10 **Heredity**	Like mammals, the fruit fly *Drosophila* has an XY system of sex determination. *Drosophila* usually have large, round eyes, but a dominant allele at the Bar gene on the X chromosome causes small, narrow eyes, called 'Bar eyes'. If a male with Bar eyes is crossed with a female with normal eyes, then (a) half of the female offspring will have Bar eyes but none of the males. (b) half of the male offspring will have Bar eyes but none of the females. (c) all of the male and female offspring will have Bar eyes. **(d) all of the female offspring will have Bar eyes but none of the males. – Answer**

2019 Section 1 Question 11-12 **Heredity**	Questions 11 and 12 relate to the diagram of a RNA molecule below.  11. The structure at location 3 is (a) a ribose sugar. (b) mRNA. **(c) an anticodon. – Answer** (d) a codon. 12. An amino acid will attach to this molecule at location **(a) 1. – Answer** (b) 2. (c) 3. (d) 4.

2019 Section 1 Question 17 **Heredity**	The early evolution and diversification of eukaryotes required increasing amounts of which of the following gases in the atmosphere? **(a) oxygen – Answer** (b) carbon dioxide (c) hydrogen (d) nitrogen

2019 Section 1 Question 22 **Heredity**	22. A mutation in a DNA sequence results in the substitution of one amino acid for another in a protein product. This mutation has produced a new **(a) allele. – Answer** (b) chromosome. (c) gene. (d) species.

2019 Section 1 Question 23 **Heredity**	Variation in the height of pea plants is discontinuous. Variation in the height of wheat plants is continuous. This suggests that height in pea plants is controlled by (a) a recessive allele, whereas height in wheat plants is controlled by a dominant allele. (b) a dominant allele, whereas height in wheat plants is controlled by a recessive allele. (c) multiple genes, whereas height in wheat plants is controlled by a single gene. **(d) a single gene, whereas height in wheat plants is controlled by multiple genes. – Answer**

Marking Guide – Section 2

<table>
<tr><td>2023
Section 2
Question
33

Heredity</td><td>

Biologists measured the duration of meiosis (in minutes) at different environmental temperatures in two plant species. The results are given in the table below.

Duration of meiosis in the common bluebell and red trillium at different environmental temperatures

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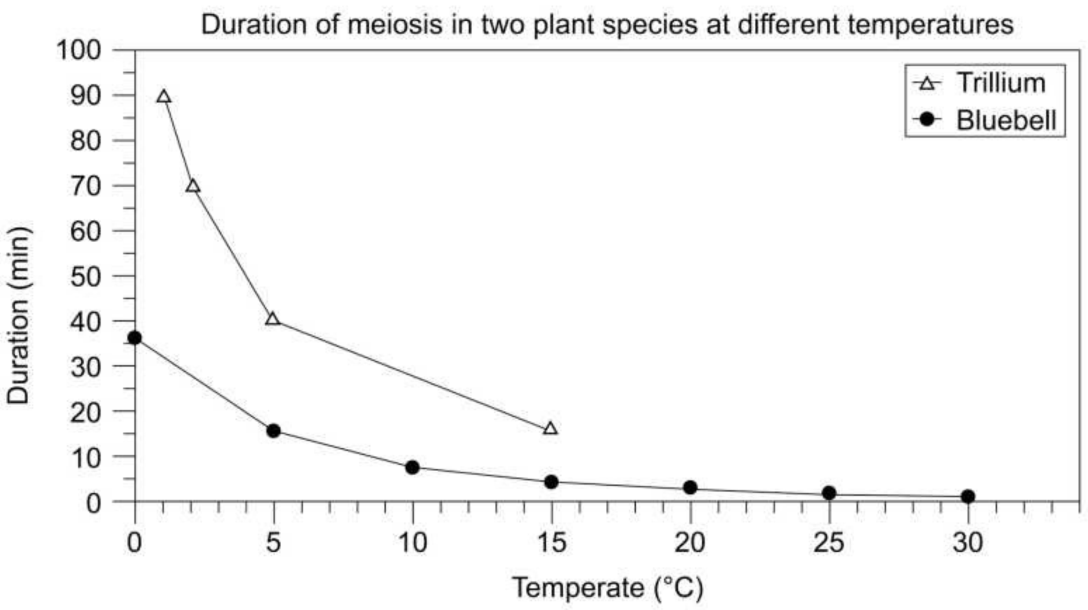
A '-' indicates that no data are available for the species at that temperature.

(a) Graph the duration of meiosis against environmental temperature for both species. (6 marks)

Description	Marks
Title, must include both variables	1
Data plotted separately for each species, with legend/key	1
Correct axes (X and Y)	1
Appropriate scale	1
Labelling, accurate labelling on both axes (including units)	1
Plotting, data plotted accurately and joined (line graph)	1
Total	**6**

Sample graph



(b) (i) Using your graph, estimate the duration of meiosis in the common bluebell at 2 °C. (1 mark)

Description	Marks
29 min (accept 28 to 30, must include units)	1
Total	**1**

(ii) Using your graph, estimate the duration of meiosis in red trillium at 20 °C. (1 mark)

Description	Marks
4 min (accept 3 to 5, must include units)	1
Total	**1**

</td></tr>
</table>

(iii) State which estimate you have the most confidence in. Justify your response. (2 marks)

Description	Marks
29 min or (i) or bluebell	1
interpolation/within the range of data for the bluebell or converse	1
Total	**2**

(c) (i) List **two** similarities between meiosis and mitosis. (2 marks)

Description	Marks
Any two of (2 x 1 mark)	
• types of cell/nuclear division • have same stages or have prophase, metaphase, anaphase, telophase • DNA replication is not part of the process/occurs beforehand • spindle forms or spindle is used to divide chromosomes	1–2
Total	**2**
Accept other relevant answers.	

(ii) Outline **one** difference between meiosis I and meiosis II. (2 marks)

Description	Marks
Either • independent assortment of homologous chromosomes/homologous chromosomes separate in meiosis I • sister chromatids separate in meiosis II or • meiosis I reduces the number of chromosomes • meiosis II keeps the number of chromosomes the same	1–2
Total	**2**
Accept other relevant answers.	

(d) The haploid number of chromosomes in the Musk ox is 24. Indicate how many chromosomes will occur in a skin cell of a Musk ox. Justify your response. (3 marks)

Description	Marks
48	1
skin cell is diploid or haploid is number of chromosomes in gamete	1
skin cells have 2X haploid number of chromosomes	1
Total	**3**

	(e) Most Banksia plants have a chromosome number of 2n = 28. Explain how an error in meiosis could generate an individual with 29 chromosomes. (4 marks)

Description	Marks
Any four of (4 x 1 mark)	
• error during random/independent assortment or an error in disjunction or non-disjunction • both members of a homologous pair should move to poles/daughter cells/gametes • both chromatids of a chromosome/sister chromatids should move to different poles/daughter cells/gametes • if both move to the same pole/daughter cell/gamete, then pole/daughter cell/gamete will have an extra/15/n+1 chromosome • gametes with 15 chromosomes fuses with gamete of 14 chromosomes (to give an individual with 29 chromosomes)	1–4
Total	**4**

2023 Section 2 Question 32

Heredity

(a) DNA occurs in three organelles in plant cells. Identify these organelles. (3 marks)

Description	Marks
nucleus	1
mitochondrion/mitochondria	1
chloroplast	1
Total	**3**

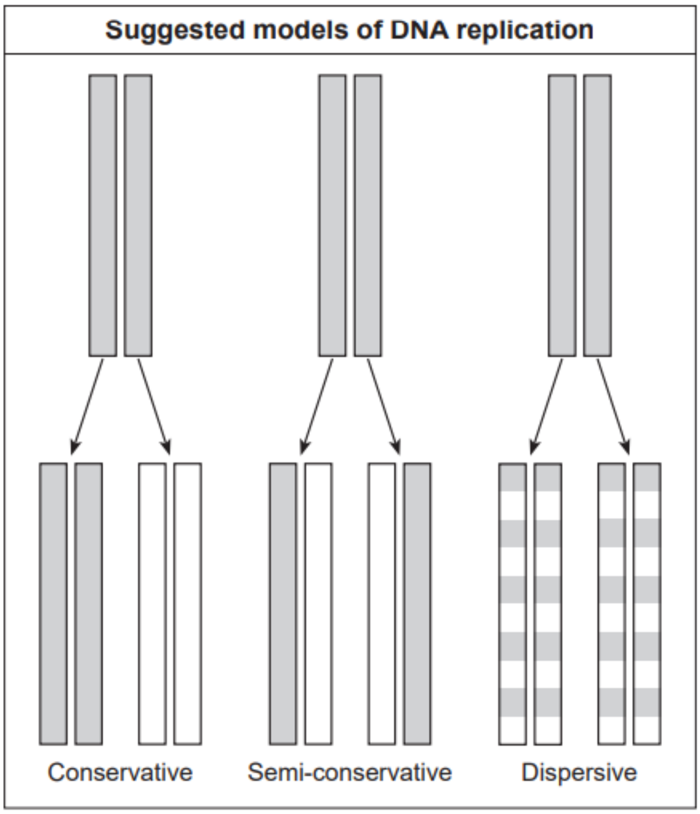
(b) (i) Identify the process by which bacterial cells reproduce. (1 mark)

Description	Marks
binary fission	1
Total	**1**

(ii) List the four main steps in the process in part (b)(i) above. (4 marks)

Description	Marks
DNA/chromosome replicates	1
cell elongates or DNA/chromosome copies attach to a different part of cell membrane	1
DNA/chromosome copies move to different end of cell **or** to different poles	1
cell divides or a new cell wall/cell plate is formed	1
Total	**4**

After DNA was discovered, three models of DNA replication (conservative, semi-conservative and dispersive) were proposed. These three models are shown in the diagram below, where the original DNA is shown in grey and newly synthesised DNA is shown in white.



(c) (i) Distinguish between the three different models of DNA replication. (3 marks)

Description	Marks
conservative: one molecule with original DNA and one with newly synthesised DNA	1
semi-conservative: molecules have one strand of original DNA and one strand of newly synthesised DNA	1
dispersive: individual strands contain a mix of original and newly synthesised DNA	1
Total	**3**

(ii) Ultimately one of the models was shown to be correct. Identify the correct model. (1 mark)

Description	Marks
semi-conservative	1
Total	**1**

A biologist analysed the base composition of a DNA molecule and a mRNA molecule. The analysis showed that the number of cytosine bases was the same as the number of guanine bases in the DNA molecule but not in the mRNA molecule.

(d) Explain why the number of cytosine bases was the same as the number of guanine bases in the DNA molecule but not in the mRNA molecule. (4 marks)

Description	Marks
DNA molecule is double stranded	1
because cytosine/C on one strand pairs with guanine/G on other strand, the number of each of these must be the same	1
mRNA is single stranded	1
can get a different number of C/G bases because there is no base pairing	1
Total	**4**

Rabbits with a coat colour pattern called Himalayan have white fur on their body and black fur on their paws and ears if they are exposed to cold temperature when born. However, the same rabbits would be all white if they had not been exposed to cold temperatures.

(e) Explain the reasons for this difference in colouring. (5 marks)

Description	Marks
Any five of (5 x 1 mark)	
• phenotypic expression of genes depends on interactions of genes with the environment or expression of gene that determines Himalayan pattern is temperature dependent • white colour occurs in the absence of black or black covers white colour or gene involved produces black fur • gene/allele/gene product that produces black is only active at low/lower temperatures • extremities are black because temperature is low/lower (hence gene/allele/gene product is active) • body is white because temperature is high/higher (hence gene/allele/gene product is active)	1–5
Total	**5**
Accept other relevant answers that identify that the pattern arises via a temperature dependent enzyme.	

2022 Section 2 Question 31 Heredity	

2022
Section 2
Question
31

Heredity

Some biologists believe that RNA, rather than DNA, played a critical role in the evolution of life on Earth.

(a) (i) Approximately when did life first evolve on Earth? (1 mark)

Description	Marks
approximately 3.5 billion years ago (accept between 3 to 4 billion years ago)	1
Total	**1**

(ii) List three structural properties of an RNA molecule. (3 marks)

Description	Marks
Any three of	
• type of nucleic acid • contains ribose sugar • phosphate group • made up of nucleotides/nitrogenous bases/contains C, G, A and U bases • single stranded molecule	1–3
Total	**3**

All living organisms essentially use the same genetic code.
(b) (i) Define the term ‘genetic code’. (1 mark)

Description	Marks
Any one of	
• set of rules that determine how genetic information/nucleotide sequences/codons in DNA/RNA is translated into amino acids/determines amino acids in a protein • how information in DNA/RNA is converted into a protein • base triplet code that determines amino acids in a protein	1
Total	**1**

(ii) Outline how the fact that all living organisms use essentially the same genetic code provides evidence for evolution. (2 marks)

Description	Marks
Organisms inherit genetic code from their ancestors.	1
All organisms can be traced back to a single ancestor.	1
Total	**2**

All cells need to synthesise proteins to function and reproduce

(c) State the role that each of the following plays in protein synthesis. (5 marks)

Description	Marks
RNA polymerase: (enzyme that) catalyses the synthesis of mRNA from DNA **or** adds nucleotides to mRNA molecule **or** binds to DNA (to initiate transcription) **or** unwinds DNA (to gain access to DNA sequence) **or** other specific action of RNA polymerase	1
Transcription: process of making a mRNA copy of a DNA/gene sequence	1
Anticodon: (three) nucleotides in tRNA that is complementary to codon in mRNA **or** (three) nucleotides in tRNA that bind to mRNA **or** that determine which amino acid tRNA carries	1
Ribosome: reads the mRNA/site of protein synthesis/performs translation/links amino acids (in correct order)	1
Amino acid: amino acids are the building blocks of protein/polypeptide **or** sequence of amino acids determine type of protein	1
Total	**5**

Life on Earth has diversified and changed over time. Mutation has played an important role in this evolution.

(d) (i) Define the term ‘mutation’. (1 mark)

Description	Marks
A permanent change in DNA/a gene/a chromosome.	1
Total	**1**

(ii) List **three** distinctly different causes of mutation. (3 marks)

Description	Marks
Any three of	
• errors in DNA replication • errors in cell division • mutagens/environmental factors • physical mutagen/ chemical mutagen/or specific example of a mutagen • biological factors/viruses	1–3
Total	**3**

	(e) Explain the role that mutation has played in diversifying life on Earth. (4 marks)

Description	Marks
Any four of	
• mutation is source of genetic variation or of all new alleles/new genes • these are the basis of differences among organisms • mutations have accumulated over time • differences among organisms/the diversity of organisms have increased over time • without mutation all organisms would be the same (except for environmental differences)	1–4
Total	**4**

2022 Section 2 Question 31

Heredity

Some biologists believe that RNA, rather than DNA, played a critical role in the evolution of life on Earth.

(a) (i) Approximately when did life first evolve on Earth? (1 mark)

Description	Marks
approximately 3.5 billion years ago (accept between 3 to 4 billion years ago)	1
Total	**1**

(ii) List three structural properties of an RNA molecule. (3 marks)

Description	Marks
Any three of	
• type of nucleic acid • contains ribose sugar • phosphate group • made up of nucleotides/nitrogenous bases/contains C, G, A and U bases • single stranded molecule	1–3
Total	**3**

All living organisms essentially use the same genetic code.
(b) (i) Define the term 'genetic code'. (1 mark)

Description	Marks
Any one of	
• set of rules that determine how genetic information/nucleotide sequences/codons in DNA/RNA is translated into amino acids/determines amino acids in a protein • how information in DNA/RNA is converted into a protein • base triplet code that determines amino acids in a protein	1
Total	**1**

(ii) Outline how the fact that all living organisms use essentially the same genetic code provides evidence for evolution. (2 marks)

Description	Marks
Organisms inherit genetic code from their ancestors.	1
All organisms can be traced back to a single ancestor.	1
Total	**2**

All cells need to synthesise proteins to function and reproduce

(c) State the role that each of the following plays in protein synthesis. (5 marks)

Description	Marks
RNA polymerase: (enzyme that) catalyses the synthesis of mRNA from DNA **or** adds nucleotides to mRNA molecule **or** binds to DNA (to initiate transcription) **or** unwinds DNA (to gain access to DNA sequence) **or** other specific action of RNA polymerase	1
Transcription: process of making a mRNA copy of a DNA/gene sequence	1
Anticodon: (three) nucleotides in tRNA that is complementary to codon in mRNA **or** (three) nucleotides in tRNA that bind to mRNA **or** that determine which amino acid tRNA carries	1
Ribosome: reads the mRNA/site of protein synthesis/performs translation/links amino acids (in correct order)	1
Amino acid: amino acids are the building blocks of protein/polypeptide **or** sequence of amino acids determine type of protein	1
Total	**5**

Life on Earth has diversified and changed over time. Mutation has played an important role in this evolution.

(d) (i) Define the term ‘mutation’. (1 mark)

Description	Marks
A permanent change in DNA/a gene/a chromosome.	1
Total	**1**

(ii) List **three** distinctly different causes of mutation. (3 marks)

Description	Marks
Any three of	
• errors in DNA replication • errors in cell division • mutagens/environmental factors • physical mutagen/ chemical mutagen/or specific example of a mutagen • biological factors/viruses	1–3
Total	**3**

(e) Explain the role that mutation has played in diversifying life on Earth. (4 marks)

Description	Marks
Any four of	
• mutation is source of genetic variation or of all new alleles/new genes • these are the basis of differences among organisms • mutations have accumulated over time • differences among organisms/the diversity of organisms have increased over time • without mutation all organisms would be the same (except for environmental differences)	1–4
Total	**4**

2019 Section 2 Question 35

Heredity

(a) (i) State **two** similarities between binary fission and mitosis. (2 marks)

Description	Marks
States any **two** of the following similarities:	
• types of cell division • produce genetically identical cells **or** types of asexual reproduction • produce two (daughter) cells	1–2
Total	**2**

(ii) State **two** differences between binary fission and mitosis. (2 marks)

Description	Marks
States any **two** of the following differences:	
• binary fission (mainly) occurs in bacteria/prokaryotes, mitosis occurs in (most) eukaryotes **or** binary fission divides cells without a nucleus, mitosis divides cells with a nucleus • mitosis has a spindle, binary fission does not **or** binary fission divides only a single chromosome type, mitosis divides multiple chromosome types • binary fission is faster **or** mitosis is slower	1–2
Total	**2**

(b) Explain the role of fertilisation in sexual reproduction. (4 marks)

Description	Marks
Explains the role of fertilisation in sexual reproduction (any **four** of):	
• fusion of gametes • combines genetic material from two different parents/male and female parents/egg and sperm • meiosis produces haploid gametes or gametes with only one copy of each chromosome type • restores diploid number of chromosomes **or** ensures individuals have two copies of each chromosome type • create genetic variation/differences	1–4
Total	**4**

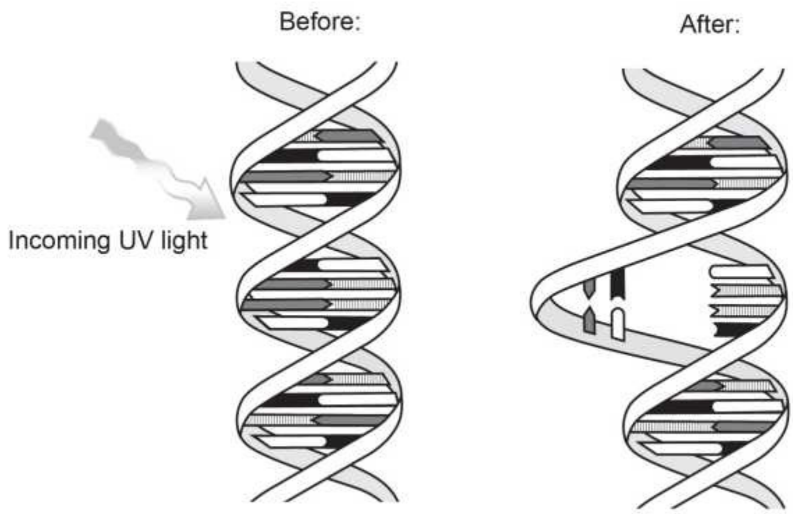
(c) (i) Outline how crossing over creates genotypic variation. (2 marks)

Description	Marks
Outlines how crossing over creates genotypic variation (any **two** of):	
• (crossing over) exchanges alleles between homologous chromosomes/pairs of chromosomes • chromosomes therefore have a different/new/unique combination of alleles (compared to those in the parent they were inherited from) • the different/new/unique combination of alleles creates different/new/novel genotypes	1–2
Total	**2**

(ii) Outline how independent assortment creates genotypic variation. (2 marks)

Description	Marks
Outlines how independent assortment creates genotypic variation (any **two** of):	
• homologous chromosomes/chromosome pair separate independently of each (during meiosis I) • form random combinations of chromosomes **or** a (unique) mix of maternal and paternal chromosomes in a gamete • novel combinations of chromosomes creates different/new/novel genotypes	1–2
Total	**2**

The following diagram shows the structure of a DNA molecule before and after exposure to ultraviolet (UV) light.



(d) Describe the effect that UV light has on DNA structure. (4 marks)

Description	Marks
Describes the effect that ultraviolet light has on DNA structure (any **four** of):	
• ultraviolet/UV light is a physical mutagen or the photons in ultraviolet/UV light can damage DNA • interferes with base pairing • breaks the hydrogen bonds between bases (on complementary/ different DNA strands) • free bases pair with neighbouring bases on the same strand **or** form dimers **or** the free bases are facing each other (as shown in the diagram) • usually thymine/T or cytosine/C or pyrimidines (that form dimers)	1–4
Total	**4**
Note to markers: the diagram is a guide only, additional correct information is acceptable.	

(e) Explain why mutation is the ultimate source of genetic variation. (4 marks)

Description	Marks
Explains why mutation is the ultimate source of genetic variation:	
• mutation changes DNA sequence/structure **or** chromosome structure/number **or** permanent change in DNA • this creates new genetic/DNA variation/polymorphism **or** new alleles • only process that creates new/unique alleles • new/different alleles (which come from mutation) are needed to create novel combinations of alleles/genotypes/individuals	1–4
Total	**4**

Unit 3 – Continuity of life on Earth

Section 1

2023 Section 1 Question 5 **Continuity of life on Earth**	The earliest fossils are of (a) protists from 3.5 million years ago. (b) protists from 3.5 billion years ago. (c) prokaryotes from 3.5 million years ago. (d) prokaryotes from 3.5 billion years ago.

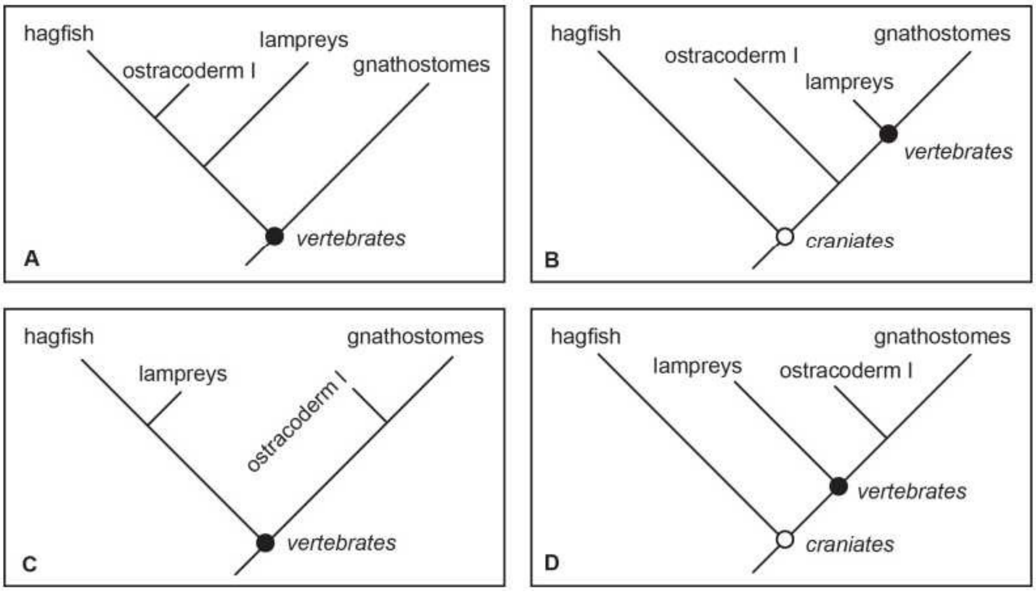
2023 Section 1 Question 8 **Continuity of life on Earth**	Which of the following reduces genetic differences between populations? (a) genetic drift (b) gene flow (c) speciation (d) mutation

2023 Section 1 Question 16 **Continuity of life on Earth**	The evolution of land plants from freshwater algae is an example of (a) macroevolution. (b) microevolution. (c) artificial selection. (d) natural selection.

2023 Section 1 Question 19 **Continuity of life on Earth**	Cabbage, cauliflower, broccoli and kale are some of the oldest known vegetables. They descended from the wild mustard plant Brassica oleracea, which humans began planting thousands of years ago. These vegetables were developed by (a) natural selection. (b) artificial selection. (c) transgenesis. (d) mutagenesis.

2023 Section 1 Question 26 **Continuity of life on Earth**	A volcanic explosion randomly kills 90% of the individuals in a lizard population. The allele frequencies in the surviving lizards were different from those in the population before the explosion. This is an example of (a) natural selection. (b) gene flow. (c) genetic drift. (d) founder effect.

2022 Section 1 Question 4 **Continuity of life on Earth**	Female lions prefer to mate with male lions with dark manes rather than those with light manes. Males with dark manes are more likely to suffer heat stress in hot weather than males with light manes. This suggests that dark manes evolved via (a) sexual selection by male competition. (b) sexual selection by female choice. (c) natural selection for mate attraction. (d) natural selection for thermoregulation.

2022 Section 1 Question 18 Continuity of life on Earth	The phylogenetic trees in the diagrams below show four different hypotheses about the early evolution of vertebrates. Use the information in this figure to answer Questions 18 and 19.  18. There is debate about the relationship between hagfish and lampreys. The so-called cyclostome hypothesis suggests that these two taxa are each other's closest relatives. Which phylogenetic tree displays the cyclostome hypothesis? (a) A (b) B (c) C (d) D 19. The information shown in the phylogenetic trees indicates that there is also debate about whether (a) hagfish are vertebrates. (b) gnathostomes are vertebrates. (c) lampreys are craniates. (d) ostracoderm I are craniates.

2022 Section 1 Question 20 Continuity of life on Earth	Biologists have determined that ostracoderms became extinct about 420 million years ago. What type of evidence would they have used to support this conclusion? (a) bioinformatic (b) fossil (c) comparative anatomy (d) comparative embryology

2022 Section 1 Question 23 Continuity of life on Earth	The enzyme tyrosinase determines the amount of melanin pigment in the fur of mice. Some individuals are unable to produce tyrosine due to a mutation. In other individuals, tyrosinase activity varies with temperature and is usually absent at temperatures above 25 °C. The amount of melanin in the fur of mice is an example of (a) an environmentally-determined trait. (b) a genetically-determined trait. (c) a genotype determined by a gene-environment interaction. (d) a phenotype determined by a gene-environment interaction.

2022 Section 1 Question 24 **Continuity of life on Earth**	The application of computers and statistics to manage and interpret large biological data sets is called (a) bioinformatics. (b) biochemistry. (c) biotechnology. (d) comparative genomics.

2022 Section 1 Question 30 **Continuity of life on Earth**	Orchids grown in the laboratory were released into a wild population of the same species. The laboratory-grown orchids contained an allele that was not present in the wild population at the time of release. After the laboratory-grown orchids bred with the wild orchids, the allele became incorporated into the wild population. The incorporation of the allele from laboratory-grown orchids into the wild population is an example of (a) gene flow. (b) genetic drift. (c) artificial selection. (d) natural selection.

2021 Section 1 Question 1 **Continuity of life on Earth**	Which of the following organisms would be least likely to be found in fossil form? (a) frog (b) jellyfish (c) beetle (d) pine tree

2021 Section 1 Question 11 **Continuity of life on Earth**	The fossil record shows that the first reptiles evolved 305 million years ago. On this basis the first fish would have evolved (a) later than 305 million years ago. (b) about 305 million years ago. (c) earlier than 305 million years ago. (d) about 3.5 billion years ago.

2021 Section 1 Question 15 **Continuity of life on Earth**	A biologist studying what were believed to be two species of frog concluded that there was, in fact, just one species. Which of the following findings provides the strongest evidence that the frogs were of the same species? (a) they interbreed in nature and produce fertile offspring (b) they live in the same habitat and have the same diet (c) they change their appearance according to environmental factors (d) they have many genes and alleles in common

2021 Section 1 Question 20 **Continuity of life on Earth**	Homologous structures are structures that are similar in related organisms because they were inherited from a common ancestor. An example of homologous structures is the (a) wings of birds and bats. (b) eyes of lizards and flies. (c) cell walls of bacteria and fungi. (d) fins of fish and squid.

2021 Section 1 Question 30 **Continuity of life on Earth**	There have been five mass extinctions during the history of life on Earth, when many species went extinct over a short period of geological time. After each one, biodiversity recovered and increased beyond what it was before the mass extinction. What was the ultimate source of the genetic variation that supported the recovery of biodiversity after each mass extinction? (a) mutation (b) macroevolution (c) allopatric speciation (d) natural selection

2020 Section 1 Question 3

Continuity of life on Earth

A biologist kept four beetle populations in a laboratory. The number of beetles in each population is shown in the table below. The populations were identical except for the number of beetles.

Population	Number of beetles
A	54
B	84
C	72
D	36

The effects of genetic drift will be greatest in population

(a) A.
(b) B.
(c) C.
(d) D.

2020 Section 1 Question 5 **Continuity of life on Earth**	Fur colour in rabbits is determined by four alleles of the C gene. Himalayan rabbits are homozygous for the ch allele at this gene. This allele produces an enzyme that results in black fur. However, this enzyme is inactivated if the skin temperature exceeds 20 °C, resulting in white fur. Fur colour in Himalayan rabbits is an example of (a) a polygenic trait. (b) a recessive mutation. (c) an interaction between two genes. (d) a gene-environment interaction.

2020 Section 1 Question 9 **Continuity of life on Earth**	A biologist observed small changes in the allele frequencies of a gene in a population of paper daisies for three generations. These changes are an example of (a) microevolution. (b) macroevolution. (c) stasis. (d) speciation.

2020 Section 1 Question 22 **Continuity of life on Earth**	During mating, many male redback spiders position themselves above the jaws of the female even though they are more likely to be eaten than males in other positions. These males are, however, able to copulate for longer and fertilise more eggs. On this basis, male positioning above the jaws of the female likely evolved by (a) natural selection. (b) sexual selection. (c) artificial selection. (d) directional selection.

2020 Section 1 Question 24 **Continuity of life on Earth**	Which of the following combination of factors makes a population most vulnerable to extinction? (a) low levels of inbreeding and a changing environment (b) low levels of inbreeding and a stable environment (c) low levels of genetic diversity and a changing environment (d) low levels of genetic diversity and a stable environment

2019 Section 1 Question 6 **Continuity of life on Earth**	Select the correct statement. (a) Natural selection can result in the evolution of new species but artificial selection cannot. (b) Artificial selection can result in the evolution of new species but natural selection cannot. (c) Both natural and artificial selection can result in the evolution of new species. (d) Neither natural nor artificial selection can result in the evolution of new species.

2019 Section 1 Question 24 **Continuity of life on Earth**	Which of the following is evidence for the process of evolution? (a) the fossil record has many gaps (b) the Earth is about 4.5 billion years old (c) all species share a genetic code (d) interspecific hybrids are usually sterile

2019 Section 1 Question 26 **Continuity of life on Earth**	26. Genetic differences between populations are reduced by (a) gene flow. (b) mutation. (c) sexual selection. (d) genetic drift.

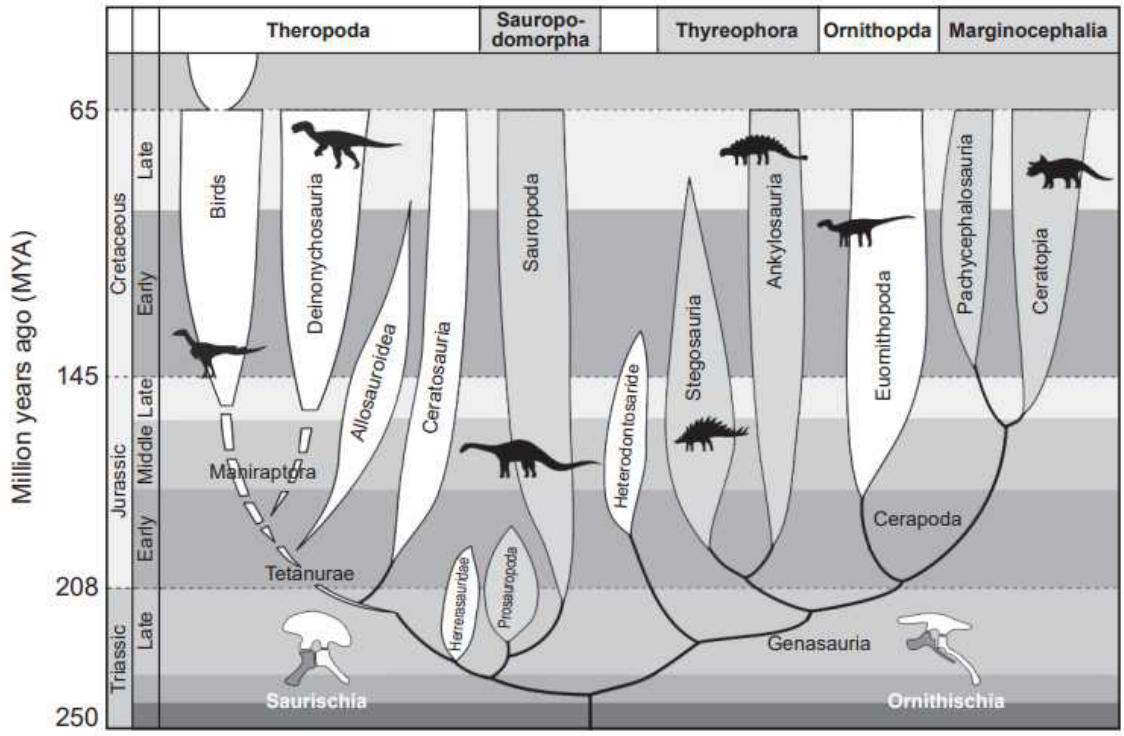
2019 Section 1 Question 28 **Continuity of life on Earth**	A population of humpback whales was hunted almost to extinction before hunting was stopped. Since then, the population has been increasing. The genetic diversity of the population will (a) not have been affected by the changes in population size. (b) not recover as quickly as the population size. (c) have returned to pre-hunting levels as soon as the hunting stopped. (d) be decreasing as the population size increases.

Section 2

2023 Section 2 Question 35

Continuity of life on Earth

The following diagram shows a phylogenetic tree of dinosaurs.



(a) Use the information in the phylogenetic tree to answer the following questions.

(i) Identify the lineages that make up the Marginocephalia. (1 mark)

____

____

(ii) Identify the lineage that is most closely related to the Stegosauria. (1 mark)

____

____

(iii) State when the Jurassic period started and finished. (1 mark)

____

____

(iv) State when the Sauropoda became extinct. (1 mark)

____

____

(b) Outline what the phylogenetic tree suggests about the evolution of birds. (2 marks)

Dinosaurs and birds were traditionally classified in separate groups.

(c) State whether the phylogenetic tree on page 22 supports this view. Give a reason for your answer. (2 marks)

(d) (i) Outline why vertebrates are relatively common in the fossil record. (2 marks)

(ii) Outline why burrowing organisms are relatively common in the fossil record. (2 marks)

(e) Explain how comparative embryology provides evidence for evolution. Include a specific example in your answer. (4 marks)

(f) (i) Outline why geographic isolation is important in allopatric speciation. (2 marks)

(ii) Outline why natural selection is important in allopatric speciation. (2 marks)

2022 Section 2 Question 33

Continuity of life on Earth

Biologists studied the gene pool of two populations of a mosquito species. The biologists estimated the frequency of a particular allele (*Ace*^{R}) at the acetylcholinesterase gene in the two populations over nine generations. The allele frequency data are given in the table below.

	Generation number								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Population 1	0.31	0.29	0.30	0.33	0.28	0.33	0.27	0.31	0.30
Population 2	0.27	0.31	0.35	0.37	0.41	0.49	0.53	0.58	0.60

(a) Graph the frequency of the *Ace*^{R} allele for both Populations 1 and 2 against generation number. (6 marks)

(b) (i) Define the term ‘gene pool’. (1 mark)

(ii) Define the term ‘allele’. (1 mark)

(iii) State whether the allele frequency changes in the mosquito populations are an example of macroevolution. Provide a reason to support your answer. (3 marks)

An insecticide was applied to Population 2 but not to Population 1.

(c) Propose an explanation for the increase in the frequency of the AceR allele in Population 2 during the study. (5 marks)

(d) The Australian Government's biosecurity agency deploys insect traps around airports and other ports of entry into Australia. Explain why. (4 marks)

2022 Section 2 Question 34 **Continuity of life on Earth**	Fleece colour in sheep is determined by the alleles at an autosomal gene, where a dominant allele (T) gives white fleece, and a recessive allele (t) gives black fleece. (a) (i) Distinguish between a dominant and a recessive allele. (2 marks) (ii) Distinguish between autosomal and sex-linked alleles. (2 marks) Two white sheep are mated. They produce offspring with white fleece and with black fleece. (b) Calculate the probability of these sheep producing an offspring with black fleece. Explain your answer. (5 marks)

(c) Spider lamb syndrome (SLS) is an inherited condition in sheep. Affected animals have abnormal spines and long, often splayed (spread out) legs. SLS is caused by a recessive SLS allele at an autosomal gene. Outline an approach that can be used to determine whether an unaffected individual has the SLS allele without breeding the sheep.(5 marks)

(d) Body size in sheep is a polygenic trait. Explain what a polygenic trait is. (3 marks)

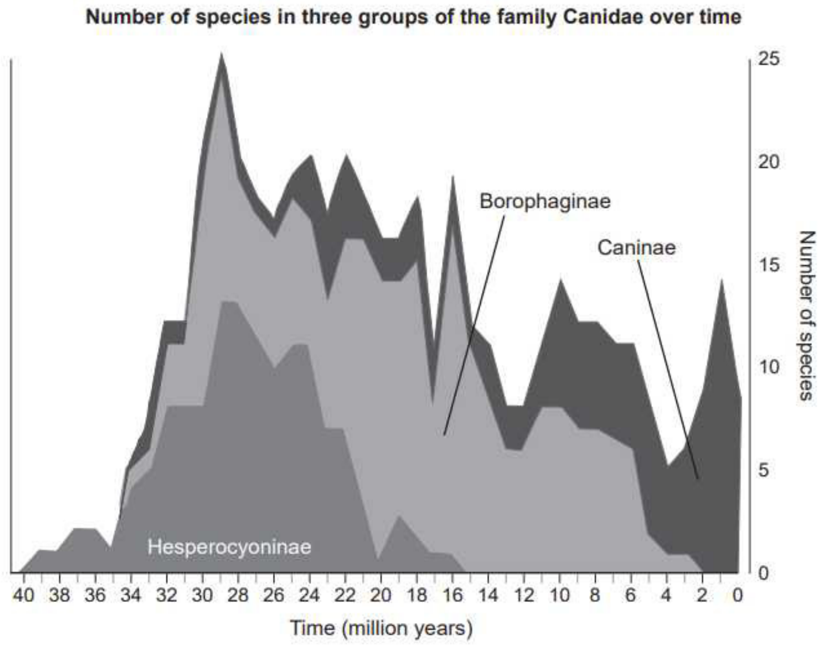
(e) A group of biologists want to produce a line of sheep with increased resistance to fleece rot. They could do this either by artificial selection or by transgenesis. Outline one advantage and one disadvantage of producing this line of sheep by artificial selection rather than transgenesis. (4 marks)

Advantage:

Disadvantage:

2021 Section 2 Question 31 **Continuity of life on Earth**	(a) Microevolution occurs through changes in the allele frequencies in a population. Name the four factors (microevolutionary forces) that can change allele frequencies. (4 marks) One: ______ Two: ______ Three: ______ Four: ______ (b) The World Canine Association recognises 360 breeds of domestic dog, ranging in size from Chihuahuas to Great Danes. They all belong to one species, Canis familiaris. They were first domesticated about 14 000 to 17 000 years ago but most breeds have been developed in the last several hundred years. Explain how such a range of variation has arisen within domestic dogs. (5 marks)

(c) The figure below shows the number of species for three groups of dog-like animals within the family Canidae over evolutionary time.



According to the figure:
(i) When did the Hesperocyoninae become extinct? (1 mark)

(ii) Which of the three groups evolved first? (1 mark)

(iii) Which group has persisted for the longest period of time? (1 mark)

(iv) When did most species across all three groups of the family Canidae occur? (1 mark)

	(d) Explain the type of evidence biologists would have used to determine the number of species for the three groups of the family Canidae over evolutionary time. (4 marks) (e) The red wolf is the most endangered canid species on Earth. Fewer than 200 individuals remain in the wild. Explain one reason why small populations are at risk of extinction. (4 marks)

2021 Section 2 Question 35 **Continuity of life on Earth**	Botanic gardens, such as those in Sydney, and in Kings Park, Perth, house large collections of plants and seeds. These gardens play an important role in plant conservation and research and in educating the general public. (a) Some botanic gardens supply information to the general public about how to detect certain diseases in their garden plants. Provide advice to someone seeking information about how to detect crown gall disease in their garden plants. (3 marks)

(b) Other than providing education or advice, outline two ways in which botanic gardens can contribute to plant conservation. (4 marks)

One: ____

____

____

____

Two: ____

____

____

____

Biologists at botanic gardens often investigate the evolutionary relationships among plant groups.

The table below shows the presence or absence of four characters in four types of plant.

	Plant type			
Character	**Angiosperms**	**Ferns**	**Mosses**	**Conifers**
Cuticle	✓	✓	✓	✓
Xylem and phloem	✓	✓	X	✓
Seeds	✓	X	X	✓
Flowers	✓	X	X	X

X – character is absent. ✓– character is present.

(c) Draw a phylogenetic tree showing the evolutionary relationships among the four types of plant based on the characters in the table. Show the point on the tree where seeds evolved. (5 marks)

Developments in DNA sequencing technology are allowing biologists to use comparative genomics to develop an in-depth understanding of plant evolution.

(d) Explain comparative genomics and how it can lead to an in-depth understanding of plant evolution. (4 marks)

(e) Explain bioinformatics and why it is important to the field of comparative genomics. (4 marks)

2020 Section 2 Question 33 **Continuity of life on Earth**	The *malleefowl* (Leipoa ocellata) is a ground-dwelling bird that is found in scrubland in southern Australia. It is vulnerable to extinction. (a) The following terms are relevant to developing conservation plans for the malleefowl. Define each term. (i) Gene pool (1 mark) (ii) Population dynamics (1 mark) (iii) Biogeography (1 mark) (iv) Reproductive behaviour (1 mark) (b) To investigate genetic diversity, biologists produced DNA profiles for malleefowl. List the main steps involved in producing a DNA profile. (4 marks)

(c) Biologists are breeding malleefowl in captivity to assist in the recovery of wild populations. Describe two ways in which captive breeding can assist in the recovery of wild populations. (4 marks)

One:

Two:

(d) Explain how a consideration of population dynamics can assist conservation planning to maintain viable gene pools in a vulnerable species, such as the malleefowl. (4 marks)

(e) Habitat destruction has reduced the opportunity for gene flow between malleefowl populations. Explain how gene flow affects the gene pool of a population. (4 marks)

2020 Section 2 Question 35 **Continuity of life on Earth**	*Glossopteris* is a genus of flowerless seed ferns, common 250 million years ago, it is now extinct. Many species of *Glossopteris* have been identified from leaf fossils. (a) (i) Define the term ‘fossil’. (1 mark) (ii) Outline how fossils can provide evidence for evolution. (3 marks) It has not been possible to determine the total number of *Glossopteris* species because the fossil record is incomplete. (b) List **four** reasons why the fossil record is incomplete. (4 marks) One: Two: Three: Four: (c) (i) Approximately when did life first evolve on Earth? (1 mark)

(ii) Describe the first life forms on Earth. (3 marks)

The table below shows the number of amino acid differences in a protein molecule in five different types of monkey.

	Saki	Macaque	Colobus	Squirrel	Woolly
Saki					
Macaque	6				
Colobus	8	2			
Squirrel	4	7	9		
Woolly	1	8	8	4	

(d) Use these data to describe the evolutionary relationships of these monkeys. (4 marks)

	(e) Explain how differences in the amino acid sequence of a protein can provide evidence of evolutionary relationships between organisms. (4 marks)

2019 Section 2 Question 31 **Continuity of life on Earth**	Dung beetles are a type of insect and feed on animal faeces. A recent survey identified over 500 species of dung beetle that are native to Australia. (a) Define a species. (2 marks) (b) Explain how new species of dung beetle could evolve by allopatric speciation. (5 marks)

Most dung beetle populations are small and experience genetic drift.

(c) Describe how genetic drift affects the genetic composition of populations. (3 marks)

One species of dung beetle has males with larger horns than the females. The larger horns make movement and eating more difficult.

(d) Explain how the larger horns in the males of this species could have evolved. (5 marks)

A biologist constructed a phylogenetic tree showing the evolutionary relationships among the Australian species of dung beetle.

(e) Explain how a phylogenetic tree can represent the evolutionary relationships among different species. (4 marks)

Marking Guide – Section 1

2023 Section 1 Question 5 **Continuity of life on Earth**	The earliest fossils are of (a) protists from 3.5 million years ago. (b) protists from 3.5 billion years ago. (c) prokaryotes from 3.5 million years ago. **(d) prokaryotes from 3.5 billion years ago. – Answer**

2023 Section 1 Question 8 **Continuity of life on Earth**	Which of the following reduces genetic differences between populations? (a) genetic drift **(b) gene flow – Answer** (c) speciation (d) mutation

2023 Section 1 Question 16 **Continuity of life on Earth**	The evolution of land plants from freshwater algae is an example of **(a) macroevolution. – Answer** (b) microevolution. (c) artificial selection. (d) natural selection.

2023 Section 1 Question 19 **Continuity of life on Earth**	Cabbage, cauliflower, broccoli and kale are some of the oldest known vegetables. They descended from the wild mustard plant Brassica oleracea, which humans began planting thousands of years ago. These vegetables were developed by (a) natural selection. **(b) artificial selection. – Answer** (c) transgenesis. (d) mutagenesis.

2023 Section 1 Question 26 **Continuity of life on Earth**	A volcanic explosion randomly kills 90% of the individuals in a lizard population. The allele frequencies in the surviving lizards were different from those in the population before the explosion. This is an example of (a) natural selection. (b) gene flow. **(c) genetic drift. – Answer** (d) founder effect.

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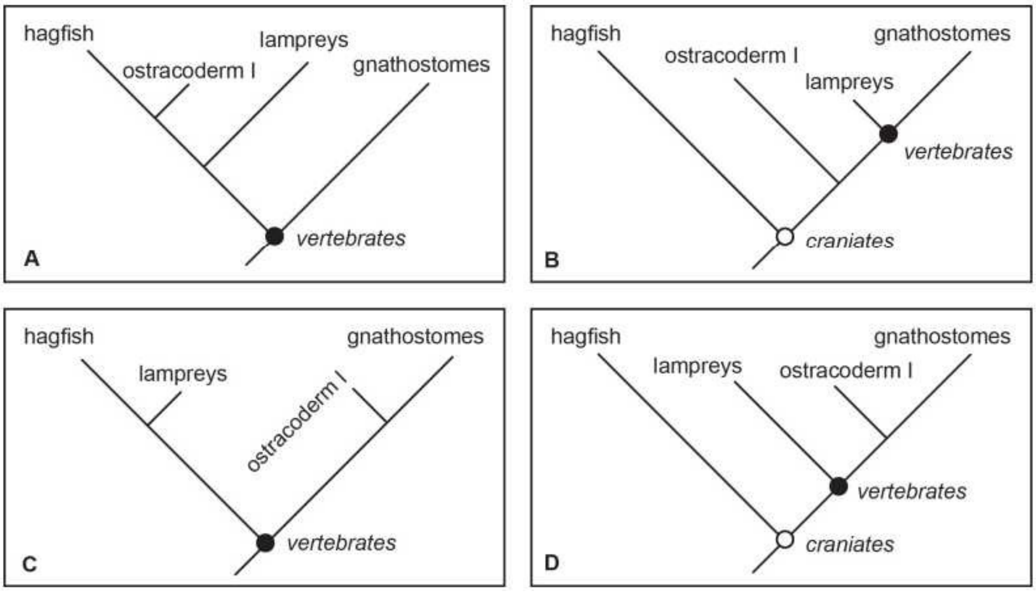
2022 Section 1 Question 18 **Continuity of life on Earth**	The phylogenetic trees in the diagrams below show four different hypotheses about the early evolution of vertebrates. Use the information in this figure to answer Questions 18 and 19.  18. There is debate about the relationship between hagfish and lampreys. The so-called cyclostome hypothesis suggests that these two taxa are each other's closest relatives. Which phylogenetic tree displays the cyclostome hypothesis? (a) A (b) B **(c) C – Answer** (d) D 19. The information shown in the phylogenetic trees indicates that there is also debate about whether **(a) hagfish are vertebrates. – Answer** (b) gnathostomes are vertebrates. (c) lampreys are craniates. (d) ostracoderm I are craniates.

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2020 Section 1 Question 3

Continuity of life on Earth

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B	84
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D	36

The effects of genetic drift will be greatest in population

(a) A.
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(c) C.
(d) D. – Answer

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2019 Section 1 Question 6 **Continuity of life on Earth**	Select the correct statement. (a) Natural selection can result in the evolution of new species but artificial selection cannot. (b) Artificial selection can result in the evolution of new species but natural selection cannot. **(c) Both natural and artificial selection can result in the evolution of new species. – Answer** (d) Neither natural nor artificial selection can result in the evolution of new species.

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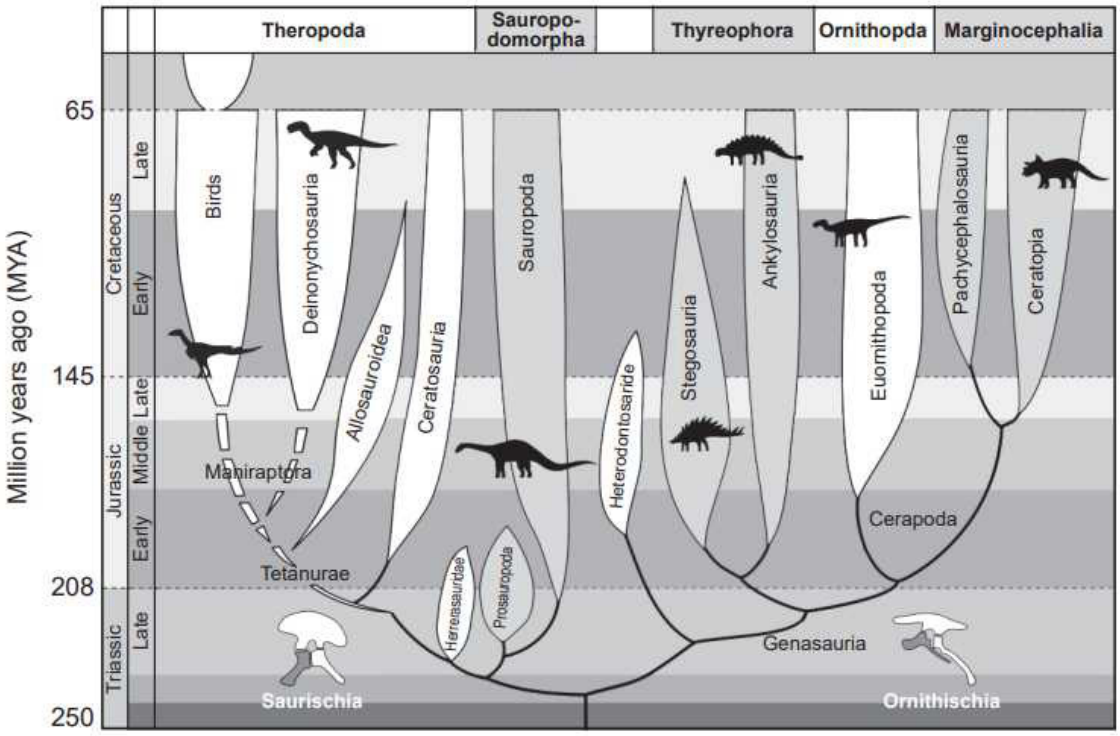
2023 Section 2 Question 35

Continuity of life on Earth

The following diagram shows a phylogenetic tree of dinosaurs.



(a) Use the information in the phylogenetic tree to answer the following questions.

(i) Identify the lineages that make up the Marginocephalia. (1 mark)

Description	Marks
Pachycephalosauria and Ceratopia	1
Total	**1**

(ii) Identify the lineage that is most closely related to the Stegosauria. (1 mark)

Description	Marks
Ankylosauria	1
Total	**1**

(iii) State when the Jurassic period started and finished. (1 mark)

Description	Marks
208 to 145 million years ago/MYA (must have units)	1
Total	**1**

(iv) State when the Sauropoda became extinct. (1 mark)

Description	Marks
65 million years ago/MYA or end of Cretaceous	1
Total	**1**

(b) Outline what the phylogenetic tree suggests about the evolution of birds. (2 marks)

Description	Marks
Either • evolved from a type of theropod dinosaur • during the late Jurassic period or about 150 million years ago or • evolve from Maniraptora/shares a common ancestor with Deinonychosauria • during the Early Jurassic period or 175 million years ago	1–2
Total	**2**

Dinosaurs and birds were traditionally classified in separate groups.

(c) State whether the phylogenetic tree on page 22 supports this view. Give a reason for your answer. (2 marks)

Description	Marks
no	1
tree suggests that birds are a type of dinosaur, not separate or tree includes the birds with the dinosaurs	1
Total	**2**

(d) (i) Outline why vertebrates are relatively common in the fossil record. (2 marks)

Description	Marks
Either • vertebrates have hard parts/bones • these are hard to destroy or are likely to persist long enough to fossilise or • vertebrates evolved recently • less time for fossils to be destroyed	1–2
Total	**2**
Accept other relevant answers.	

(ii) Outline why burrowing organisms are relatively common in the fossil record. (2 marks)

Description	Marks
Either • burrowing organisms live in sediment or are more likely to be buried in sediment • burial in sediment reduces the chances of predators/scavengers destroying the remains or • burrowing organisms live in low oxygen environment • slows down decay by bacteria	1–2
Total	**2**
Accept other relevant answers.	

(e) Explain how comparative embryology provides evidence for evolution. Include a specific example in your answer. (4 marks)

Description	Marks
embryos of different organisms may be similar or show similarities	1
even though the adults may be different or not show the similarities	1
similarities are evidence that the different organisms evolved from a common ancestor or are closely related or converse	1
embryos of all vertebrates have gill slits or embryos have a similar sequence of development or other relevant example	1
Total	**4**

(f) (i) Outline why geographic isolation is important in allopatric speciation. (2 marks)

Description	Marks
prevents gene flow/gene exchange between populations	1
so genetic differences can build over time	1
Total	**2**

(ii) Outline why natural selection is important in allopatric speciation. (2 marks)

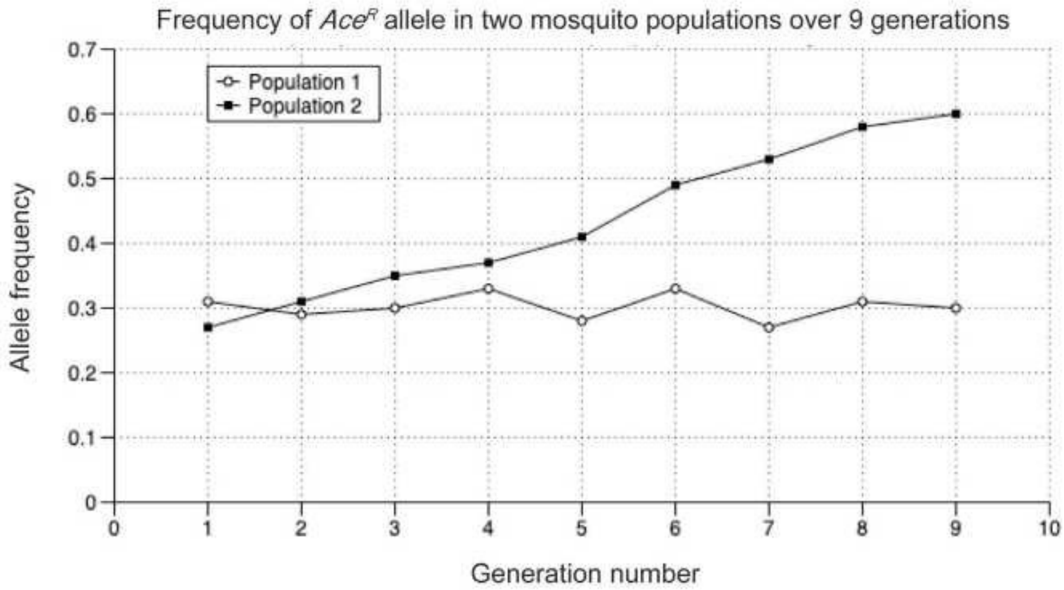
Description	Marks
speciation depends on populations evolving genetic differences/reproductive isolation	1
differing selection pressures can cause the evolution of genetic differences/reproductive isolation	1
Total	**2**

2022 Section 2 Question 33 **Continuity of life on Earth**	Biologists studied the gene pool of two populations of a mosquito species. The biologists estimated the frequency of a particular allele (*Ace^R*) at the acetylcholinesterase gene in the two populations over nine generations. The allele frequency data are given in the table below.

	Generation number								
	1	2	3	4	5	6	7	8	9
Population 1	0.31	0.29	0.30	0.33	0.28	0.33	0.27	0.31	0.30
Population 2	0.27	0.31	0.35	0.37	0.41	0.49	0.53	0.58	0.60

(a) Graph the frequency of the *Ace^R* allele for both Populations 1 and 2 against generation number. (6 marks)

Description	Marks
title must include both variables	1
data plotted separately for populations 1 and 2 including key	1
correct axes (X and Y)	1
appropriate scale	1
labelling – accurate labelling on both axes	1
plotting – data plotted accurately and joined (line graph)	1
Total	**6**



(b) (i) Define the term 'gene pool'. (1 mark)

Description	Marks
all of the genetic information/genes/alleles in a population/species	1
Total	**1**

(ii) Define the term 'allele'. (1 mark)

Description	Marks
a form/version of a gene	1
Total	**1**

(iii) State whether the allele frequency changes in the mosquito populations are an example of macroevolution. Provide a reason to support your answer. (3 marks)

Description	Marks
Clearly states no.	1
Macroevolution refers to large scale changes or changes above the species level.	1
The changes (in the mosquito populations) are small scale or occurring below the species level or the (mosquito) populations are undergoing microevolution (not macroevolution).	1
Total	**3**

An insecticide was applied to Population 2 but not to Population 1.

(c) Propose an explanation for the increase in the frequency of the AceR allele in Population 2 during the study. (5 marks)

Description	Marks
Natural selection/selective pressure of insecticide	1
Subtotal	**1**
Any four of	
Either • the *Ace*^{R} allele gives resistance to the insecticide • individuals with *Ace*^{R} allele survive/reproduce/are fitter/produce more offspring • the *Ace*^{R} allele is passed to offspring/inherited • more individuals in the next generation have *Ace*^{R} allele • process is repeated over multiple/10 generations leading to progressive increase in frequency of the *Ace*^{R} allele or • progressive increase in frequency of the *Ace*^{R} allele, which is characteristics of natural selection • unlikely to be due to genetic drift because the frequency of the *Ace*^{R} allele does not change at random • unlikely to be to due mutation because the frequency *Ace*^{R} allele does not change at random • because the allele frequency change is too fast/large to be explained by mutation (which changes allele frequencies slowly) • could only be gene flow if individuals were coming from a population with a high frequency *Ace*^{R} allele	1–4
Subtotal	**4**
Total	**5**

(d) The Australian Government's biosecurity agency deploys insect traps around airports and other ports of entry into Australia. Explain why. (4 marks)

Description	Marks
To detect/capture exotic/non-native insects or mosquitos.	1
Subtotal	**1**
Any three of	
• before they have a chance to spread/become established (in Australia) • (if not stopped) insects/mosquitoes could introduce new disease or contribute to the spread of existing diseases • could damage crops or some insects are crop pests • could displace native species or disrupt natural ecosystems or become an invasive species	1–3
Subtotal	**3**
Total	**4**

2022 Section 2 Question 34

Continuity of life on Earth

Fleece colour in sheep is determined by the alleles at an autosomal gene, where a dominant allele (T) gives white fleece, and a recessive allele (t) gives black fleece.

(a) (i) Distinguish between a dominant and a recessive allele. (2 marks)

Description	Marks
dominant – only one copy of allele is needed for an individual to show phenotype or heterozygote will show phenotype	1
recessive – two copies of allele are needed for an individual to show phenotype or only recessive homozygote will show phenotype or can be masked by a dominant allele	1
Total	**2**

(ii) Distinguish between autosomal and sex-linked alleles. (2 marks)

Description	Marks
autosomal – alleles are on autosomal chromosomes or alleles are not on sex chromosomes or two alleles are present in both males and females	1
sex linked – alleles are on sex chromosomes or X/Y chromosome or two alleles are present in females and only one is present in males	1
Total	**2**

Two white sheep are mated. They produce offspring with white fleece and with black fleece.

(b) Calculate the probability of these sheep producing an offspring with black fleece. Explain your answer. (5 marks)

Description	Marks
0.25/25%/1 in 4	1
Both parents must be heterozygotes or *Tt* (to produce black sheep) or both will produce gametes with *T* and with *t* allele (in equal proportions)	1
Must use specified notation for alleles (T,t).	1
Black offspring must have *tt* genotype (because black fleece is recessive).	1
Only one in four offspring will have *tt* genotype or three in four offspring will have one copy of *T*/dominant allele.	1
Total	**5**
Can use a fully annotated punnett square.	

(c) Spider lamb syndrome (SLS) is an inherited condition in sheep. Affected animals have abnormal spines and long, often splayed (spread out) legs. SLS is caused by a recessive SLS allele at an autosomal gene. Outline an approach that can be used to determine whether an unaffected individual has the SLS allele without breeding the sheep.(5 marks)

Description	Marks
DNA sequencing or (comparative) genomics	1
determine nucleotide sequence	1
compare genomes/DNA sequences of affected and unaffected sheep	1
Subtotal	**3**
Any two of	
• take samples from affected and unaffected sheep • extract DNA • use PCR/restriction enzymes/gel electrophoresis	1–2
Subtotal	**2**
Total	**5**

(d) Body size in sheep is a polygenic trait. Explain what a polygenic trait is. (3 marks)

Description	Marks
controlled/influenced by the alleles at many genes/by many genes	1
also influenced by the environment	1
trait shows many different phenotypes in a population or trait shows continuous variation/a normal distribution in a population	1
Total	**3**

(e) A group of biologists want to produce a line of sheep with increased resistance to fleece rot. They could do this either by artificial selection or by transgenesis. Outline one advantage and one disadvantage of producing this line of sheep by artificial selection rather than transgenesis. (4 marks)

Description	Marks
Advantage	
• (breeding sheep is a) natural process • can be done on farm/does not require specialist equipment/less controversial	1–2
Subtotal	**2**
Disadvantage	
Either • artificial selection changes allele/gene frequencies gradually • slower process or will take many generations to produce desired line or • artificial selection relies on alleles/genes/variation already present in sheep • less effective than using a (targeted) gene from another type of organism.	1–2
Subtotal	**2**
Total	**4**

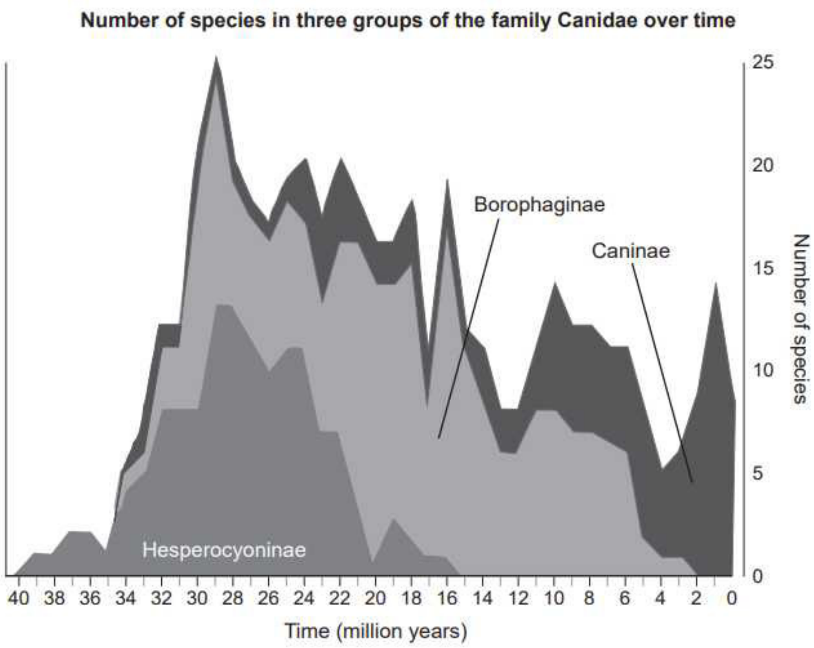
2021 Section 2 Question 31 **Continuity of life on Earth**	(a) Microevolution occurs through changes in the allele frequencies in a population. Name the four factors (microevolutionary forces) that can change allele frequencies. (4 marks)

Description	Marks
(natural, sexual or artificial) selection	1
genetic drift	1
gene flow	1
mutation	1
Total	**4**

(b) The World Canine Association recognises 360 breeds of domestic dog, ranging in size from Chihuahuas to Great Danes. They all belong to one species, Canis familiaris. They were first domesticated about 14 000 to 17 000 years ago but most breeds have been developed in the last several hundred years. Explain how such a range of variation has arisen within domestic dogs. (5 marks)

Description	Marks
artificial selection or selective breeding by humans	1
(ancestral) dogs with a desirable trait/s were selectively breed or only dogs with desirable trait/s were allowed breed/pass on genes	1
this process was repeated over many generations	1
this resulted in a group/breed of dogs showing the desired trait/s or only having genes/alleles for the desired trait/s	1
this happened independently for different traits resulting in breeds with different traits **or** cumulative effect of breeding different variants/traits in different lines **or** dogs were bred for different purposes	1
Total	**5**

(c) The figure below shows the number of species for three groups of dog-like animals within the family Canidae over evolutionary time.



According to the figure:
(i) When did the Hesperocyoninae become extinct? (1 mark)

Description	Marks
Accept anywhere between 15 and 16 million years	1
Total	**1**

(ii) Which of the three groups evolved first? (1 mark)

Description	Marks
Hesperocyoninae	1
Total	**1**

(iii) Which group has persisted for the longest period of time? (1 mark)

Description	Marks
Caninae	1
Total	**1**

(iv) When did most species across all three groups of the family Canidae occur? (1 mark)

Description	Marks
Accept anywhere between 29 and 31 million years	1
Total	**1**

(d) Explain the type of evidence biologists would have used to determine the number of species for the three groups of the family Canidae over evolutionary time. (4 marks)

Description	Marks
fossil evidence **or** preserved remains **or** preserved/fossilised hard parts	1
different species/families recognised via differences in morphology of fossils	1
count number of different species for each time period	1
use isotope data **or** index fossils **or** sediment layers to determine age	1
Total	**4**

(e) The red wolf is the most endangered canid species on Earth. Fewer than 200 individuals remain in the wild. Explain one reason why small populations are at risk of extinction. (4 marks)

Description	Marks
Either (genetic reason)	
small populations lose genetic diversity faster than large population **or** small populations have lower genetic diversity than large populations	1
due to genetic drift **or** random/chance loss of genetic variation	1
(under genetic drift) advantageous alleles can become rare/lost **or** disadvantageous alleles can become common/fixed	1
not enough variation to resist disease **or** to adapt to environment/ environmental change	1
Or (ecological reason)	
individuals may not be able to find a suitable mate because of unequal sex ratio or low population density	1
this may also change/stop important social behaviour/s	1
amount of inbreeding may increase resulting in reduced fitness/increased inbreeding depression	1
susceptible to environmental fluctuations as may lose all/most individuals in a poor year.	1
Total	**4**

2021 Section 2 Question 35 **Continuity of life on Earth**	Botanic gardens, such as those in Sydney, and in Kings Park, Perth, house large collections of plants and seeds. These gardens play an important role in plant conservation and research and in educating the general public.

(a) Some botanic gardens supply information to the general public about how to detect certain diseases in their garden plants. Provide advice to someone seeking information about how to detect crown gall disease in their garden plants. (3 marks)

Description	Marks
look for tumours/lumpy growths/galls	1
(especially) near the base of the plant **or** just above the soil **or** crown	1
(especially) on plants that are stunted/unproductive **or** on fruit trees/grapes/olives/ornamental plants (which are common hosts)	1
Total	**3**

(b) Other than providing education or advice, outline two ways in which botanic gardens can contribute to plant conservation. (4 marks)

Description	Marks
Any **two** options (2 x 2 marks):	
Option one • selective breeding/cultivate/genetically modify/seed banks endangered/vulnerable/threatened species • can release individuals to supplement/restore wild population **or** so some individuals will remain even if species goes extinct in the wild	1–2
Subtotal	**2**
Option two • keep seed banks/gene banks/genetic resources • use to replenish genetic diversity of wild populations	1–2
Subtotal	**2**
Option three • archive data on/research the biology/ecology/taxonomy/genetics of species • improve understanding of how species will respond to environmental change **or** factors that might improve species' recovery	1–2
Subtotal	**2**
Total	**4**

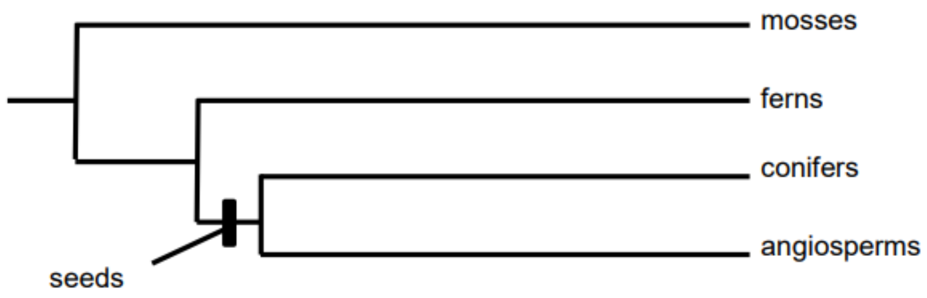
Biologists at botanic gardens often investigate the evolutionary relationships among plant groups.

The table below shows the presence or absence of four characters in four types of plant.

	Plant type			
Character	**Angiosperms**	**Ferns**	**Mosses**	**Conifers**
Cuticle	✓	✓	✓	✓
Xylem and phloem	✓	✓	X	✓
Seeds	✓	X	X	✓
Flowers	✓	X	X	X

X – character is absent. ✓– character is present.

(c) Draw a phylogenetic tree showing the evolutionary relationships among the four types of plant based on the characters in the table. Show the point on the tree where seeds evolved. (5 marks)



Description	Marks
tree shows mosses in correct position	1
tree shows ferns in correct position	1
tree shows conifers in correct position	1
tree shows angiosperms in correct position	1
tree shows evolution of seeds in correct position	1
Total	**5**

Developments in DNA sequencing technology are allowing biologists to use comparative genomics to develop an in-depth understanding of plant evolution.

(d) Explain comparative genomics and how it can lead to an in-depth understanding of plant evolution. (4 marks)

Description	Marks
comparison of the entire genomes of different species/groups	1
used to identify all similarities/differences between different species/groups	1
and genes/DNA sequences that are unique particular groups **or** that control particular traits	1
(can use the information to) deduce evolutionary relationships **or** when traits evolved **or** how traits have changed over time	1
Total	**4**

(e) Explain bioinformatics and why it is important to the field of comparative genomics. (4 marks)

Description	Marks
Bioinformatics	
Any **two** of:	
• science of analysing large/complex data sets in biology • multidisciplinary **or** applies computers/mathematics/statistics to the study of problems in (molecular) biology • involves the development of software **or** storage/analysis of biological/molecular data	1–2
Subtotal	**2**
Importance to comparative genomics	
comparative genomics produces very large data sets	1
specialised computing/analyses provided by bioinformatics is needed to store/analyse such large data sets **or** traditional methods for analysing genetic data are not capable of storing/analysing such large data sets	1
Subtotal	**2**
Total	**4**

2020 Section 2 Question 33 Continuity of life on Earth	The *malleefowl* (Leipoa ocellata) is a ground-dwelling bird that is found in scrubland in southern Australia. It is vulnerable to extinction.

(a) The following terms are relevant to developing conservation plans for the malleefowl. Define each term.

(i) Gene pool (1 mark)

Description	Marks
all of the genes/alleles/genetic diversity/genetic information in a population/species	1
Total	**1**

(ii) Population dynamics (1 mark)

Description	Marks
study of changes in population size **or** of how and why populations change size **or** of size and age composition of populations	1
Total	**1**

(iii) Biogeography (1 mark)

Description	Marks
study of the geographical distribution of organisms/species/ communities	1
Total	**1**

(iv) Reproductive behaviour (1 mark)

Description	Marks
behaviour associated with mating **or** rearing young	1
Total	**1**

(b) To investigate genetic diversity, biologists produced DNA profiles for malleefowl. List the main steps involved in producing a DNA profile. (4 marks)

Description	Marks
extract/isolate/obtain DNA (from the malleefowl)	1
(PCR) amplify DNA/make large amounts of DNA/clone DNA	1
use electrophoresis to separate DNA fragments/pieces **or** to visualise DNA	1
record DNA sequence **or** number of short tandem repeats/STRs **or** restriction enzyme fragments	1
Total	**4**

(c) Biologists are breeding malleefowl in captivity to assist in the recovery of wild populations. Describe two ways in which captive breeding can assist in the recovery of wild populations. (4 marks)

Description	Marks
• release genetically diverse individuals to • boost/maintain genetic diversity (of wild populations)	1–2
Subtotal	**2**
• release additional/large numbers of individuals to • boost population size	1–2
Subtotal	**2**
Total	**4**

(d) Explain how a consideration of population dynamics can assist conservation planning to maintain viable gene pools in a vulnerable species, such as the malleefowl. (4 marks)

Description	Marks
can identify trends in population size **or** when populations will grow/decline	1
smallest population sizes pose the most risk to gene pool **or** population will lose genetic diversity when small	1
(therefore) conservation planning should be based around smallest population size **or** should allow for times when population numbers will drop **or** should consider small sizes in the past	1
can identify and potentially correct factors that cause numbers to drop	1
Total	**4**

(e) Habitat destruction has reduced the opportunity for gene flow between malleefowl populations. Explain how gene flow affects the gene pool of a population. (4 marks)

Description	Marks
Any **four** of:	
• gene flow is the exchange of genetic material/alleles between populations • gene flow/migrants/immigrants can bring new alleles into the gene pool/population • because they come from populations with different alleles • gene flow/migrants/immigrants can change allele frequencies in the allele in the gene pool/population • because they come from populations with different allele frequencies • gene flow/migrants/immigrants reduce differences between the gene pool of the source and recipient populations	1–4
Total	**4**

2020 Section 2 Question 35 Continuity of life on Earth	*Glossopteris* is a genus of flowerless seed ferns, common 250 million years ago, it is now extinct. Many species of *Glossopteris* have been identified from leaf fossils.

(a) (i) Define the term 'fossil'. (1 mark)

Description	Marks
preserved remains/impression/traces of an old/ancient/extinct organism	1
Total	**1**

(ii) Outline how fossils can provide evidence for evolution. (3 marks)

Description	Marks
show past life/extinct organisms	1
show that life has changed over time **or** that life on earth has a long history	1
show how one type of organism/structure has transitioned to another	1
Total	**3**

It has not been possible to determine the total number of *Glossopteris* species because the fossil record is incomplete.

(b) List **four** reasons why the fossil record is incomplete. (4 marks)

Description	Marks
Any **four** of:	
• only hard parts are likely to form fossils **or** soft parts are unlikely to form fossils • only organisms that avoid decomposition/scavengers/predators form fossils **or** fossils only form in areas with no oxygen/bacteria • only organisms that are buried in sediment/mineral rich water form fossils **or** rapid burial • not all fossils have been found yet • some fossils have been destroyed (by volcanic eruptions/human activities/earthquakes)	1–4
Total	**4**

(c) (i) Approximately when did life first evolve on Earth? (1 mark)

Description	Marks
3.5 billion years ago (accept any answer between 3 and 4 billion) **or** Archaean **or** Palaeozoic	1
Total	**1**

(ii) Describe the first life forms on Earth. (3 marks)

Description	Marks
Any **three** of:	
• microbes/single cell • simple cells/prokaryotes • bacteria/bacteria-like/archaea • aquatic/anaerobes/marine	1–3
Total	**3**

The table below shows the number of amino acid differences in a protein molecule in five different types of monkey.

	Saki	Macaque	Colobus	Squirrel	Woolly
Saki					
Macaque	6				
Colobus	8	2			
Squirrel	4	7	9		
Woolly	1	8	8	4	

(d) Use these data to describe the evolutionary relationships of these monkeys. (4 marks)

Description	Marks
saki and woolly are closely related/most closely related	1
colobus and macaque are closely related/next most closely related	1
squirrel, saki and woolly form a related group **or** colobus and macaque are distantly related to others **or** form a distinctive group	1
any accurate quote of data (must give names of monkeys and number of amino acid substitutions)	1
Total	**4**

(e) Explain how differences in the amino acid sequence of a protein can provide evidence of evolutionary relationships between organisms. (4 marks)

Description	Marks
Any **four** of:	
Either • sequence of amino acids in a protein is determined by a DNA sequence • the more similar the amino acids, the more similar the DNA sequence • organisms with similar DNA/amino acid sequences are closely related • because they diverged more recently • less time to accumulate mutations/differences **or** • sequence of amino acids in a protein is determined by a DNA sequence • the more different the amino acids, the more different the DNA sequence • organisms with different DNA/amino acid sequences are not closely related • because they diverge a long time ago • more time to accumulate mutations/differences	1–4
Total	**4**

2019 Section 2 Question 31 **Continuity of life on Earth**	Dung beetles are a type of insect and feed on animal faeces. A recent survey identified over 500 species of dung beetle that are native to Australia.

(a) Define a species. (2 marks)

Description	Marks
Any **two** of:	
Mark one species definition only **Either** Defines the biological species concept • a group of organisms that interbreed • to produce fertile offspring • cannot breed with the individuals of another species **or** Defines the phenetic species concept • a group of organisms that are similar to each other • and are distinct from those in other sets • based on overall similarity (genetic morphological, ecological) **or** Defines the evolutionary species concept • a lineage of organisms that maintains its identity from other lineages • and has its own evolutionary tendencies and fate **or** Provides a taxonomic definition • taxonomic unit/category • that is below genus **or** that comprises populations • main taxonomic/working unit (in biology)	1–2
Total	**2**
Accept other valid species definition	

(b) Explain how new species of dung beetle could evolve by allopatric speciation. (5 marks)

Description	Marks
Explains the process of allopatric speciation (any **five** of):	
• a physical barrier divides population/geographical isolation • prevents gene flow (between the different populations) **or** individuals (from the different populations) from interbreeding • environment/conditions/selection pressures on either side of barrier are different • population on either side of barrier become different due to natural selection • may also become different due to mutation **or** genetic drift • differences will increase/accumulate over time • if individuals are no longer able to interbreed, new species **or** speciation	1–5
Total	**5**

Most dung beetle populations are small and experience genetic drift.

(c) Describe how genetic drift affects the genetic composition of populations. (3 marks)

Description	Marks
Describes the process of genetic drift (any **three** of):	
• changes allele frequencies • changes are random or occur by chance • (causes) loss of diversity/alleles from a population • (causes) differences between populations	1–3
Total	**3**

One species of dung beetle has males with larger horns than the females. The larger horns make movement and eating more difficult.

(d) Explain how the larger horns in the males of this species could have evolved. (5 marks)

Description	Marks
states that larger horns have evolved by sexual selection **or** due to their disadvantageous effects	1
Subtotal	**1**
Explains how larger horns evolved by sexual selection:	
• larger horns are not favoured by natural selection • females preferred the males with larger horns/males out-compete other males to mate with females • males with larger horns were more likely to mate **or** breed • therefore males with larger horns left more offspring than males with smaller horns **or** passed on allele/s for larger horns to offspring • therefore the frequency of allele/s for large horns increased over time	1–4
Total	**5**

A biologist constructed a phylogenetic tree showing the evolutionary relationships among the Australian species of dung beetle.

(e) Explain how a phylogenetic tree can represent the evolutionary relationships among different species. (4 marks)

Description	Marks
Explains how a phylogenetic tree can represent the evolutionary relationships (any **four** of):	
• branching of the tree represents the relationships • recent/descendent species are at the tips of branches • shared/common ancestors are at base/trunk of the tree • nodes/branching point represent a common ancestor • branch length represents divergence time/similarities/differences • closely related species will be grouped in same part of tree **or** unrelated species will be grouped in different parts of tree • tree constructed from DNA/morphological/biochemical data (which reflect relationships)	1–4
Total	**4**

Unit 3 - Section 3 Questions

Section 3

2023 Section 3 Question 36 **Unit 3 – Section 3**	The Montara oil spill, which occurred off the northwest coast of Western Australia in August 2009, is classed as one of the worse oil disasters in Australian waters. Oil spills are initially treated with detergents (to disperse the spill) and fire, but genetically-modified bacteria that can digest the oil are sometimes also used. (a) Describe how recombinant DNA technology is used to genetically modify bacteria to digest oil and discuss two advantages and two disadvantages of using a genetically-modified microorganism for environmental conservation. (10 marks) Gene pools are dynamic, with changes in allele frequencies being caused by several factors, including mutation and genetic drift. (b) Describe how mutation and genetic drift change the frequency of alleles in a population and explain the significance of these changes. (10 marks)

2023 Section 3 Question 37 **Unit 3 – Section 3**	The genetic code is used to convert the information in a gene into a specific protein. (a) Explain how the genetic code converts the information in a gene into a specific protein. (10 marks) The Woylie is a critically-endangered Australian mammal. Some populations are held in wildlife sanctuaries. Woylies have been translocated from the Karakamia Wildlife Sanctuary east of Perth to a sanctuary in the Northern Territory, where they have been locally extinct for 60 years.  (b) Explain how DNA profiling and a consideration of population dynamics can help to ensure that the gene pool of the woylies translocated to the sanctuary in the Northern Territory is viable. (10 marks)

2022 Section 3 Question 36 **Unit 3 – Section 3**	New species can arise via several processes, including allopatric speciation. (a) Describe how new species can arise via allopatric speciation. (10 marks) Proteins are essential to cell structure and functioning. (b) Explain how structural proteins are essential to cellular structure and how enzymes are essential for cellular functioning. Include specific examples in your answer. (10 marks)

2022 Section 3 Question 37 **Unit 3 – Section 3**	Cell reproduction is needed for growth and to replace damaged cells. It involves DNA replication followed by mitosis. (a) Describe how a DNA molecule replicates itself and the process of mitosis. (10 marks) The woolly mammoth (a large hairy mammal) was once common and widespread. Most populations became extinct about 10 000 years ago, but a small population survived on an island until about 4000 years ago. Reduced genetic diversity played a major role in the extinction of this island population. (b) Explain why genetic diversity is reduced in small populations and why populations with reduced genetic diversity face an increased risk of extinction. (10 marks)

2021 Section 3 Question 36 **Unit 3 – Section 3**	The phenotypic expression of some genes depends on interactions with the environment. (a) Outline the four main steps involved in gene expression. Explain, using examples, how the phenotypic expression of a gene can depend on interactions with the environment. (10 marks) (b) Explain sexual selection and how it is similar to, and different from, natural selection. Include a specific example of a trait that evolved by sexual selection in your answer. (10 marks)

2021 Section 3 Question 37

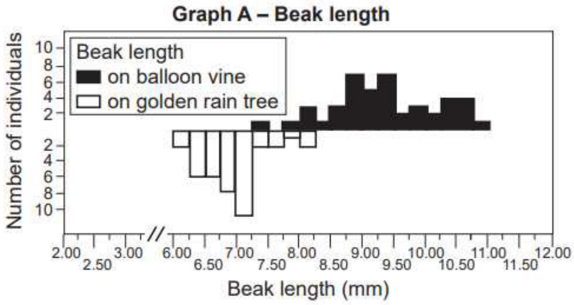
Unit 3 – Section 3

The soapberry bug is native to Florida. It feeds on seeds of the balloon vine, a plant which is also native to the state. The golden rain tree was introduced to Florida in the 1950s and, soon afterwards, the soapberry bug began feeding on the fruit of this plant as well.

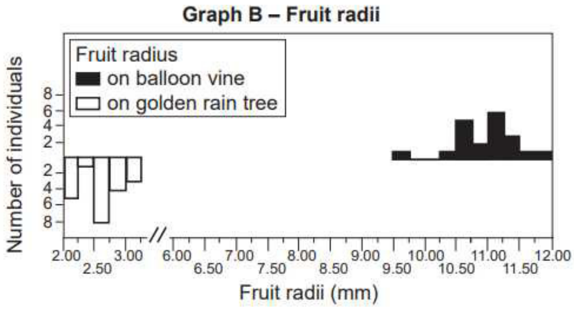
The soapberry bug feeds by inserting its beak through the fruit into the seed. A longer beak is required to reach the seed in larger fruit and vice versa. The graphs below show data collected in 1990 on:

- soapberry bugs and balloon vine fruit at Key Largo; and
- soapberry bugs and golden rain tree fruit at Lake Wales.

Graph A shows the beak lengths of soapberry bugs feeding on balloon vine fruit at Key Largo and on golden rain tree fruit at Lake Wales.



Graph B shows the radii of balloon vine fruit at Key Largo and of golden rain tree fruit at Lake Wales.



(a) Using your knowledge of microevolutionary forces and the data provided, explain how the soapberry bugs feeding on the fruits of the golden rain tree came to have much shorter beaks than the soapberry bugs feeding on the fruit of the balloon vine. (10 marks)

Mutations can arise from several sources, including chemical factors in the environment. The consequences of mutation depend on whether it occurs in a germline cell or in a somatic cell.

(b) Explain, including examples, how chemical factors in the environment can cause mutations and discuss the consequences of a mutation occurring in a germline cell and in a somatic cell. (10 marks)

2020 Section 3 Question 36 **Unit 3 – Section 3**	A DNA molecule has the capacity to replicate itself. (a) Describe the structure of a double-stranded DNA molecule and explain how the structural properties allow for replication. (10 marks) Both artificial selection and transgenesis can be used to produce organisms with desirable traits. (b) Compare artificial selection and transgenesis. (10 marks)

2020 Section 3 Question 37 **Unit 3 – Section 3**	There are more species of rock wallaby than of any other type of wallaby or kangaroo. Rock wallabies live in small populations on isolated rocky outcrops in a range of environments across Australia. Interactions between populations on different outcrops are non-existent or very rare. (a) Explain why there are so many species of rock wallaby. (10 marks) Mitosis and meiosis are important cellular processes. (b) Compare mitosis and meiosis. (10 marks)

2019 Section 3 Question 36 **Unit 3 – Section 3**	(a) Describe the functions of DNA and messenger RNA. (10 marks) (b) Explain how speciation and macro-evolutionary changes result from an accumulation of micro-evolutionary changes over time. (10 marks)

2019 Section 3 Question 37 **Unit 3 – Section 3**	(a) Describe how micro-evolution could result in salt tolerance in a species of plant. (10 marks) (b) Explain how the use of transgenic crop plants may have adverse biological effects. (10 marks)

Marking Guide – Section 3

2023 Section 3 Question 36 **Unit 3 – Section 3**	The Montara oil spill, which occurred off the northwest coast of Western Australia in August 2009, is classed as one of the worse oil disasters in Australian waters. Oil spills are initially treated with detergents (to disperse the spill) and fire, but genetically-modified bacteria that can digest the oil are sometimes also used. (a) Describe how recombinant DNA technology is used to genetically modify bacteria to digest oil and discuss two advantages and two disadvantages of using a genetically-modified microorganism for environmental conservation. (10 marks)

Description	Marks
Description of recombinant DNA technology used to genetically modify bacteria: any six of (6 x 1 mark)	
• identify/isolate a suitable gene • must be a gene that produces enzyme that digests oil • choose a suitable bacterium for genetic modification (one that can survive in aquatic environments) • use same restriction enzyme to remove gene from host and insert in plasmid • amplify target gene (in plasmid or by polymerase chain reaction (PCR)) • insert gene into bacteria/target organism • transform bacteria using heat shock or other relevant method • check ability of bacteria to reproduce/produce gene product	1-6
Subtotal	**6**
Advantages of use: any two of (2 x 1 mark)	
• can use genes from other species or can achieve outcomes not possible via natural processes • (after development) easy/fast to produce/supply transgenics in large quantities • microorganisms are easy to transport/handle/store	1–2
Subtotal	**2**
Disadvantages of use: any two of (2 x 1 mark)	
• transgenic organisms could have negative impact on other organisms/the environment or oil-digesting bacteria could take over/displace natural bacteria • gene transfer to other organisms • fairly new technology, may be unknown effects or may not be effective or development can be very expensive	1–2
Subtotal	**2**
Total	**10**

Gene pools are dynamic, with changes in allele frequencies being caused by several factors, including mutation and genetic drift.

(b) Describe how mutation and genetic drift change the frequency of alleles in a population and explain the significance of these changes. (10 marks)

Description	Marks
Mutation: any two of (2 x 1 mark)	
• permanent change to DNA or change in DNA structure • changes one allele to another or creates new alleles • occurs at random	1–2
Subtotal	**2**
Significance of changes made by mutation: any three of (3 x 1 mark)	
• can have deleterious effects on individuals or can result in the death of individuals or can have neutral, advantageous or disadvantageous effects (depending on the mutation) • limited effect on allele frequencies (because rate of mutation is low) • source of all genetic variation/alleles/biological diversity • other evolutionary processes are dependent on this variation or populations cannot evolve without genetic variation	1–3
Subtotal	**3**
Genetic drift: any two of (2 x 1 mark)	
• random death of individuals or selection of gametes or founder effect • random/chance changes in allele frequencies • has the biggest effect in small populations	1–2
Subtotal	**2**
Significance of changes made by genetic drift: any three of (3 x 1 mark)	
• leads to loss of diversity/alleles or can result in loss of advantageous alleles • places populations at risk of extinction • due to increased inbreeding or inability to adapt or susceptibility to pathogens	1–3
Subtotal	**3**
Total	**10**

2023 Section 3 Question 37 **Unit 3 – Section 3**	The genetic code is used to convert the information in a gene into a specific protein. (a) Explain how the genetic code converts the information in a gene into a specific protein. (10 marks)

Description	Marks
Any 10 of (10 x 1 mark)	
• gene/DNA consists of a sequence of nucleotides • gene/DNA sequence is copied into mRNA • nucleotides are organised into groups of three • three nucleotides are called a codon • each codon codes for a specific amino acid (or stop signal) • some codons code for the same amino acid or there are 64 different codons that specify 21 amino acids • tRNA molecules carry specific amino acids or different tRNA molecules carry different amino acids • tRNA molecules (carrying specific amino acids) bind to mRNA • tRNA molecules bind at a position determined by anticodon/three nucleotides that are complementary to codon in mRNA • different tRNAs bind at different positions on the mRNA • they add their amino acid to protein chain at this position • this determines the sequence of amino acids in a protein • type of protein is determined by sequence of amino acids	1–10
Total	**10**

The Woylie is a critically-endangered Australian mammal. Some populations are held in wildlife sanctuaries. Woylies have been translocated from the Karakamia Wildlife Sanctuary east of Perth to a sanctuary in the Northern Territory, where they have been locally extinct for 60 years.

(b) Explain how DNA profiling and a consideration of population dynamics can help to ensure that the gene pool of the woylies translocated to the sanctuary in the Northern Territory is viable. (10 marks)

Description	Marks
DNA profiling: any three of (3 x 1 mark)	
• estimate relatedness/diversity/genetic background of woylies (before translocation) • translocate unrelated/genetically different individual woylies or converse • to stop inbreeding/ensure gene pool has diversity/range of alleles • identify/do not transfer individual woylies carrying a genetic disease or transfer individuals with adaptations/alleles that will favour survival in new location	1–3
Subtotal	**3**
Population dynamics: any five of (5 x 1 mark)	
• consider number of individuals needed to maintain diversity or stop loss of diversity or ensure individuals can find a mate (in new location) • consider the age of individuals (to be translocated) • need individuals that can survive in the long-term or survive/reproduce • consider birth rate/fecundity of individuals • to ensure enough individual woylies in next generation or population can grow/persist • consider sex ratio • ensure ratio of males and females (to be translocated) will maximise the chances of most/all individuals reproducing/contributing to next generation • consider migration/immigration/emigration • can/will woylies leave the sanctuary (thereby reducing population size) or no possibility that migration/immigration will improve numbers/genetic diversity in new location (because woylie was extinct in NT)	1–5
Subtotal	**5**
Meaning of viability	
gene pool needs diversity to be viable or populations with reduced diversity face an increased risk of extinction	1
large number of woylies/large population size is needed (to avoid genetic drift/loss of diversity)	1
Subtotal	**2**
Total	**10**

2022 Section 3 Question 36 Unit 3 – Section 3	New species can arise via several processes, including allopatric speciation. (a) Describe how new species can arise via allopatric speciation. (10 marks)

Description	Marks
Any ten of	
• (allopatric speciation is where) new species arise in geographic isolation/different places • ancestral species/population is subdivided by a barrier • example of a barrier (e.g. change in course of river/formation of desert/breakup of continent/other relevant example) • creates two subpopulations/populations • gene flow/migration between two subpopulations/populations is not possible (because of barrier) • subpopulations/populations evolve independently or evolve different allele/gene frequencies (because there is no gene flow) • natural selection causes adaptive differences • because subpopulations/populations are in different environments • mutation/genetic drift may cause random differences • genetic differences increase through time • eventually individuals in different subpopulations/populations will be unable to reproduce (and produce fertile offspring) or individuals in different subpopulations/populations will be genetically/reproductively incompatible • regarded as new species when individuals can no longer reproduce with each other	1–10
Total	**10**

Proteins are essential to cell structure and functioning.

(b) Explain how structural proteins are essential to cellular structure and how enzymes are essential for cellular functioning. Include specific examples in your answer. (10 marks)

Description	Marks
Histone proteins combine with DNA to form chromatin/chromosomes or spindle/microtubules move chromosomes during cell division or other specific example that states a type of structural protein and its function	1
Subtotal	**1**
Structural proteins: Any four of	
• contribute to structure of organelles/cell membranes • form spindles/microtubules • give the cell its shape/form cytoskeleton • organise location of organelles in cells/chromosomes in nucleus • move chromosome during cell division/mitosis/meiosis • combine with DNA to form chromosomes/chromatin (Do not accept duplicates from description above.)	1–4
Subtotal	**4**
DNA polymerase catalyses DNA synthesis or other specific example with named enzyme and process.	1
Subtotal	**1**
Enzymes: Any four of	
• act as catalysts or speed up rate of biochemical reactions • lower the activation energy (in biochemical reactions) • required for all biochemical reactions/photosynthesis/respiration/protein synthesis • needed for building new molecules/anabolism • needed for breakdown of large/toxic molecules/catabolism	1–4
Subtotal	**4**
Total	**10**

2022 Section 3 Question 37 Unit 3 – Section 3	Cell reproduction is needed for growth and to replace damaged cells. It involves DNA replication followed by mitosis. (a) Describe how a DNA molecule replicates itself and the process of mitosis. (10 marks)

Description	Marks
DNA replication	
Two strands of the DNA molecule separate/unwind/unzip.	1
(Weak) hydrogen bonds between (nitrogenous) bases are broken.	1
Each strand acts as a template for synthesis of the other strand **or** DNA replication is semiconservative **or** each DNA strand is copied.	1
Base pairing ensures that the new strand is complimentary to the template or A and T, and G and C are paired on template and new strands.	1
Subtotal	**4**
Mitosis	
Chromosomes condense or nuclear membrane breaks down.	1
Chromosomes line up in centre of cell/on metaphase plate/at centre of spindle.	1
Sister chromatids/one chromatid of each chromosome moves to opposites poles/opposite ends of the cell*.	1
Spindle/microtubules move chromosomes to centre of cell or move chromatids/chromosomes to opposite ends of cell.	1
Subtotal	**4**
Any two of	
• divided into four stages or divided into prophase, metaphase, anaphase, and telophase • (at end of mitosis) cell divides/cytokinesis takes place or chromosomes decondense or nuclear membrane reforms • DNA replication occurs before mitosis begins or at start of mitosis chromosomes consist of two chromatids or two identical DNA molecules • results in two genetically identical daughter cells or results in two daughter cells with a copy of each chromosome or results in two cells that are identical to/have same number of chromosomes as parent cell	1–2
Subtotal	**2**
Total	**10**
*Must be clear that it is sister chromatids or chromatids that are part of same chromosome that separate. Homologous pairs do not synapse or segregate in mitosis.	

The woolly mammoth (a large hairy mammal) was once common and widespread. Most populations became extinct about 10 000 years ago, but a small population survived on an island until about 4000 years ago. Reduced genetic diversity played a major role in the extinction of this island population.

(b) Explain why genetic diversity is reduced in small populations and why populations with reduced genetic diversity face an increased risk of extinction. (10 marks)

Description	Marks
Reduced genetic diversity: Any four of	
• because of genetic drift • causes random/chance changes in allele frequencies • results in loss of alleles/genes/variation from populations • loss happen quicker in smaller populations • because random/chance events are magnified in smaller populations	1–4
Subtotal	**4**
Increased risk of extinction: Any six of	
• populations need genetic variation to evolve/change/respond to changes or reduced diversity means populations cannot adapt/adjust to environmental change • advantageous alleles may have been lost (due to genetic drift) • individuals in population are genetically the same/similar • individuals may have decreased disease resistance • inbreeding/inbreeding depression is more likely in small populations • fitness of individuals may be reduced • because individuals are more likely to inherit two deleterious recessive alleles or are more likely to be homozygotes or are less likely to be heterozygotes	1–6
Subtotal	**6**
Total	**10**

2021 Section 3 Question 36 **Unit 3 – Section 3**	The phenotypic expression of some genes depends on interactions with the environment. (a) Outline the four main steps involved in gene expression. Explain, using examples, how the phenotypic expression of a gene can depend on interactions with the environment. (10 marks)

Description	Marks
Main steps in gene expression	
DNA is transcribed into mRNA or a mRNA molecule that is complementary to the DNA template is produced	1
introns are removed from mRNA so that only exons/coding sequence remains	1
mRNA moves to cytoplasm **or** moves to ribosome	1
mRNA interacts with tRNA to translate genetic code or to add correct amino acid to growing protein/polypeptide chain	1
Subtotal	**4**
Any **six** of:	
Effects of environment External environment • expression of some genes varies with external environment • temperature/availability of food/light exposure can determine whether or not a gene is expressed **or** expression of genes that determine sex in reptiles is affected by temperature **or** other specific example of how gene expression can vary with external environment Body condition • expression of some genes varies with body conditions/internal environment/hormones • hormones regulate expression of genes that are expressed only in one sex **or** more strongly in one sex **or** genes needed for lactation are expressed only in female mammals **or** other specific example of how gene expression can vary with body condition/hormones Environmental influence on gene products • gene products/proteins/enzymes of some genes are affected by external environment **or** environment may prevent some gene products/proteins/enzymes from functioning • enzymes may not function at high/low temperatures/pHs **or** Himalayan rabbits are white except for black extremities because the enzyme needed to produce black fur only functions at low temperatures **or** other specific example of how environment can determine whether or not a gene product can function Chemical changes to DNA • environment can result in chemical changes to DNA that affect gene expression (called epigenetics) • e.g. methylation of DNA (usually results in gene silencing) **or** acetylation of (histone) proteins (usually results in gene expression)	1–6
Subtotal	**6**
Total	**10**

(b) Explain sexual selection and how it is similar to, and different from, natural selection. Include a specific example of a trait that evolved by sexual selection in your answer. (10 marks)

Description	Marks
Sexual selection	
sexual selection acts on an organism's ability to find a mate **or** results in the evolution of traits that help an organism to find a mate	1
it can occur when males compete with each other to mate with females	1
it can occur when females choose a male to mate with	1
(large) antlers in stags/male deer **or** courtship display/vocalisation in male frogs **or** large/colourful/ornamental feathers in peacock **or** red patches in male marine iguana **or** other specific example (must include trait, sex, type of organism)	1
Subtotal	**4**
Any **three** of:	
Similarities • both apply to inherited traits • sexual selection is a special type/case of natural selection • both select for traits that increase an organism's chance of having offspring **or** in both cases individuals with favoured traits will leave more offspring • both increase the frequency of favoured alleles • both require variation to exist in population	1–3
Subtotal	**3**
Differences • natural selection favours traits that help an organism to survive **or** (rather than to find a mate) • sexual selection can result in the evolution of traits that reduce an organism's chances of survival • because traits that attract a mate can also attract a predator **or** can take a lot of energy to produce/maintain **or** because male-male competition can injure/damage an individual	1–3
Subtotal	**3**
Total	**10**

2021 Section 3 Question 37

Unit 3 – Section 3

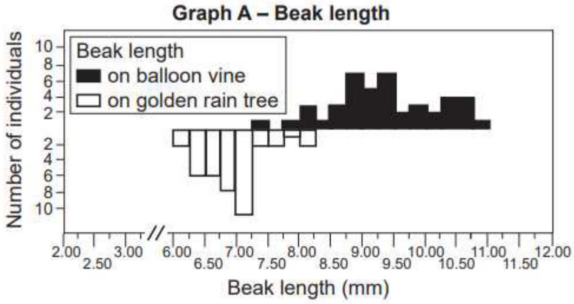
The soapberry bug is native to Florida. It feeds on seeds of the balloon vine, a plant which is also native to the state. The golden rain tree was introduced to Florida in the 1950s and, soon afterwards, the soapberry bug began feeding on the fruit of this plant as well.

The soapberry bug feeds by inserting its beak through the fruit into the seed. A longer beak is required to reach the seed in larger fruit and vice versa. The graphs below show data collected in 1990 on:

- soapberry bugs and balloon vine fruit at Key Largo; and
- soapberry bugs and golden rain tree fruit at Lake Wales.

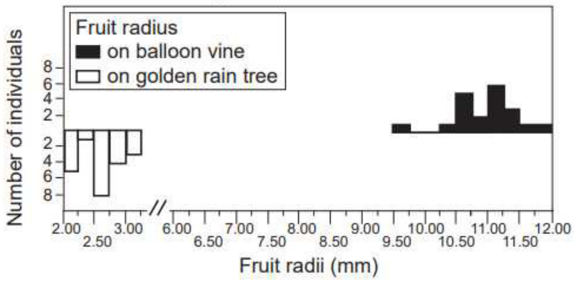
Graph A shows the beak lengths of soapberry bugs feeding on balloon vine fruit at Key Largo and on golden rain tree fruit at Lake Wales.

Graph A – Beak length



Graph B shows the radii of balloon vine fruit at Key Largo and of golden rain tree fruit at Lake Wales.

Graph B – Fruit radii



(a) Using your knowledge of microevolutionary forces and the data provided, explain how the soapberry bugs feeding on the fruits of the golden rain tree came to have much shorter beaks than the soapberry bugs feeding on the fruit of the balloon vine. (10 marks)

Description	Marks
Any **eight** of:	
• prior to the introduction of the Golden Rain Tree, natural selection favoured bugs with long beaks • because bugs only had balloon vine fruit to feed on **or** long beaks are suitable for feeding on balloon vine fruit (because the fruit is larger) • (once the Golden Rain Tree was introduced) some bugs started to feed on the fruit of the Golden Rain tree • smaller beaks were suitable for feeding on the Golden Rain tree fruit (because the fruit are smaller) • shorter beaks may have arisen by mutation **or** there was variation in beak length in the population • bugs with shorter beaks feeding on Golden Rain tree fruit are favoured by natural selection/fitter/leave more offspring • pass alleles for shorter beak length to offspring • over time/generations alleles for shorter beaks became increasingly common in bugs feeding on Golden Rain tree fruit • absence of gene flow keeps gene pools of bugs with different beak lengths/feeding on different fruits separate	1–8
Subtotal	**8**
Accurate quote of the data • quote relevant to beak length • quote relevant to fruit size	1–2
Subtotal	**2**
Total	**10**

Mutations can arise from several sources, including chemical factors in the environment. The consequences of mutation depend on whether it occurs in a germline cell or in a somatic cell.

(b) Explain, including examples, how chemical factors in the environment can cause mutations and discuss the consequences of a mutation occurring in a germline cell and in a somatic cell. (10 marks)

Description	Marks
Chemical factors (any two of the following) • mutagens are chemicals in the environment that react with DNA • a mutation is a permanent change to DNA or the genome • they can substitute/change chemistry of bases or inhibit DNA repair/replication/mitosis/meiosis	1–2
Specific examples (any two of the following) • names chemical mutagen, • describes the specific effect on DNA structure Answers could include • nitric acid/deaminating agent - changes one nitrogenous base into another • colchicine - prevents spindle formation so chromosomes cannot segregate **or** doubles chromosome number **or** interferes with mitosis/meiosis • ethidium bromide/intercalating agents - are inserted into DNA and distort DNA helix **or** cause problems with DNA replication/repair • mustard gas/alkylating agent - causes base-pair mismatches **or** cross-link guanine bases **or** prevents DNA molecule from unwinding • other specific example that states type of chemical and its specific effect	1–2
Subtotal	**4**
Any **six** of:	
Consequences • germline cell is a gamete **or** a cell that undergoes meiosis (to produce gametes) • germline mutations usually do not affect the health/viability of the individual that underwent the mutation because the mutation is limited to the germline/germ cells • germline mutations can be passed to offspring because they occur in the gametes • the health/viability/fertility of these offspring can be (badly) affected because all of their cells will carry the mutation • somatic cell is a general body cell • a mutation that occurs in a somatic cell usually does not affect the health/viability/fertility of the individual because it is limited to a particular cell line • however, the health/viability of an individual can be affected if the mutation causes cancer **or** if the mutation affected occurs early in embryonic development (because most cells will have the mutation) • somatic cell mutations cannot be inherited because they do not occur in the gametes	1–6
Subtotal	**6**
Total	**10**

2020 Section 3 Question 36

Unit 3 – Section 3

A DNA molecule has the capacity to replicate itself.

(a) Describe the structure of a double-stranded DNA molecule and explain how the structural properties allow for replication. (10 marks)

Description	Marks
Any **six** of:	
Structure of DNA • arranged as a double-helix • antiparallel strands **or** two strands that run in opposite directions • each strand consists of a chain of nucleotides • nucleotides consist of a sugar (deoxyribose), phosphate group and a nitrogenous base • nitrogenous bases on opposite strands are complementary **or** pair with a base on the other strand **or** there is complementary base pairing • adenine pairs with thymine and cytosine pairs with guanine **or** A pairs with T and C pairs with G • complementary bases/two strands are held together by hydrogen bonds	1–6
Subtotal	**6**
Explains how structural properties allow for replication	
• the hydrogen bonds are weak **or** can be easily broken • allows the two strands to separate (which is needed for replication to occur) • the complementary base pairing • means each strand can be synthesised from its complementary strand **or** each strand can be used as a template to synthesise the complementary strand (semiconservative replication)	1–4
Subtotal	**4**
Total	**10**

Both artificial selection and transgenesis can be used to produce organisms with desirable traits.

(b) Compare artificial selection and transgenesis. (10 marks)

Description	Marks
Any **two** of:	
Similarities • both alter the genetic composition of individuals (to produce the traits) • both reduce the genetic diversity in the selected/modified organisms • both involve human intervention	1–2
Subtotal	**2**
Artificial selection methods • artificial selection uses selective breeding **or** selects individuals with desirable trait to breed • results in gradual/progressive changes in frequency of alleles (across generations)	1–2
Subtotal	**2**
Transgenesis methods • artificial production of a genetically modified organism • involves cloning/biotechnology/DNA recombinant technology	1–2
Subtotal	**2**
Any **four** of:	
Differences • artificial selection can be slow whereas transgenesis can be fast • artificial selection does not require specialist equipment whereas production of transgenics requires specialist equipment • artificial selection affects all/most of genome whereas transgenesis affects one gene • artificial selection (usually) changes alleles/genes normally found in target organism whereas transgenesis may involve transfer of gene from different species • artificial selection is viewed as natural/environmental friendly whereas transgenesis is viewed as more controversial/artificial/environmental threat	1–4
Subtotal	**4**
Total	**10**

2020 Section 3 Question 37 **Unit 3 – Section 3**	There are more species of rock wallaby than of any other type of wallaby or kangaroo. Rock wallabies live in small populations on isolated rocky outcrops in a range of environments across Australia. Interactions between populations on different outcrops are non-existent or very rare. (a) Explain why there are so many species of rock wallaby. (10 marks)

Description	Marks
Any **ten** of:	
• due to high rates of speciation/allopatric speciation **or** repeated speciation • common ancestor colonised different rock outcrops • populations (on different outcrops) experienced different environmental conditions **or** different selection pressures • these populations evolved different adaptations **or** genetic differences evolved by natural selection • genetic drift/bottlenecks/founder effects resulted in random genetic changes/differences among populations • effects of genetic drift are likely to be large because of small size **or** number of founders was small • populations (on different outcrops) had different mutations **or** mutation introduce new/different alleles into populations • gene flow/migration/dispersal between populations (on different outcrops) was non-existent/rare **or** populations (on different outcrops) were isolated from each other • (therefore) populations on different outcrops became genetically different **or** evolved genetic differences **or** different gene pools • over time populations (on different outcrops) became increasingly different • eventually individuals on different outcrops were no longer able to interbreed/became new species	1–10
Total	**10**

Mitosis and meiosis are important cellular processes.

(b) Compare mitosis and meiosis. (10 marks)

<table>
<tr><th colspan="2">Description</th><th>Marks</th></tr>
<tr><td colspan="3">Similarities</td></tr>
<tr><td colspan="3">Any four of:</td></tr>
<tr><td colspan="2">• both are types of cell/nuclear division
• both start with a diploid cell
• both have same/similar substages or prophase, metaphase, anaphase, telophase
• DNA replication occurs before mitosis/meiosis starts/during interphase or both produce daughter cells with less DNA (i.e. compared to the amount of DNA in the parent cell at the start of mitosis/meiosis)
• sister chromatids separate (to different poles) in mitosis and meiosis II</td><td>1–4</td></tr>
<tr><td colspan="2">Subtotal</td><td>4</td></tr>
<tr><td colspan="3">Differences</td></tr>
<tr><td colspan="3">Any six of:</td></tr>
<tr><td>Mitosis</td><td>Meiosis</td><td rowspan="8">1–6</td></tr>
<tr><td>daughter cells identical or type of asexual reproduction</td><td>daughter cells not identical or involved in sexual reproduction</td></tr>
<tr><td>one division</td><td>two divisions</td></tr>
<tr><td>results in two daughter cells</td><td>results in four daughter cells</td></tr>
<tr><td>daughter cells diploid</td><td>daughter cells haploid</td></tr>
<tr><td>produces somatic/general body cells or occurs in somatic/general body cells</td><td>produces gametes/sex cells or occurs in gonads/germ-line cells</td></tr>
<tr><td>homologous chromosomes do not pair</td><td>homologous chromosomes pair (in meiosis I)</td></tr>
<tr><td>no crossing-over and/or independent assortment</td><td>crossing-over and/or independent assortment occur (in meiosis I)</td></tr>
<tr><td colspan="2">Subtotal</td><td>6</td></tr>
<tr><td colspan="2">Total</td><td>10</td></tr>
</table>

2019 Section 3 Question 36 **Unit 3 – Section 3**	(a) Describe the functions of DNA and messenger RNA. (10 marks)

Description	Marks
Describes the functions of DNA	
DNA stores/holds genetic information	1
this information is required for development/function of cells/organisms	1
information is passed to next generation/offspring/daughter cells	1
DNA contains • genes that code for (essential) proteins **or** RNA • genes that regulate gene expression **or** switches other genes on/off at correct time/in the correct cell • sequences that hold genes/DNA in the correct place in nucleus **or** that maintain chromosome structure and function • proof reading functions (to ensure replication is accurate) • DNA self-replicates **or** acts as a template to produce a new DNA strand (complementary)	1–3
Subtotal	**6**
Describes the function of messenger RNA	
RNA reads/transcribes the genetic code	1
RNA • copies the sequence of genes/DNA • take this information to the cytoplasm/ribosome • interact with tRNA/ribosome • ensures amino acids are assembled to form a protein	1–3
Subtotal	**4**
Total	**10**

(b) Explain how speciation and macro-evolutionary changes result from an accumulation of micro-evolutionary changes over time. (10 marks)

Description	Marks
Explains micro-evolutionary change (and **three** of):	
change within a population/species **or** small scale change	1
Microevolution • involves changes in the frequency of alleles/genotypes/phenotypes • via natural selection/genetic drift/mutation/gene flow • change from one generation to the next is small • operates over small time scales	1–2
Subtotal	**3**
Explains how speciation and macro-evolutionary change results from an accumulation of micro-evolutionary change (any **seven** of):	
macro-evolution is change at/above the level of species or large-scale evolution	1
occurs over many generations **or** very long periods of time	1
(over this time scale) micro-evolutionary changes accumulate into large changes	1
changes may become so great that they lead to the production of a new species **or** speciation **or** individuals that cannot interbreed	1
• macro-evolution focusses on trends/patterns within whole taxa/lineages (rather than changes within a species) **or** the evolution of new lineages (rather than species) • these patterns arise (in part) because different populations/species evolve in new/different directions by micro-evolution • life has been evolving for approximately 3.5 billion years ago (which is sufficient for very large changes to accumulate) • specific example that shows relationship between micro-evolution and macro-evolution	1–3
Subtotal	**7**
Total	**10**

2019 Section 3 Question 37 Unit 3 – Section 3	(a) Describe how micro-evolution could result in salt tolerance in a species of plant. (10 marks)

Description	Marks
(micro-evolution is) change within a population/species **or** small scale change	1
description includes that salt tolerance would evolve by natural selection (must state natural selection)	1
description includes that plants must vary in their ability to tolerate salt **or** that a mutation produces a genetic variant/allele that confers salt tolerance	1
Subtotal	**3**
Describes how salt tolerance could have evolved (any **seven** of):	
• plants are exposed to salt (in the environment) • plants that tolerate the salt/saline environment survive for longer/are healthier/more productive/have a selective advantage **or** the converse • (therefore the salt tolerant plants) produce more offspring compared to those that are not tolerant **or** the converse • offspring (of salt tolerant plants) inherit the alleles/genes for salt tolerance • (therefore) the frequency of the alleles/genes for salt tolerance is higher in the next generation • (so long as the salt is present) salt tolerant plants will leave more offspring compared to other plants **or** the process will continue over many generations • the frequency of the alleles/genes for tolerance will get higher and higher • eventually/after many generations all plants/the whole population will be salt tolerant **or** will have the salt tolerant alleles/genes	1–7
Subtotal	**7**
Total	**10**

(b) Explain how the use of transgenic crop plants may have adverse biological effects. (10 marks)

Description	Marks
Effect on plant crop	
Explanation recognises that there may be a loss of genetic diversity in the plant crop	1
Explains why genetic diversity may be lost (any **one** of): • transgenic crop is a single line or strain/monoculture • only the transgenic crop may be farmed **or** unmodified crop may not be farmed (due to favourable characteristics of transgenic)	1
Explains the consequences of a loss of diversity (any **one** of): • may limit ability of crop to adapt to other aspects of the environment/pests • could reduce potential to develop desirable crop lines in the future (e.g. by selective breeding)	1
Subtotal	**3**
Effects on environment/non-target species	
Any **seven** of: Explains how transgenic overshoots environment/becomes a pest • water/pests/factors limiting growth of transgenic plant/crop removed • (therefore transgenic plant/crop) becomes a weed **or** difficult to control **or** shows increased growth/productivity • (transgenic plant/crop) may monopolise/deplete other resources/soil nutrients/water • overgrow/outcompete other plants **or** change food web Explains how the gene/trait may be transferred to other crops/species • transgenic/crop plants may exchange genes/transfer gene/genetic material to other plants/crops/species **or** introduced gene may be transferred to other plants/crops/species • resulting in (engineered) trait in another plants/crops/species • these plants/crops/species may become a weed/superweed/pest because they can no longer be controlled by pests/herbicides/low water/environmental factors Explains how the use herbicide-resistant transgenics may lead to overuse of herbicides • if the plant/crop was engineered for herbicide resistance, farmers may overuse herbicides (to kill weeds) • (overuse will) pollute the environment **or** cause evolution of resistant weeds (by natural selection as a result of exposure to a lot of herbicides)	1–7
Subtotal	**7**
Total	**10**

Unit 4 – Surviving in a changing environment

Unit 4 – Homeostasis

Section 1

2023 Section 1 Question 2 **Homeostasis**	The leaves of xerophytes often have a (a) large number of stomata. (b) thin waterproof cuticle. (c) poorly-developed xylem. (d) dense covering of hairs.

2023 Section 1 Question 15 **Homeostasis**	The Spinifex hopping mouse lives in deserts in Australia and obtains water by (a) producing concentrated urine. (b) having a slow breathing rate. (c) metabolising fat and carbohydrates. (d) sheltering in a humid burrow.

2023 Section 1 Question 17 **Homeostasis**	Muscle cells from a saltwater fish and from a freshwater fish are placed in a tube filled with distilled water. The cells from (a) both the saltwater and freshwater fish will lose water. (b) both the saltwater and freshwater fish will gain water. (c) the saltwater fish will lose water and the freshwater fish will gain water. (d) the saltwater fish will gain water and the freshwater fish will lose water.

2023 Section 1 Question 20 **Homeostasis**	Which of the following is an example of an organism losing heat to the environment via convection? (a) a warm lizard laying on a cold rock (b) evaporation of water from a beached seal (c) a small rat sitting in the cold night air (d) cool air flowing over the ears of a hot rabbit

2023 Section 1 Question 25 **Homeostasis**	Great white sharks use metabolic heat and counter-current blood flow to maintain a core body temperature that, while variable, is above the temperature of the surrounding water. Despite this, great white sharks are classed as ectothermic because they (a) do not maintain a constant body temperature. (b) are aquatic vertebrates and all aquatic vertebrates are ectothermic. (c) lose body heat to the environment. (d) feed too infrequently to maintain a high metabolism.

2023 Section 1 Question 27 **Homeostasis**	Some birds can dilate or constrict the blood vessels in their beaks to control heat exchange with the environment. Smooth muscles constrict the blood vessels. In this example of a negative feedback loop, the diameter of blood vessels is the (a) response and the smooth muscles are the effector. (b) response and the smooth muscles are the control centre. (c) effector and the smooth muscles are the control centre. (d) effector and the smooth muscles are the stimulus.

2022 Section 1 Question 2 **Homeo-stasis**	Which of the following lists the five steps in the stimulus-response model in the correct order? (a) receptor, stimulus, coordinating centre, effector, response (b) receptor, stimulus, effector, coordinating centre, response (c) stimulus, receptor, coordinating centre, effector, response (d) stimulus, effector, coordinating centre, receptor, response

2022 Section 1 Question 6-7 **Homeo-stasis**	The table below gives some information on osmoregulation for two species of bony fish in their natural environment. Use this information to answer Questions 6 and 7.

Fish species	Exchange across skin	Exchange across gills
A	• water diffuses in	• water diffuses in • active uptake of ions
B	• water diffuses out	• water diffuses out • active secretion of ions

Fish species
(a) A occurs in sea water.
(b) B occurs in fresh water.
(c) A is hypotonic to the environment.
(d) B drinks large amounts of water.

Which species will excrete ammonia?

(a) A
(b) B
(c) both A and B
(d) neither A nor B

2022 Section 1 Question 8 **Homeo-stasis**	Halophytic plants can be used for (a) revegetating cleared rain forest. (b) stabilising coastal sand dunes. (c) reclaiming land at the edges of freshwater swamps. (d) lowering the water table on river floodplains.

2022 Section 1 Question 14-15 **Homeo-stasis**	Biologists measured the body temperature of an animal and the air temperature in the animal's environment, every 4 hours over a 20-hour period. The results are shown in the table below. Use this information to answer Questions 14 and 15.

Time (hrs)	Body temperature (°C)	Air temperature (°C)
04	37.3	19.2
08	37.1	18.8
12	36.8	21.5
16	37.4	26.4
20	37.2	27.5
24	37.5	23.0

14. The median body temperature in the animal over the 20-hour period was

(a) 37.30 °C.
(b) 37.25 °C.
(c) 37.22 °C.
(d) 37.20 °C.

15. The data suggest that the animal is an

(a) ectotherm, because its body temperature is around 37 °C.
(b) endotherm, because its body temperature is around 37 °C.
(c) ectotherm, because its body temperature is independent of air temperature.
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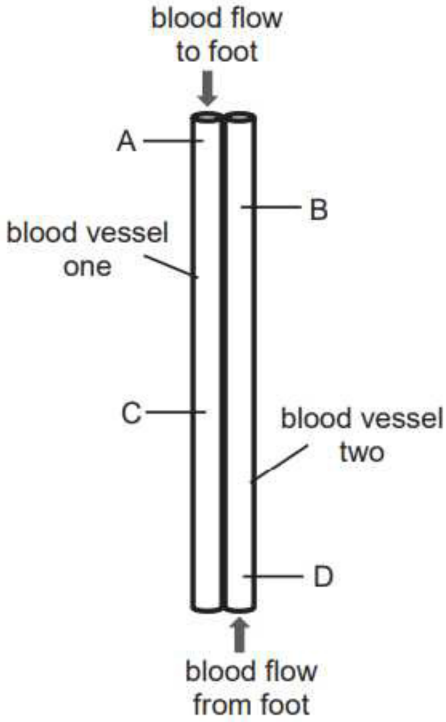
2022 Section 1 Question 28 **Homeo-stasis**	The level of expression in a gene in the bacterium E. coli varies. It depends on the amount of gene product in the bacterial cell, where the level of expression declines as the amount of product increases and vice-versa. This is an example of (a) transcription. (b) translation. (c) positive feedback. (d) negative feedback.

2021 Section 1 Question 2 **Homeo-stasis**	The rate of heat exchange between an animal and its environment could be increased by (a) the animal standing in the open in a strong wind. (b) insulating layers of feathers or fur on the animal. (c) vasoconstriction in the limbs of the animal. (d) reducing the number of sweat glands in the animal.

2021 Section 1 Question 6-7 **Homeo-stasis**	Birds that live in cold environments have a counter-current heat exchange system in their legs, which is shown in the diagram below. Use this diagram to answer questions 6 and 7.  6. The temperature of the blood is lowest at position (a) A. (b) B. (c) C. (d) D. 7. Heat is transferred from blood vessel (a) one to two by conduction. (b) one to two by convection. (c) two to one by conduction. (d) two to one by convection.

2021 Section 1 Question 12 **Homeo-stasis**	Chimpanzees use piloerection (raising of body hair) to modify heat exchange with the environment. Piloerection is controlled by muscles around the hair follicles. In a negative feedback loop, these muscles represent (a) a response. (b) a sensor. (c) a stimulus. (d) an effector.

2021 Section 1 Question 16 **Homeo-stasis**	The defining feature of a negative feedback loop is that it acts to (a) disrupt homeostasis. (b) change a behaviour. (c) counter a stimulus. (d) stimulate a response.

2021 Section 1 Question 18 **Homeo-stasis**	Many bats reduce their body temperature greatly when at rest to just above the temperature of their surroundings. Despite this, bats are still classed as endothermic because they (a) are vertebrates and all vertebrates are endothermic. (b) can fly and all flying animals are endothermic. (c) vary their body temperature with that of the environment. (d) depend on internal metabolism to generate body heat.

2021 Section 1 Question 25 **Homeo-stasis**	Which of the following animals will use the largest percentage of its energy to maintain homeostasis? (a) a bird in a jungle (b) a lizard in a desert (c) a frog in a swamp (d) a grasshopper in a field

2020 Section 1 Question 1 **Homeo-stasis**	Which of the following lists the main types of nitrogenous waste from least toxic to most toxic? (a) uric acid, ammonia, urea (b) uric acid, urea, ammonia (c) urea, uric acid, ammonia (d) urea, ammonia, uric acid

2020 Section 1 Question 6 **Homeo-stasis**	Most xerophytes have (a) fewer stomata open in the day than in the night. (b) more stomata open in the day than in the night. (c) the same number of open stomata in the day and night. (d) no stomata open during either the day or the night.

2020 Section 1 Question 7 **Homeo-stasis**	Transpiration in xerophytes results in a (a) gain of water and heat. (b) loss of water and heat. (c) gain of water and loss of heat. (d) loss of water and gain of heat.

2020 Section 1 Question 10 **Homeo-stasis**	Excreting uric acid instead of ammonia (a) saves energy and water. (b) costs energy and water. (c) saves energy but costs water. (d) costs energy but saves water

2020 Section 1 Question 25 **Homeo-stasis**	Some desert mammals obtain water from fat metabolism. What type of adaptation is this? (a) physiological (b) immunological (c) behavioural (d) structural

2020 Section 1 Question 26 **Homeo-stasis**	A camel can obtain 1.12 mL of water from each gram of fat stored in its hump. On this basis, how many millilitres of water would a camel obtain from 36 kg of stored fat? (a) 32.142 (b) 40.320 (c) 32 142 (d) 40 320

2019 Section 1 Question 3 **Homeo-stasis**	When the cells from a plant root are placed in a solution, they lose water to the solution. Relative to the cells, the solution is (a) hypertonic. (b) hypotonic. (c) isotonic. (d) osmotic.

2019 Section 1 Question 9 **Homeo-stasis**	Select the correct statement. (a) All mammals excrete nitrogenous waste in the form of urine. (b) All mammals excrete nitrogenous waste in the form of urea. (c) Aquatic mammals excrete ammonia and land mammals excrete urine. (d) Desert mammals excrete uric acid and other mammals excrete urea.

2019 Section 1 Question 14 **Homeo-stasis**	Penguins have an inner layer of soft feathers that trap air close to the body. This reduces heat loss due to (a) conduction. (b) convection. (c) evaporation. (d) radiation.

2019 Section 1 Question 15 **Homeo-stasis**	Penguins also have a thick layer of fat. This reduces heat loss due to (a) conduction. (b) convection. (c) evaporation. (d) radiation.

2019 Section 1 Question 18 **Homeo-stasis**	A behavioural adaptation that some animals use to regulate their body temperature in a hot environment is (a) panting. (b) burrowing. (c) vasodilation. (d) vasoconstriction.

2019 Section 1 Question 25 **Homeo-stasis**	Freshwater bony fish mainly (a) gain salts by active transport through the skin. (b) gain salts by active transport through the gills. (c) lose salts by osmosis through the skin. (d) lose salts by osmosis through the gills.

2023 Section 2 Question 31 **Homeostasis**	(a) (i) Define the term ‘homeostasis’. (1 mark) (ii) Define the term ‘endothermy’. (1 mark) (iii) Indicate **two** classes of organisms that are endotherms. (2 marks) One: Two: (b) List four advantages of endothermy. (4 marks) One: Two: Three: Four: (c) Consider an ectotherm and an endotherm that weigh the same amount, live in the same environment and eat the same type of food. Indicate which would need more food and justify your answer. (3 marks) More food is needed by: Justification:

African elephants live in hot environments. They only have sweat glands on their feet, but water can evaporate directly through their skin. The skin has intricate patterns of wrinkles and creases, which trap water when the elephants bathe. African elephants have few hairs scattered across the body.

(d) (i) Outline how the wrinkles and creases in the skin assist temperature regulation in African elephants. (2 marks)

(ii) Outline how the sparse distribution of hairs assists temperature regulation in African elephants. (2 marks)

(e) Explain why drinking salt water is harmful to land mammals, like the African elephant, but not to marine fish. (4 marks)

2022 Section 2 Question 32 Homeo-stasis	A range of rodent species (e.g. mice and rats) lives in hot deserts. (a) Outline two main ways in which rodents that live in deserts lose water to the environment. (4 marks) One: Two:

The following table shows data on the body mass and kidney mass in two species of rodent that live in deserts and in related species that live in moist environments. Kidney mass as a percentage of body mass is given for three of these species.

Species	Environment	Kidney mass (g)*	Body mass (kg)*	Kidney mass as a percentage of body mass
Octodon degus	desert	1.400	0.160	0.875
Octodon bridgesi	moist	0.920	0.163	0.564
Peromyscus eremicus	desert	0.445	0.023	1.934
Peromyscus leucopus	moist	0.117	0.027	

* 1 kg = 1000 g

(b) Calculate kidney mass as a percentage of body mass for Peromyscus leucopus. Show your workings. (4 marks)

(c) Kidney mass as a percentage of body mass is often higher in rodents that live in deserts than in related species that live in moist environments. Explain why. (4 marks)

A range of bird species also live in hot deserts.

(d) The hornbill is a type of desert bird noted for having a very large beak with a rich supply of blood vessels. Explain how such a beak aids the hornbill in regulating its body temperature. (4 marks)

(e) The body temperature of desert birds is typically around 5 °C higher than that of desert rodents. This gives the birds an advantage over the rodents in losing heat to the environment via radiation. Explain why. (3 marks)

2021 Section 2 Question 32

Homeo-stasis

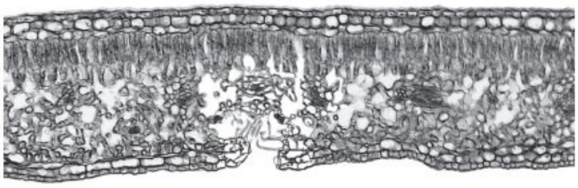
Many animal and plant species inhabit arid environments.

(a) (i) What name is used to describe plants adapted to arid environments? (1 mark)

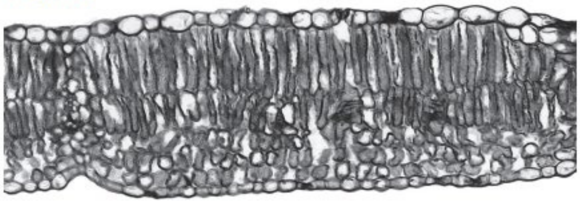
(ii) Describe how these plants lose water to the environment. (2 marks)

(b) The figures below show cross-sections through the leaves of two plants. One of these plants occurs in an arid environment.

Plant A



Plant B



(i) On the basis of the features visible in each cross-section, indicate which plant (A or B) occurs in an arid environment. (1 mark)

(ii) On the relevant cross-section, label four features that indicate one of the plants is from an arid environment. (4 marks)

(c) The seeds of some plants that live in arid environments can germinate after many years in the soil. Explain how this characteristic can help these plants to survive in these environments. (4 marks)

(d) Apart from drinking, outline two ways in which animals obtain water in arid environments. (4 marks)

One:

Two:

(e) Some species of fish inhabit bodies of water in arid regions in Australia. The salinity (salt content) of these bodies of water is usually higher than that of sea water but can fall below that of sea water after large amounts of rainfall. Explain the challenges that a fish faces in maintaining salt-water balance in these bodies of water. (4 marks)

2020 Section 2 Question 34 Homeo-stasis	The greater bilby (*Macrotis lagotis*) lives in desert and grassland areas in northern Australia.  (a) (i) Thermoregulation in the greater bilby is an example of homeostasis. Define homeostasis. (1 mark) __________ __________ (ii) The greater bilby uses a negative feedback mechanism to thermoregulate. State the defining feature of a negative feedback mechanism. (1 mark) __________ __________ The greater bilby's body temperature is normally 37 °C. (iii) Indicate whether a rise in the body temperature above 37 °C would be a stimulus or a response in a negative feedback mechanism. Give a reason for your answer. (2 marks) __________ __________ __________ __________

(b) Explain how a greater bilby's ears could help it to thermoregulate. (4 marks)

The thorny lizard (*Moloch horridus*) lives in desert areas in Australia. Scientists measured the rate of oxygen consumption in thorny lizards at rest at four different environmental temperatures in the laboratory. The results are shown in the table below.

Environmental temperature (°C)	Mean rate of oxygen consumption at rest ($cm^3 g^{-1} hr^{-1}$)
15	0.3
20	0.6
25	1.1
35	1.5

(c) (i) State the relationship between environmental temperature and mean rate of oxygen consumption in thorny lizards at rest. (1 mark)

(ii) Explain the reason for the relationship described in part (c)(i). (3 marks)

(d) The colour of the scales on a thorny lizard changes from pale during warmer months to darker during cooler months. Explain how this helps the lizard to thermoregulate. (4 marks)

(e) There are approximately 55 species of true sea snakes. These snakes are common in warm tropical waters but do not occur in colder waters. Provide a plausible explanation for this distribution. (4 marks)

2019 Section 2 Question 33 Homeo-stasis	(a) (i) Outline the role of the effector in homeostasis. (2 marks) (ii) Outline the role of the receptor in homeostasis. (2 marks) (iii) State the defining feature of a negative feedback loop. (1 mark) (b) A marine fish regulates its water and salt balance. Is this an example of homeostasis? Give reasons for your answer. (3 marks)

The diagram below shows a cross-section through a plant leaf.

Copyright restrictions prohibit the release of this SCSA exam material.

(c) List four features visible in the diagram above that would assist the plant to conserve water. (4 marks)

One:

Two:

Three:

Four:

(d) The root systems of xerophytes often include spreading roots just beneath the soil surface. Outline two advantages of these surface roots for xerophytes. (4 marks)

One:

Two:

	(e) Some xerophytes produce heat-shock proteins in response to heat stress. These proteins prevent the denaturation of other proteins. Explain how this could assist the survival of the xerophyte. (4 marks)

Marking Guide – Section 1

2023 Section 1 Question 2 **Homeostasis**	The leaves of xerophytes often have a (a) large number of stomata. (b) thin waterproof cuticle. (c) poorly-developed xylem. **(d) dense covering of hairs. – Answer**

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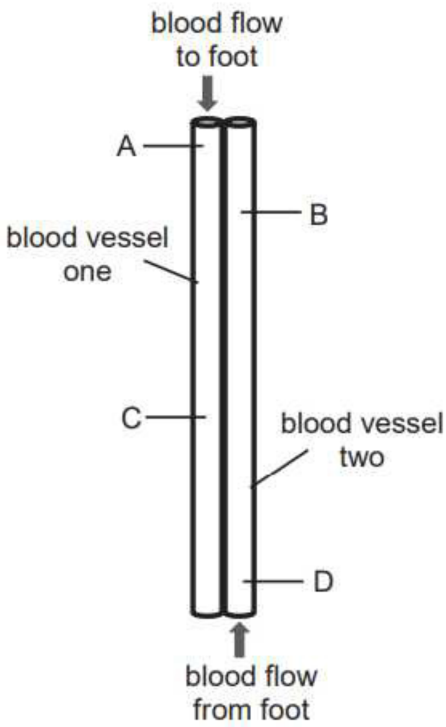
2021 Section 1 Question 6-7 **Homeo-stasis**	Birds that live in cold environments have a counter-current heat exchange system in their legs, which is shown in the diagram below. Use this diagram to answer questions 6 and 7.  6. The temperature of the blood is lowest at position (a) A. (b) B. (c) C. **(d) D. – Answer** 7. Heat is transferred from blood vessel **(a) one to two by conduction. – Answer** (b) one to two by convection. (c) two to one by conduction. (d) two to one by convection.

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2020 Section 1 Question 7 **Homeo-stasis**	Transpiration in xerophytes results in a (a) gain of water and heat. **(b) loss of water and heat. – Answer** (c) gain of water and loss of heat. (d) loss of water and gain of heat.

2020 Section 1 Question 10 **Homeo-stasis**	Excreting uric acid instead of ammonia (a) saves energy and water. (b) costs energy and water. (c) saves energy but costs water. **(d) costs energy but saves water – Answer**

2020 Section 1 Question 25 **Homeo-stasis**	Some desert mammals obtain water from fat metabolism. What type of adaptation is this? **(a) physiological – Answer** (b) immunological (c) behavioural (d) structural

2020 Section 1 Question 26 **Homeo-stasis**	A camel can obtain 1.12 mL of water from each gram of fat stored in its hump. On this basis, how many millilitres of water would a camel obtain from 36 kg of stored fat? (a) 32.142 (b) 40.320 (c) 32 142 **(d) 40 320 – Answer**

2019 Section 1 Question 3 **Homeo-stasis**	When the cells from a plant root are placed in a solution, they lose water to the solution. Relative to the cells, the solution is **(a) hypertonic. – Answer** (b) hypotonic. (c) isotonic. (d) osmotic.

2019 Section 1 Question 9 **Homeo-stasis**	Select the correct statement. (a) All mammals excrete nitrogenous waste in the form of urine. **(b) All mammals excrete nitrogenous waste in the form of urea. – Answer** (c) Aquatic mammals excrete ammonia and land mammals excrete urine. (d) Desert mammals excrete uric acid and other mammals excrete urea.

2019 Section 1 Question 14 **Homeo-stasis**	Penguins have an inner layer of soft feathers that trap air close to the body. This reduces heat loss due to (a) conduction. **(b) convection. – Answer** (c) evaporation. (d) radiation.

2019 Section 1 Question 15 **Homeo-stasis**	Penguins also have a thick layer of fat. This reduces heat loss due to **(a) conduction. – Answer** (b) convection. (c) evaporation. (d) radiation.

2019 Section 1 Question 18 **Homeo-stasis**	A behavioural adaptation that some animals use to regulate their body temperature in a hot environment is (a) panting. **(b) burrowing. – Answer** (c) vasodilation. (d) vasoconstriction.

2019 Section 1 Question 25 **Homeo-stasis**	Freshwater bony fish mainly (a) gain salts by active transport through the skin. **(b) gain salts by active transport through the gills. – Answer** (c) lose salts by osmosis through the skin. (d) lose salts by osmosis through the gills.

2023 Section 2 Question 31

Homeostasis

(a) (i) Define the term 'homeostasis'. (1 mark)

Description	Marks
the process by which the body maintains a relatively constant internal environment	1
Total	**1**

(ii) Define the term 'endothermy'. (1 mark)

Description	Marks
Any one of (1 x 1 mark)	
• maintenance of a relatively constant body temperature (independent of the environment) • system of temperature control using internally generated heat	1
Total	**1**

(iii) Indicate **two** classes of organisms that are endotherms. (2 marks)

Description	Marks
Mammalia/Mammals	1
Aves/Birds	1
Total	**2**

(b) List four advantages of endothermy. (4 marks)

Description	Marks
Any four of (4 x 1 mark)	
• metabolic reactions are always at optimum temperature • less susceptibility to environmental variation or can occupy a wider range of ecological niches/live in a wider range of environments (compared to ectotherms) • can sustain high levels of activity • can always respond quickly to stimuli • (consistently) higher body temperatures may deter pathogens	1–4
Total	**4**

(c) Consider an ectotherm and an endotherm that weigh the same amount, live in the same environment and eat the same type of food. Indicate which would need more food and justify your answer. (3 marks)

Description	Marks
endotherm	1
endotherms use metabolic reactions to generate heat or converse	1
metabolic reactions require energy (from food)	1
Total	**3**

African elephants live in hot environments. They only have sweat glands on their feet, but water can evaporate directly through their skin. The skin has intricate patterns of wrinkles and creases, which trap water when the elephants bathe. African elephants have few hairs scattered across the body.

(d) (i) Outline how the wrinkles and creases in the skin assist temperature regulation in African elephants. (2 marks)

Description	Marks
Any two of (2 x 1 mark)	
• increases surface area for evaporation • evaporation can occur over a longer period of time or can retain water for some time after bathing • evaporation of water cools elephant or draws heat energy from elephant	1–2
Total	**2**

(ii) Outline how the sparse distribution of hairs assists temperature regulation in African elephants. (2 marks)

Description	Marks
Any two of (2 x 1 mark)	
• increase heat loss (to the environment) • (sparse hairs) provide no/little insulation • warm air is not trapped close to elephant or thick fur/dense hairs would trap warm layer of air next to elephant	1–2
Total	**2**

(e) Explain why drinking salt water is harmful to land mammals, like the African elephant, but not to marine fish. (4 marks)

Description	Marks
fish can actively remove excess salt via gills	1
fish kidneys can also remove a lot of salt/concentrated urine	1
land mammals do not have a mechanism to remove excess salt or kidneys of land mammals can only remove some of the extra salt	1
the extra salt in land mammals disrupts the salt-water balance of blood/body fluids/cells	1
Total	**4**

2022 Section 2 Question 32 Homeo-stasis	A range of rodent species (e.g. mice and rats) lives in hot deserts.

2022 Section 2 Question 32

Homeo-stasis

A range of rodent species (e.g. mice and rats) lives in hot deserts.

(a) Outline two main ways in which rodents that live in deserts lose water to the environment. (4 marks)

Description	Marks
Any two of (2 x 2 marks)	
• breathing/exhaling/panting and evaporation of moisture from lungs • excretion/urination/expelling waste/defaecation and water is needed to excrete urea/urine or to expel faeces/waste • sweat glands/sweating and evaporation of water from skin	1–4
Total	**4**

The following table shows data on the body mass and kidney mass in two species of rodent that live in deserts and in related species that live in moist environments. Kidney mass as a percentage of body mass is given for three of these species.

Species	Environment	Kidney mass (g)*	Body mass (kg)*	Kidney mass as a percentage of body mass
Octodon degus	desert	1.400	0.160	0.875
Octodon bridgesi	moist	0.920	0.163	0.564
Peromyscus eremicus	desert	0.445	0.023	1.934
Peromyscus leucopus	moist	0.117	0.027	

* 1 kg = 1000 g

(b) Calculate kidney mass as a percentage of body mass for Peromyscus leucopus. Show your workings. (4 marks)

Description	Marks
0.433	1
0.027 × 1000 (to convert kg to g) or 0.117 ÷ 1000 (to convert g to kg)	1
0.117 ÷ 27 or 0.000117 ÷ 0.027	1
0.0043 × 100 (to convert to percentage) or (0.117 ÷ 0.027) × (100 ÷ 1000) or (0.117 ÷ 0.027) × 0.1	1
Total	**4**

(c) Kidney mass as a percentage of body mass is often higher in rodents that live in deserts than in related species that live in moist environments. Explain why. (4 marks)

Description	Marks
Any four of	
• desert rodents need to minimise water loss **or** rodents in moist environments do not need to minimise water loss • the kidney is used to maintain salt-water balance/control the amount of water excreted/reabsorb water • (in desert rodents) large amounts of water are reabsorbed/recovered from urine **or** urine is highly concentrated • larger kidney size gives larger area for water reabsorption or the Loop of Henle is longer in (some) desert rodents • the Loop of Henle (is the part of the kidney that) recovers the water	1–4
Total	**4**

A range of bird species also live in hot deserts.

(d) The hornbill is a type of desert bird noted for having a very large beak with a rich supply of blood vessels. Explain how such a beak aids the hornbill in regulating its body temperature. (4 marks)

Description	Marks
Any four of	
• heat transfer/loss with the environment can occur via the beak • (rich supply of blood vessels) so a lot of blood moves through the beak • (beak is large) so there is a large area in contact with the environment/air **or** there is a large area over which heat can be lost/transferred • blood vessels bring warm blood (from the core of the body) to the beak • heat is lost to the environment by convection/conduction/radiation (if the environment is cooler than the blood) • can constrict blood vessels to minimise blood flow/heat loss **or** can dilate blood vessels to maximise blood flow/heat loss	1–4
Total	**4**

(e) The body temperature of desert birds is typically around 5 °C higher than that of desert rodents. This gives the birds an advantage over the rodents in losing heat to the environment via radiation. Explain why. (3 marks)

Description	Marks
Heat moves from a higher to a lower temperature **or** there is a net transfer of heat from a higher to a lower temperature.	1
(Birds/rodents/animals can lose heat to environment/air/surroundings) when their body temperature is higher than the environment/air/surroundings.	1
the birds can lose heat at a hotter temperature/over a broader range of temperatures than the rodents **or** the converse/at a faster rate.	1
Total	**3**

2021 Section 2 Question 32 **Homeo-stasis**	Many animal and plant species inhabit arid environments.

(a) (i) What name is used to describe plants adapted to arid environments? (1 mark)

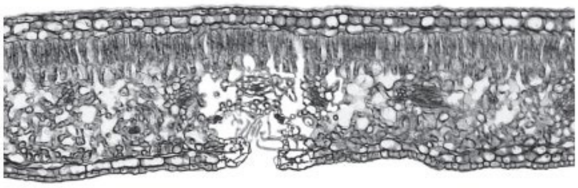
Description	Marks
xerophyte	1
Total	**1**

(ii) Describe how these plants lose water to the environment. (2 marks)

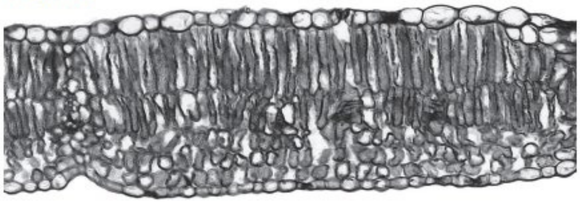
Description	Marks
as water vapour **or** via evaporation of water **or** via transpiration	1
from (open) stomata (in the leaves)	1
Total	**2**

(b) The figures below show cross-sections through the leaves of two plants. One of these plants occurs in an arid environment.

Plant A



Plant B

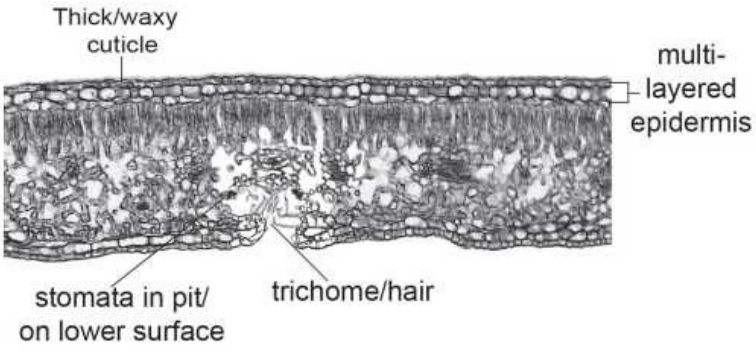


(i) On the basis of the features visible in each cross-section, indicate which plant (A or B) occurs in an arid environment. (1 mark)

Description	Marks
(plant) A	1
Total	**1**

(ii) On the relevant cross-section, label four features that indicate one of the plants is from an arid environment. (4 marks)

Description	Marks
• thick/waxy cuticle • multi-layered epidermis • hairs/trichomes • stomata on lower surface/pit/sunken	1–4
Total	**4**



(c) The seeds of some plants that live in arid environments can germinate after many years in the soil. Explain how this characteristic can help these plants to survive in these environments. (4 marks)

Description	Marks
seeds are dormant so do not need water	1
plants are growing and need water	1
seeds only germinate after rain/when water is available	1
thus active plant growth occurs at times when water is available	1
Total	**4**

(d) Apart from drinking, outline two ways in which animals obtain water in arid environments. (4 marks)

Description	Marks
• diet • gain water from plants/animals that they consume	1–2
Subtotal	**2**
• fat/fat stores/carbohydrates • metabolism/respiration/breakdown of fat/carbohydrate generates water	1–2
Subtotal	**2**
Total	**4**

	(e) Some species of fish inhabit bodies of water in arid regions in Australia. The salinity (salt content) of these bodies of water is usually higher than that of sea water but can fall below that of sea water after large amounts of rainfall. Explain the challenges that a fish faces in maintaining salt-water balance in these bodies of water. (4 marks)

Description	Marks
High salinity	
salt content of fish is (usually) less/hypotonic to water **or** salt content of water is (usually) higher/hypertonic to fish	1
water will tend to flow from fish to water **and/or** salt will tend to accumulate in fish	1
water loss/salt accumulation will occur at fast rate because the salt content of the water is much higher than that of fish **or** because the salt content of fish is much lower than that of water	1
Variability	
if/when salt content of water drops below that of fish (when there is a lot of rain), the fish will have the reverse problem **or** will tend to accumulate water and lose salts **or** will have to change the direction of osmoregulation	1
Total	**4**

2020 Section 2 Question 34

Homeostasis

The greater bilby (*Macrotis lagotis*) lives in desert and grassland areas in northern Australia.

(a) (i) Thermoregulation in the greater bilby is an example of homeostasis. Define homeostasis. (1 mark)

Description	Marks
process organisms use to maintain stable internal conditions/constant internal environment	1
Total	**1**

(ii) The greater bilby uses a negative feedback mechanism to thermoregulate. State the defining feature of a negative feedback mechanism. (1 mark)

Description	Marks
response counteracts the change **or** response reduces stimulus	1
Total	**1**

The greater bilby's body temperature is normally 37 °C.

(iii) Indicate whether a rise in the body temperature above 37 °C would be a stimulus or a response in a negative feedback mechanism. Give a reason for your answer. (2 marks)

Description	Marks
stimulus	1
it is a disruption of homeostasis **or** it is the change that brings about the response	1
Total	**2**

(b) Explain how a greater bilby's ears could help it to thermoregulate. (4 marks)

Description	Marks
Any **four** of:	
• blood/ blood vessels bring heat (from the core of the body) to the ears • heat is exchanged (with the environment) via the ears **or** heat is lost through the ears • can increase blood supply to increase heat loss **or** decrease blood supply to reduce heat loss • large size/high surface area to volume ratio allows for a lot of heat exchange **or** a for large area for heat exchange • hairless ears make heat loss more efficient **or** there is no insulation (to trap air close to the body) **or** the surface of the ears is in direct contact with the air	1–4
Total	**4**

The thorny lizard (*Moloch horridus*) lives in desert areas in Australia. Scientists measured the rate of oxygen consumption in thorny lizards at rest at four different environmental temperatures in the laboratory. The results are shown in the table below.

Environmental temperature (°C)	Mean rate of oxygen consumption at rest ($cm^3g^{-1}hr^{-1}$)
15	0.3
20	0.6
25	1.1
35	1.5

(c) (i) State the relationship between environmental temperature and mean rate of oxygen consumption in thorny lizards at rest. (1 mark)

Description	Marks
as environmental temperature increases so does oxygen consumption **or** as environmental temperature decreases so does oxygen consumption **or** environmental temperature and oxygen consumption are positively correlated	1
Total	**1**

(ii) Explain the reason for the relationship described in part (c)(i). (3 marks)

Description	Marks
oxygen consumption is a measure of the metabolic rate	1
the metabolic rate of the lizard depends on the body temperature **or** the metabolic rate is higher at higher temperatures **or** the metabolic rate is lower at lower temperatures	1
because the lizard is an ectotherm **or** because the body temperature of the lizard varies with the environment	1
Total	**3**

(d) The colour of the scales on a thorny lizard changes from pale during warmer months to darker during cooler months. Explain how this helps the lizard to thermoregulate. (4 marks)

Description	Marks
external temperature is higher than optimal body temperature during warmer months **or** lower than optimal body temperature during cooler months	1
pale scales reflect more (radiant) heat	1
dark scales absorb more (radiant) heat	1
reduce heating in warmer months **or** increase heating during cooler months	1
Total	**4**

(e) There are approximately 55 species of true sea snakes. These snakes are common in warm tropical waters but do not occur in colder waters. Provide a plausible explanation for this distribution. (4 marks)

Description	Marks
Any **four** of:	
• sea snakes are ectotherms **or** the body temperature of the sea snakes varies with the environment • need to retain/gain body heat in order to function • heat will be lost to water by conduction • the rate of heat loss is determined by the temperature difference between the sea snakes and the water • (therefore) heat loss will be less in warm water **or** greater in colder water **or** more opportunity to gain heat in warm water **or** less opportunity to gain heat in colder water • heat loss/conduction is higher in water than land (so the problem is acute for sea snakes) • sea snakes are relatively small/have a high surface area to volume ratio (and therefore experience relatively high rates of heat loss)	1–4
Total	**4**

2019 Section 2 Question 33

Homeostasis

(a) (i) Outline the role of the effector in homeostasis. (2 marks)

Description	Marks
effector receives signals from the processor/coordinating centre/modulator	1
brings about change (needed to maintain homeostasis)	1
Total	**2**

(ii) Outline the role of the receptor in homeostasis. (2 marks)

Description	Marks
receptor detects stimulus	1
sends signal to the processor/coordinating centre/modulator	1
Total	**2**

(iii) State the defining feature of a negative feedback loop. (1 mark)

Description	Marks
response/feedback reduces stimulus	1
Total	**1**

(b) A marine fish regulates its water and salt balance. Is this an example of homeostasis? Give reasons for your answer. (3 marks)

Description	Marks
Example of homeostasis	
yes (must be a clear yes)	1
Subtotal	**1**
Reasons why this is an example of homeostasis:	
• homeostasis is maintenance of a relatively constant internal environment • (marine) fish maintains (relatively) constant salt-water balance despite external environment **or** (marine) fish maintain internal salt concentration at a lower concentration than seawater **or** (marine) fish is osmoregulating to maintain internal salt-water balance	1–2
Subtotal	**2**
Total	**3**

The diagram below shows a cross-section through a plant leaf.

(c) List four features visible in the diagram above that would assist the plant to conserve water. (4 marks)

Description	Marks
Lists any **four** of the following features:	
• stomata on lower surface • stomata in pits or sunken stomata • hairs/trichomes • cuticle (on upper surface) • multicellular/thick epidermis • guard cells	1–4
Total	**4**

(d) The root systems of xerophytes often include spreading roots just beneath the soil surface. Outline two advantages of these surface roots for xerophytes. (4 marks)

Description	Marks
Any **two** of the following advantages:	
Advantage 1 (large surface area of roots) • (roots) cover a large surface area • increases chances of finding water **or** provide anchorage Advantage 2 (roots close to surface) • can access surface water **or** small amounts of water on the surface • can absorb water before it evaporates **or** can quickly absorb water Advantage 3 (large volume of roots) • large volume (of roots) • more room to store water	1–4
Total	**4**

(e) Some xerophytes produce heat-shock proteins in response to heat stress. These proteins prevent the denaturation of other proteins. Explain how this could assist the survival of the xerophyte. (4 marks)

Description	Marks
Explains how heat shock proteins assist survival:	
• proteins/enzymes are essential for organism/cell function • proteins are essential for organism/cell structure • heat can denature proteins • heat shock proteins prevent death **or** heat shock proteins ensure normal function	1–4
Total	**4**

Unit 4 – Infectious disease

Section 1

2023 Section 1 Question 1 **Infectious disease**	*Phytophthora* is a pathogen that infects (a) Australian native plants only. (b) Australian native animals only. (c) a broad range of plants. (d) a broad range of animals

2023 Section 1 Question 6 **Infectious disease**	Herd immunity for a particular infectious disease (a) reduces the chances of an epidemic occurring. (b) removes the need for effective disease treatment. (c) stops all transmission of the disease. (d) depends on a suitable antibiotic treatment.

2023 Section 1 Question 9 **Infectious disease**	The pathogen that causes malaria (a) is transmitted by *Aedes* mosquitoes. (b) typically kills both the human and mosquito hosts. (c) infects the salivary glands of humans. (d) multiplies in human liver and red blood cells.

2023 Section 1 Question 11 **Infectious disease**	In crown gall disease, the galls are made up of (a) bacterial cells. (b) fungal cells. (c) protist cells. (d) host cells.

2023 Section 1 Question 18 **Infectious disease**	In Western Australia, permits are required to move honeybees, honey and bee-keeping equipment between regions within the State. The **main** reason for this regulation is to (a) reduce competition between honeybees and native bees. (b) ensure that honeybees are available to pollinate crops. (c) limit the spread of honeybee pathogens. (d) regulate the number of honeybees present in a region.

2023 Section 1 Question 22 **Infectious disease**	An infectious disease that spreads by direct contact between hosts will spread most rapidly if host population density is (a) high and infected hosts rarely die from the disease. (b) high and hosts quickly die from the disease. (c) low and infected hosts rarely die from the disease. (d) low and hosts quickly die from the disease.

2022 Section 1 Question 3 **Infection disease**	Tuberculosis is (a) a viral disease of the nervous system. (b) a fungal disease of the lungs. (c) transmitted by a vector. (d) transmitted by airborne particles.

2022 Section 1 Question 9 **Infection disease**	Which one of the following is an example of a disease management strategy that disrupts the life cycle of the pathogen? (a) biosecurity at airports to prevent the entry of disease-carrying materials (b) immunisation to prevent tetanus infection from a puncture wound (c) prohibition of access to forest areas to control phytophthora dieback (d) application of insecticides to the indoor walls of houses to control malaria

2022 Section 1 Question 12 **Infection disease**	Select the correct statement about infectious diseases. (a) All human diseases are caused by pathogens. (b) Antiviral medications destroy viruses. (c) Vectors do not transmit bacterial diseases. (d) A zoonosis is an animal disease that can infect humans.

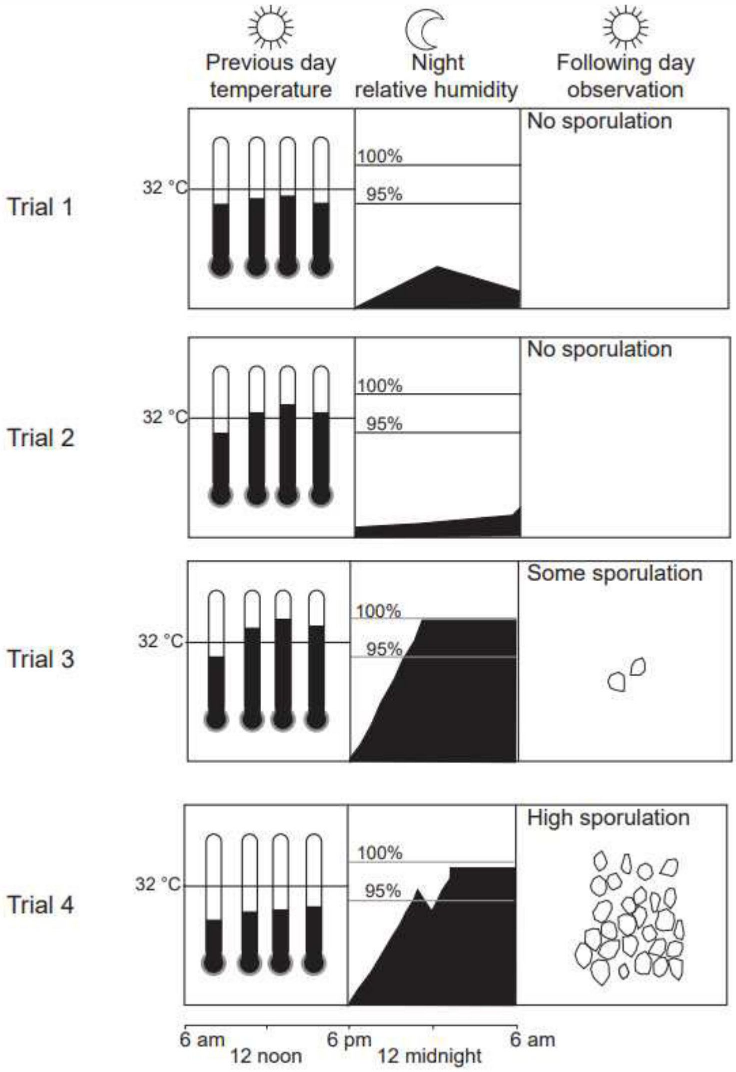
2022 Section 1 Question 13 **Infection disease**	Which of the following pathogens causes a zoonotic disease? (a) Australian bat lyssavirus (b) Phytophthora (c) Agrobacterium (d) Ross River virus

2022 Section 1 Question 21 **Infection disease**	Viruses are (a) unicellular. (b) multicellular. (c) smaller than bacteria. (d) larger than protists.

2022 Section 1 Question 25 **Infection disease**	Antibiotic resistance evolves rapidly in pathogens because they have (a) small genomes. (b) large genomes. (c) short generation times. (d) long generation times.

2021 Section 1 Question 3 **Infection disease**	Chytridiomycosis is caused by a (a) protist and affects a large number of amphibian species. (b) protist and affects a small number of amphibian species. (c) fungus and affects a large number of amphibian species. (d) fungus and affects a small number of amphibian species.

2021 Section 1 Question 8 **Infection disease**	Ross River fever is (a) transmitted by mosquitoes. (b) spread through the air. (c) a fungal disease of plants. (d) a bacterial disease of humans.

2021 Section 1 Question 13-14 **Infection disease**	Questions 13 and 14 relate to the following information. Blue mould disease in tobacco plants is caused by a fungus that grows within the leaves. The fungus reproduces by forming spores on the underside of the leaves (sporulation). Biologists investigated the influence of temperature from the previous day and relative humidity during the night on the extent of sporulation. The results are summarised below.  13. Which of the following statements about the data in the figure is correct? (a) In trial 1, the relative humidity reached 95% during the night. (b) In trial 2, the temperature reached 32 °C during the previous day. (c) In trial 3, the relative humidity was higher at 6 pm than at 12 midnight. (d) In trial 4, morning temperatures were higher than afternoon temperatures during the previous day. 14. According to the figure, sporulation is highest when the temperature during the previous day (a) does not exceed 32 °C and relative humidity is below 95% for at least 6 hours overnight. (b) fluctuates widely and relative humidity exceeds 95% for at least 6 hours overnight. (c) exceeds 32 °C and relative humidity is below 95% for at least 6 hours overnight. (d) does not exceed 32 °C and relative humidity exceeds 95% for at least 6 hours overnight.

2021 Section 1 Question 17 **Infection disease**	The Australian bat lyssavirus is usually transmitted to humans as a result of (a) a scratch or bite from a bat. (b) contact with bat faeces. (c) ingesting fruit contaminated with bat saliva. (d) a bite from a mosquito that has previously bitten a bat.

2021 Section 1 Question 24 **Infection disease**	Which of the following management strategies is effective in reducing the incidence of tetanus? (a) antiviral medication (b) herd immunity (c) vaccination (d) quarantine

2021 Section 1 Question 26 **Infection disease**	A bacterial pathogen causes eye disease in finches. Biologists wanted to know whether the finches could evolve resistance to this pathogen. Finches from a population that had prior exposure to the pathogen, and from a population that had no prior exposure, were infected with the pathogen deliberately. After two weeks, the biologists determined the pathogen load in the two groups of finches. The independent variable in this experiment is the (a) deliberate infection of finches with the pathogen. (b) prior exposure of a population to the pathogen. (c) two-week duration of the experiment. (d) pathogen load in the two groups of finches.

2021 Section 1 Question 27 **Infection disease**	Compared to their hosts, pathogens are typically able to evolve more rapidly because they have (a) simpler genomes. (b) more complex genomes. (c) longer generation times. (d) shorter generation times.

2021 Section 1 Question 29 **Infection disease**	Which of the following statements about herd immunity is correct? (a) Herd immunity is a theoretical goal in disease management but cannot be achieved in practice. (b) Herd immunity is effective for preventing disease transmission in low-density populations but not in high-density populations. (c) The percentage of people who need to be immune for a population to achieve herd immunity varies with each disease. (d) Antibiotics can help a population obtain herd immunity against bacterial diseases.

2020 Section 1 Question 2 **Infection disease**	A virus consists of a (a) protein coat and a nucleic acid. (b) protein coat and ribosomes. (c) cell wall and a nucleic acid. (d) cell wall and ribosomes.

2020 Section 1 Question 4 **Infection disease**	A zoonotic disease is transmitted (a) by an animal pathogen. (b) by a mosquito vector. (c) between animals and humans. (d) between animals and plants.

2020 Section 1 Question 8 **Infection disease**	Crown gall in plants is caused by (a) a DNA virus. (b) an RNA virus. (c) *Agrobacterium.* (d) *Phytophthora.*

2020 Section 1 Question 15 **Infection disease**	The amphibian chytrid pathogen causes disease in frogs by invading the (a) lungs and reducing the ability of the frog to breathe. (b) mouth and reducing the ability of the frog to breathe. (c) kidneys and reducing the ability of the frog to exchange water and gases. (d) skin and reducing the ability of the frog to exchange water and gases.

2020 Section 1 Question 17 **Infection disease**	Climate change is affecting the distribution of Ross River virus through its effects on activity and reproduction in the (a) viral pathogen. (b) bacterial pathogen. (c) human host. (d) mosquito vector.

2020 Section 1 Question 18 **Infection disease**	The pathogen that causes tetanus (a) is directly transmitted from host to host. (b) invades a host through a wound. (c) cannot survive outside of the host. (d) reproduces by mitosis.

2020 Section 1 Question 30 **Infection disease**	Antibiotics are effective in treating the (a) virus that causes influenza. (b) bacterium that causes influenza. (c) secondary bacterial infections in people with influenza. (d) secondary viral infections in people with influenza.

2019 Section 1 Question 1 **Infection disease**	A sudden increase in the number of people with an infectious disease in a location is called (a) an endemic. (b) an epidemic. (c) a pandemic. (d) a peridemic.

2019 Section 1 Question 4 **Infection disease**	A virus (a) does not contain protein. (b) does not contain nucleic acid. (c) can synthesise both proteins and nucleic acids. (d) cannot synthesise either proteins or nucleic acids.

2019 Section 1 Question 7 **Infection disease**	The **best** strategy for controlling the incidence of tetanus is the use of (a) antibiotics. (b) antivirals. (c) quarantine. (d) immunisation.

2019 Section 1 Question 13 **Infection disease**	Herd immunity (a) can be obtained through vaccination but not through natural infection. (b) can be obtained through natural infection but not through vaccination. (c) can be obtained through both vaccination and natural infection. (d) cannot be obtained through either vaccination or natural infection.

2019 Section 1 Question 16 **Infection disease**	Which of the following would lead to a significant decline in the incidence of malaria in an area? (a) People are exposed to the pathogen. (b) People are treated with antibiotics. (c) Stagnant water bodies are drained. (d) Wild populations of bats are removed.

2019 Section 1 Question 19-20

Infection disease

Questions 19 and 20 relate to the information below. Some businesses provide life insurance for pets. Data were obtained from one business on the cause of death of insured cats over the period 1999–2006. The data are shown in the table below.

Cause of death	Number of insured cats
kidney failure	907
traffic accidents	411
other accidents	153
skin cancers	165
blood cancers	235
other cancers	128
viral infections	407
bacterial infections	24
heart disease	421
hormonal disease	98

19. What proportion of cats in the data above died from cancers?

(a) 0.04
(b) 0.12
(c) 0.14
(d) 0.18

20. Which of the following is a valid conclusion from the data?

(a) Few owners vaccinate their cats against viral infections.
(b) Kidney failure is the most common cause of death in uninsured cats.
(c) Infectious diseases killed more insured cats than heart disease.
(d) Cat owners mainly insure their cats when the cats are ill.

2019 Section 1 Question 21 **Infection disease**	Protists may have (a) mitochondria but not ribosomes or cell walls. (b) ribosomes but not mitochondria or cell walls. (c) ribosomes and cell walls but not mitochondria. (d) mitochondria, ribosomes and cell walls.

2023 Section 2 Question 34 **Infectious disease**	(a) Identify the four main groups of organisms that cause infectious diseases. (4 marks) One: _____ Two: _____ Three: _____ Four: _____ Polycystic kidney is an inherited, genetic disease in cats that may eventually cause kidney failure. Bovine tuberculosis is an example of a zoonosis. (c) Define the term 'zoonosis'. (1 mark) (d) Outline how tuberculosis is transmitted. (2 marks)

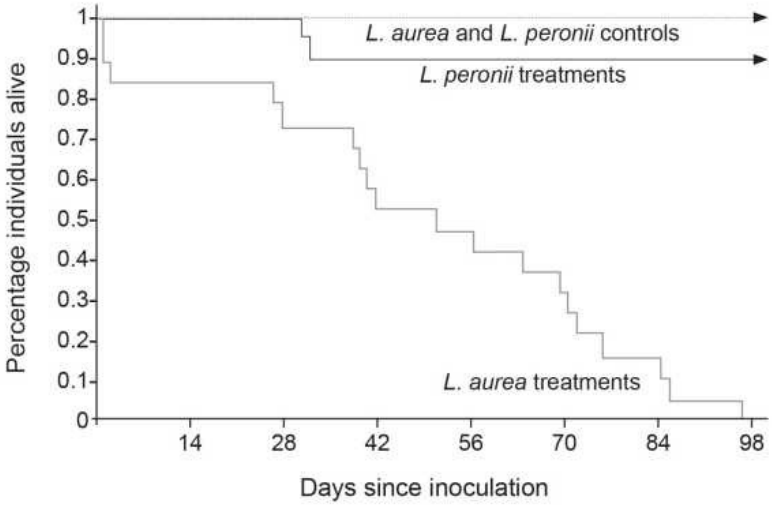
(e) Explain why antibiotics are used to treat tuberculosis, but not influenza. (4 marks)

Antibiotic treatment for tuberculosis requires daily doses for four to six months. When treatment was first made available in the 1940s, it was highly effective. Since then, antibiotic resistant strains of tuberculosis have developed.

(f) Explain how these resistant strains have arisen. (5 marks)

2022 Section 2 Question 35 **Infection disease**	Population size in many frog species is declining. The disease chytridiomycosis is contributing to the decline in some species. (a) (i) State the type of pathogen that causes chytridiomycosis. (1 mark) (ii) Chytridiomycosis disrupts homeostasis in the frog host. Define 'homeostasis'. (1 mark) (iii) State the aspect of homeostasis in the frog host that is disrupted by chytridiomycosis. (1 mark) (b) Outline how chytridiomycosis is transmitted between frogs. (3 marks)

Biologists conducted an experiment to compare survival rates in two frog species, *Litoria aurea* and *Limnodynastes peroni*, after exposure to the chytridiomycosis pathogen. The frogs were kept in tanks, with six separate tanks being used for each species. For each species, frogs in three tanks were inoculated with the pathogen (treatments) and those in the other three tanks were not inoculated with the pathogen (control). The biologists measured the percentage of individuals that remained alive in each tank every few days for up to 100 days. The mean percentages of individuals alive for the control and treatment tanks for each species are shown in the figure below.



(c) (i) State a hypothesis for the experiment. (1 mark)

___

___

(ii) On the basis of the results of the experiment, which frog species is most susceptible to chytridiomycosis? Justify your answer. (4 marks)

___

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(d) (i) Distinguish between the reliability and validity of an experiment. (2 marks)

(ii) List three distinctly different factors in the frog-chytridiomycosis experiment on page 23 that would be needed to ensure that the results were valid. (3 marks)

One:

Two:

Three:

(e) Population size is declining in some frog species due to reasons other than disease. Explain how knowledge of the reproductive behaviour of a frog species can assist with conservation planning to minimise population decline. (4 marks)

2021 Section 2 Question 33 **Infection disease**	Fish farming is the fastest-growing agricultural sector in the world. In this method of farming, fish are grown in ponds, cages, tanks or other types of enclosures, usually for food.

A major problem in fish farming is infectious diseases such as those caused by bacteria.

A team of biologists investigated the types of bacteria present in two species of fish in four settings:

- ponds
- cages
- tanks
- a lake where both species occur naturally

The biologists identified the bacteria present by sampling the following:

- six fish from each of
  - 33 ponds
  - five cages
  - two tanks
- 57 fish from eight sites in the lake.

The table below shows the numbers of ponds, cages, tanks and lake sites in which each type of bacteria was found.

	Setting			
Type of bacteria	**Ponds (n = 33)**	**Cages (n = 5)**	**Tanks (n = 2)**	**Lake sites (n = 8)**
Aeromonas hydrophila	13	3	2	3
Aeromonas sobria	8	1	0	1
Edwardsiella tarda	2	1	1	0
Flavobacterium spp.	1	1	0	0
Streptococcus spp.	1	2	0	0
Pseudomonas aeruginosa	2	0	1	0
Pseudomonas fluorescens	3	1	0	1
Vibrio cholerae	5	0	0	0
Ralstonia picketti	1	0	0	0
Comamonas testosteroni	4	0	0	0
Citrobacter freundii	0	2	0	0
Plesiomonas shigelloides	9	2	0	1
Chryseobacterium indoligenes	5	1	0	0
Pseudomonas stutzeri	1	0	0	0
Burkholderia cepacia	1	0	0	0
Klebsiella spp.	1	0	0	1
Serratia marcescens	0	2	0	0
Proteus spp.	8	1	0	1
Number of different types of bacteria	16		3	6

(a) Complete the table by determining the number of different types of bacteria found in fish from cages. (1 mark)

(b) Draw a bar graph to show the number of different types of bacteria found in fish in each of the four settings. (5 marks)

(c) (i) List the settings in which Pseudomonas fluorescens was found. (1 mark)

(ii) Identify which type of bacteria was found in ponds, cages and tanks but not from lake sites? (1 mark)

(d) A fish farmer reviewed the data and concluded that fish in tanks have fewer different types of bacteria than those in ponds, cages or the lake. Evaluate this conclusion. (4 marks)

(e) Florfenicol is a type of antibiotic that is widely used to manage outbreaks of bacterial diseases in fish farming. It acts by inhibiting translation in bacterial cells. Explain how florfenicol can help to manage outbreaks of bacterial diseases in fish farming. (3 marks)

(f) DNA technology has been used to produce a line of fish with increased resistance to infection by certain bacteria. Outline the four main steps required to produce a line of transgenic fish with increased resistance to infection by certain bacteria. (4 marks)

Step 1:

Step 2:

Step 3:

Step 4:

2021 Section 2 Question 34 **Infection disease**	Honey bees suffer from a range of viral diseases. (a) (i) List the two main structural features of a virus. (2 marks) One: Two: Many biologists do not regard a virus as a living organism. (ii) List two characteristics of a virus that suggest that it is not a living organism. (2 marks) One: Two: One of these viruses, the deformed wing virus, causes shrunken and abnormal wings in honey bees as shown in the honey bee in the photograph below.  The *Varroa* mite (a type of arthropod) invades honey bee colonies, and attacks and feeds on the bees. It is a vector for this virus. (b) (i) Is deformed wing in honey bees an infectious disease? Give reasons for your answer. (3 marks)

(ii) State what is a disease vector. (2 marks)

(c) The Varroa mite is common in many countries but there is no established infestation in Australia. However, this mite has been detected in a bee colony in Queensland. Outline two measures that could be used to reduce the chances of this mite becoming established in Australia. (4 marks)

One:

Two:

(d) The deformed wing virus is an RNA virus. Its genome is 10 140 nucleotides in length. One part of the genome, which is 450 nucleotides in length, codes for the VP1 protein. On this basis, how many amino acids are there in the VP1 protein? Justify your answer. (3 marks)

	(e) The diploid number of chromosomes in honey bees is 32. Queen bees are diploid and produce eggs by meiosis. Female worker bees hatch from fertilised eggs whereas male bees hatch from unfertilised eggs. How many chromosomes will occur in male bees? Explain your answer. (4 marks)
2020 Section 2 Question 31 **Infection disease**	The pathogen that causes jarrah dieback is a type of protist. (a) (i) List two structural features of protists that are not found in bacteria. (2 marks) One: Two: (ii) List two structural features of protists that are not found in fungi. (2 marks) One: Two:

In order to prevent the spread of jarrah dieback, vehicles are banned from driving on some tracks when the soil is wet.

(b) Explain how this can prevent the spread of jarrah dieback. (4 marks)

(c) (i) Describe how the tuberculosis pathogen is transmitted to a new host. (2 marks)

(ii) Describe the impact that the tuberculosis pathogen has on the host. (2 marks)

(d) Explain how vaccination helps to control the spread of tuberculosis. (4 marks)

	(e) When travellers enter Australia from overseas, they are required to declare all plant and animal matter that they have brought with them. Explain why. (4 marks)

2019 Section 2 Question 34 **Infection disease**	(a) (i) Name a disease that is caused by a protist and can be spread by water. (1 mark) (ii) Name a disease that is caused by a fungus and can be spread by water. (1 mark) (iii) Name a human viral disease that is transmitted by an insect. (1 mark) (iv) Name a human disease that is caused by a protist. (1 mark)

Crown gall is a disease of plants that is caused by some strains of *Agrobacterium* (sometimes called *Rhizobium*).

(b) Is crown gall an infectious disease? Give reasons for your answer. (3 marks)

(c) Describe the method used by *Agrobacterium* to invade the plant host. (4 marks)

(d) Describe the impact that Agrobacterium has on the plant host. (5 marks)

	Agrobacterium is commonly used in the production of transgenic plants (its capacity to cause disease is deactivated first). (e) Outline the role that *Agrobacterium* plays in the production of transgenic plants and explain why it is well-suited to this role. (4 marks)

Marking Guide – Section 1

2023 Section 1 Question 1 **Infectious disease**	*Phytophthora* is a pathogen that infects (a) Australian native plants only. (b) Australian native animals only. **(c) a broad range of plants. – Answer** (d) a broad range of animals

2023 Section 1 Question 6 **Infectious disease**	Herd immunity for a particular infectious disease **(a) reduces the chances of an epidemic occurring. – Answer** (b) removes the need for effective disease treatment. (c) stops all transmission of the disease. (d) depends on a suitable antibiotic treatment.

2023 Section 1 Question 9 **Infectious disease**	The pathogen that causes malaria (a) is transmitted by *Aedes* mosquitoes. (b) typically kills both the human and mosquito hosts. (c) infects the salivary glands of humans. **(d) multiplies in human liver and red blood cells. – Answer**

2023 Section 1 Question 11 **Infectious disease**	In crown gall disease, the galls are made up of (a) bacterial cells. (b) fungal cells. (c) protist cells. **(d) host cells. – Answer**

2023 Section 1 Question 18 **Infectious disease**	In Western Australia, permits are required to move honeybees, honey and bee-keeping equipment between regions within the State. The **main** reason for this regulation is to (a) reduce competition between honeybees and native bees. (b) ensure that honeybees are available to pollinate crops. **(c) limit the spread of honeybee pathogens. – Answer** (d) regulate the number of honeybees present in a region.

2023 Section 1 Question 22 **Infectious disease**	An infectious disease that spreads by direct contact between hosts will spread most rapidly if host population density is **(a) high and infected hosts rarely die from the disease. – Answer** (b) high and hosts quickly die from the disease. (c) low and infected hosts rarely die from the disease. (d) low and hosts quickly die from the disease.

2022 Section 1 Question 3 **Infection disease**	Tuberculosis is (a) a viral disease of the nervous system. (b) a fungal disease of the lungs. (c) transmitted by a vector. **(d) transmitted by airborne particles. – Answer**

2022 Section 1 Question 9 **Infection disease**	Which one of the following is an example of a disease management strategy that disrupts the life cycle of the pathogen? (a) biosecurity at airports to prevent the entry of disease-carrying materials (b) immunisation to prevent tetanus infection from a puncture wound (c) prohibition of access to forest areas to control phytophthora dieback **(d) application of insecticides to the indoor walls of houses to control malaria – Answer**

2022 Section 1 Question 12 **Infection disease**	Select the correct statement about infectious diseases. (a) All human diseases are caused by pathogens. (b) Antiviral medications destroy viruses. (c) Vectors do not transmit bacterial diseases. **(d) A zoonosis is an animal disease that can infect humans. – Answer**

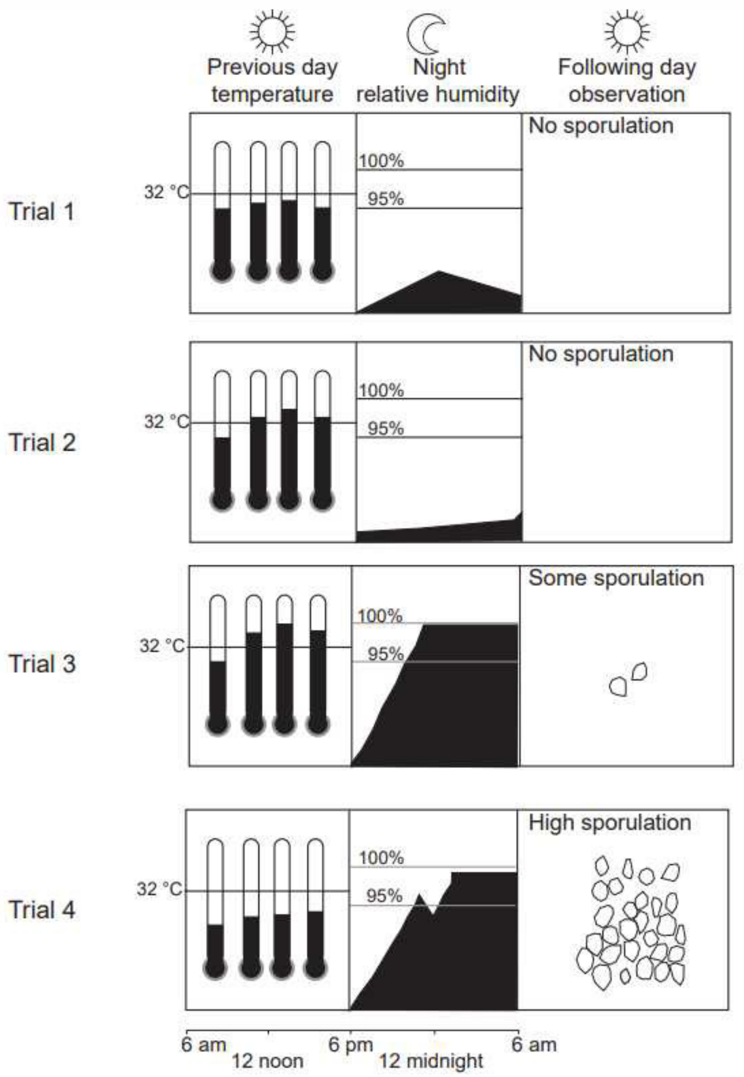
2022 Section 1 Question 13 **Infection disease**	Which of the following pathogens causes a zoonotic disease? **(a) Australian bat lyssavirus – Answer** (b) Phytophthora (c) Agrobacterium (d) Ross River virus

2022 Section 1 Question 21 **Infection disease**	Viruses are (a) unicellular. (b) multicellular. **(c) smaller than bacteria. – Answer** (d) larger than protists.

2022 Section 1 Question 25 **Infection disease**	Antibiotic resistance evolves rapidly in pathogens because they have (a) small genomes. (b) large genomes. **(c) short generation times. – Answer** (d) long generation times.

2021 Section 1 Question 3 **Infection disease**	Chytridiomycosis is caused by a (a) protist and affects a large number of amphibian species. (b) protist and affects a small number of amphibian species. **(c) fungus and affects a large number of amphibian species. – Answer** (d) fungus and affects a small number of amphibian species.

2021 Section 1 Question 8 **Infection disease**	Ross River fever is **(a) transmitted by mosquitoes. – Answer** (b) spread through the air. (c) a fungal disease of plants. (d) a bacterial disease of humans.

2021 Section 1 Question 13-14 **Infection disease**	Questions 13 and 14 relate to the following information. Blue mould disease in tobacco plants is caused by a fungus that grows within the leaves. The fungus reproduces by forming spores on the underside of the leaves (sporulation). Biologists investigated the influence of temperature from the previous day and relative humidity during the night on the extent of sporulation. The results are summarised below.  13. Which of the following statements about the data in the figure is correct? (a) In trial 1, the relative humidity reached 95% during the night. **(b) In trial 2, the temperature reached 32 °C during the previous day. – Answer** (c) In trial 3, the relative humidity was higher at 6 pm than at 12 midnight. (d) In trial 4, morning temperatures were higher than afternoon temperatures during the previous day. 14. According to the figure, sporulation is highest when the temperature during the previous day (a) does not exceed 32 °C and relative humidity is below 95% for at least 6 hours overnight. (b) fluctuates widely and relative humidity exceeds 95% for at least 6 hours overnight. (c) exceeds 32 °C and relative humidity is below 95% for at least 6 hours overnight. **(d) does not exceed 32 °C and relative humidity exceeds 95% for at least 6 hours overnight. – Answer**

2021 Section 1 Question 17 **Infection disease**	The Australian bat lyssavirus is usually transmitted to humans as a result of **(a) a scratch or bite from a bat. – Answer** (b) contact with bat faeces. (c) ingesting fruit contaminated with bat saliva. (d) a bite from a mosquito that has previously bitten a bat.

2021 Section 1 Question 24 **Infection disease**	Which of the following management strategies is effective in reducing the incidence of tetanus? (a) antiviral medication (b) herd immunity **(c) vaccination – Answer** (d) quarantine

2021 Section 1 Question 26 **Infection disease**	A bacterial pathogen causes eye disease in finches. Biologists wanted to know whether the finches could evolve resistance to this pathogen. Finches from a population that had prior exposure to the pathogen, and from a population that had no prior exposure, were infected with the pathogen deliberately. After two weeks, the biologists determined the pathogen load in the two groups of finches. The independent variable in this experiment is the (a) deliberate infection of finches with the pathogen. **(b) prior exposure of a population to the pathogen. – Answer** (c) two-week duration of the experiment. (d) pathogen load in the two groups of finches.

2021 Section 1 Question 27 **Infection disease**	Compared to their hosts, pathogens are typically able to evolve more rapidly because they have (a) simpler genomes. (b) more complex genomes. (c) longer generation times. **(d) shorter generation times. – Answer**

2021 Section 1 Question 29 **Infection disease**	Which of the following statements about herd immunity is correct? (a) Herd immunity is a theoretical goal in disease management but cannot be achieved in practice. (b) Herd immunity is effective for preventing disease transmission in low-density populations but not in high-density populations. **(c) The percentage of people who need to be immune for a population to achieve herd immunity varies with each disease. – Answer** (d) Antibiotics can help a population obtain herd immunity against bacterial diseases.

2020 Section 1 Question 2 **Infection disease**	A virus consists of a **(a) protein coat and a nucleic acid. – Answer** (b) protein coat and ribosomes. (c) cell wall and a nucleic acid. (d) cell wall and ribosomes.

2020 Section 1 Question 4 **Infection disease**	A zoonotic disease is transmitted (a) by an animal pathogen. (b) by a mosquito vector. **(c) between animals and humans. – Answer** (d) between animals and plants.

2020 Section 1 Question 8 **Infection disease**	Crown gall in plants is caused by (a) a DNA virus. (b) an RNA virus. **(c) *Agrobacterium.* – Answer** (d) *Phytophthora.*

2020 Section 1 Question 15 **Infection disease**	The amphibian chytrid pathogen causes disease in frogs by invading the (a) lungs and reducing the ability of the frog to breathe. (b) mouth and reducing the ability of the frog to breathe. (c) kidneys and reducing the ability of the frog to exchange water and gases. **(d) skin and reducing the ability of the frog to exchange water and gases. – Answer**

2020 Section 1 Question 17 **Infection disease**	Climate change is affecting the distribution of Ross River virus through its effects on activity and reproduction in the (a) viral pathogen. (b) bacterial pathogen. (c) human host. **(d) mosquito vector. – Answer**

2020 Section 1 Question 18 **Infection disease**	The pathogen that causes tetanus (a) is directly transmitted from host to host. **(b) invades a host through a wound. – Answer** (c) cannot survive outside of the host. (d) reproduces by mitosis.

2020 Section 1 Question 30 **Infection disease**	Antibiotics are effective in treating the (a) virus that causes influenza. (b) bacterium that causes influenza. **(c) secondary bacterial infections in people with influenza. – Answer** (d) secondary viral infections in people with influenza.

2019 Section 1 Question 1 **Infection disease**	A sudden increase in the number of people with an infectious disease in a location is called (a) an endemic. **(b) an epidemic. – Answer** (c) a pandemic. (d) a peridemic.

2019 Section 1 Question 4 **Infection disease**	A virus (a) does not contain protein. (b) does not contain nucleic acid. (c) can synthesise both proteins and nucleic acids. **(d) cannot synthesise either proteins or nucleic acids. – Answer**

2019 Section 1 Question 7 **Infection disease**	The **best** strategy for controlling the incidence of tetanus is the use of (a) antibiotics. (b) antivirals. (c) quarantine. **(d) immunisation. – Answer**

2019 Section 1 Question 13 **Infection disease**	Herd immunity (a) can be obtained through vaccination but not through natural infection. (b) can be obtained through natural infection but not through vaccination. **(c) can be obtained through both vaccination and natural infection. – Answer** (d) cannot be obtained through either vaccination or natural infection.

2019 Section 1 Question 16 **Infection disease**	Which of the following would lead to a significant decline in the incidence of malaria in an area? (a) People are exposed to the pathogen. (b) People are treated with antibiotics. **(c) Stagnant water bodies are drained. – Answer** (d) Wild populations of bats are removed.

2019 Section 1 Question 19-20

Infection disease

Questions 19 and 20 relate to the information below. Some businesses provide life insurance for pets. Data were obtained from one business on the cause of death of insured cats over the period 1999–2006. The data are shown in the table below.

Cause of death	Number of insured cats
kidney failure	907
traffic accidents	411
other accidents	153
skin cancers	165
blood cancers	235
other cancers	128
viral infections	407
bacterial infections	24
heart disease	421
hormonal disease	98

19. What proportion of cats in the data above died from cancers?

(a) 0.04
(b) 0.12
(c) 0.14
(d) 0.18 – Answer

20. Which of the following is a valid conclusion from the data?

(a) Few owners vaccinate their cats against viral infections.
(b) Kidney failure is the most common cause of death in uninsured cats.
(c) Infectious diseases killed more insured cats than heart disease. – Answer
(d) Cat owners mainly insure their cats when the cats are ill.

2019 Section 1 Question 21 **Infection disease**	Protists may have (a) mitochondria but not ribosomes or cell walls. (b) ribosomes but not mitochondria or cell walls. (c) ribosomes and cell walls but not mitochondria. **(d) mitochondria, ribosomes and cell walls. – Answer**

2023 Section 2 Question 34

Infectious disease

(a) Identify the four main groups of organisms that cause infectious diseases. (4 marks)

Description	Marks
bacterium/bacteria	1
protist	1
fungus/fungi	1
virus	1
Total	**4**

Polycystic kidney is an inherited, genetic disease in cats that may eventually cause kidney failure.

Description	Marks
no/not an infectious disease (must be a clear no)	1
the disease is not caused by a pathogen	1
the disease is not transmitted from one host to another	1
Total	**3**

Bovine tuberculosis is an example of a zoonosis.

(c) Define the term 'zoonosis'. (1 mark)

Description	Marks
infectious disease that can be transmitted between vertebrate species	1
Total	**1**

(d) Outline how tuberculosis is transmitted. (2 marks)

Description	Marks
Any two of (2 x 1 mark)	
• airborne or spread through air • pathogen is release into air when infected people breath/cough/speak • (pathogen) is inhaled by new host	1–2
Total	**2**

(e) Explain why antibiotics are used to treat tuberculosis, but not influenza. (4 marks)

Description	Marks
Any four of (4 x 1 mark)	
• tuberculosis is caused by a bacterium • influenza is caused by a virus • antibiotics affect bacteria but not viruses • antibiotics affect cell structures/ribosomes/cell walls/DNA replication that occur in bacteria/that do not occur in viruses • influenza is treated with antiviral medication rather than antibiotics	1–4
Total	**4**

	Antibiotic treatment for tuberculosis requires daily doses for four to six months. When treatment was first made available in the 1940s, it was highly effective. Since then, antibiotic resistant strains of tuberculosis have developed. (f) Explain how these resistant strains have arisen. (5 marks)

Description	Marks
Any five of (5 x 1 mark)	
• natural selection/selection pressure/mutation generates resistance • some bacteria are resistant to antibiotics • these bacteria survive/reproduce or susceptible bacteria do not survive reproduce • number of resistant bacteria increases or frequency of resistant allele increases through time • bacteria have a short generation time, so resistance will evolve over a short period of time • long treatment increases chances people will not complete treatment or fail to complete antibiotic course, increases chances some resistant bacterial cells will survive	1–5
Total	**5**

2022 Section 2 Question 35 **Infection disease**	Population size in many frog species is declining. The disease chytridiomycosis is contributing to the decline in some species. (a) (i) State the type of pathogen that causes chytridiomycosis. (1 mark)

Description	Marks
(Chytrid) fungus/*Batrachochytrium*	1
Total	**1**

(ii) Chytridiomycosis disrupts homeostasis in the frog host. Define 'homeostasis'. (1 mark)

Description	Marks
The process organisms use to maintain constant internal conditions or ability to maintain stable internal conditions/state.	1
Total	**1**

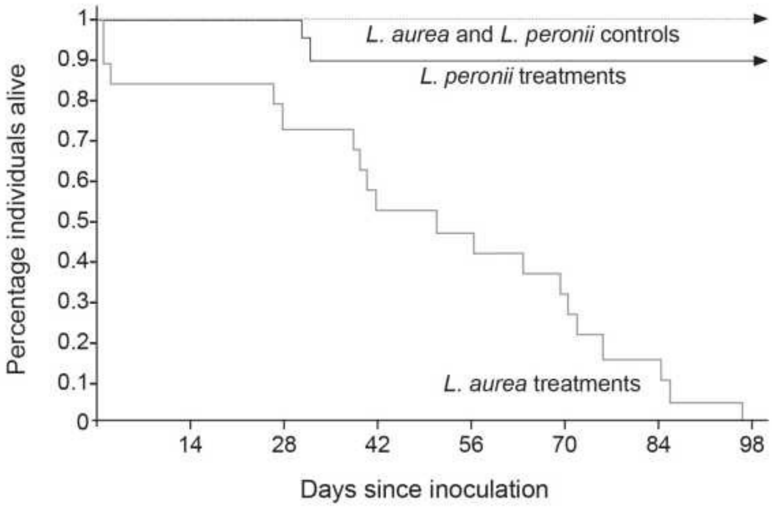
(iii) State the aspect of homeostasis in the frog host that is disrupted by chytridiomycosis. (1 mark)

Description	Marks
salt-water balance/water balance/salt balance/osmosis/ gas exchange	1
Total	**1**

(b) Outline how chytridiomycosis is transmitted between frogs. (3 marks)

Description	Marks
Any three of	
• pathogen/fungi/zoosporangia release spores/zoospores (into environment/water) • spores/zoospores are motile/swim/transported by water to new frog • by direct/skin contact between frogs • (spore/zoospores) invade skin/epidermal cells of new frog.	1–3
Total	**3**

Biologists conducted an experiment to compare survival rates in two frog species, *Litoria aurea* and *Limnodynastes peroni*, after exposure to the chytridiomycosis pathogen. The frogs were kept in tanks, with six separate tanks being used for each species. For each species, frogs in three tanks were inoculated with the pathogen (treatments) and those in the other three tanks were not inoculated with the pathogen (control). The biologists measured the percentage of individuals that remained alive in each tank every few days for up to 100 days. The mean percentages of individuals alive for the control and treatment tanks for each species are shown in the figure below.



(c) (i) State a hypothesis for the experiment. (1 mark)

Description	Marks
The survival rate is the same/different for the two frog species after inoculation with/exposure to the (chytridiomycosis) pathogen.	1
Total	**1**
Hypothesis must be written as statement, not a prediction.	

(ii) On the basis of the results of the experiment, which frog species is most susceptible to chytridiomycosis? Justify your answer. (4 marks)

Description	Marks
Litoria aurea/*L. aurea*	1
Any three of	
• individuals of *L. aurea* that were exposed to the pathogen/in the treatment tanks did not survive • (most) individuals of *L. aurea* that were not exposed to the pathogen/in the control tanks did survive • individuals of *L. peroni* (usually) survived whether they were exposed to pathogen/in control or treatment tanks • accurate quote of data – must include species, treatment and percentage alive	1–3
Total	**4**

(d) (i) Distinguish between the reliability and validity of an experiment. (2 marks)

Description	Marks
Reliability is the chances of getting the same/similar result (if the experiment was to be repeated).	1
Validity is when the experiment tests the hypothesis/what is intended to be tested.	1
Total	**2**

(ii) List three distinctly different factors in the frog-chytridiomycosis experiment on page 23 that would be needed to ensure that the results were valid. (3 marks)

Description	Marks
Any three of	
• tanks – same environment/conditions/temperature/size/lighting • food – same type/amount/timing • frogs – same size/age/number/condition/prior environment • fungus – same amount/type/method of inoculation between species • handling – frogs in control inoculated with saline solution/handled the same way as frogs in treatment • experimental design – same/similar number of treatment and control tanks	1–3
Total	**3**
Accept other relevant answer.	

(e) Population size is declining in some frog species due to reasons other than disease. Explain how knowledge of the reproductive behaviour of a frog species can assist with conservation planning to minimise population decline. (4 marks)

Description	Marks
Any two of (2 x 2 marks)	
Either • reproductive behaviour influences reproductive success • can use information to predict/understand how it will change population size/population dynamics or • document (preferred) time/location of reproduction • can add extra protections at that time/place or • document courtship/mating behaviour • can add protections to minimise disruptions to behaviour or can manipulate behaviour/population sex ratios or can ensure species can behave normally in captive breeding or • document nesting sites • can protect nesting sites/add suitable/artificial nesting sites or • document differences/similarities in behaviour among populations (of a species) • can ensure behaviours are compatible before moving individuals from one population to another	1–4
Total	**4**

2021 Section 2 Question 33 Infection disease	

2021 Section 2 Question 33

Infection disease

Fish farming is the fastest-growing agricultural sector in the world. In this method of farming, fish are grown in ponds, cages, tanks or other types of enclosures, usually for food.

A major problem in fish farming is infectious diseases such as those caused by bacteria.

A team of biologists investigated the types of bacteria present in two species of fish in four settings:

- ponds
- cages
- tanks
- a lake where both species occur naturally

The biologists identified the bacteria present by sampling the following:

- six fish from each of
  - 33 ponds
  - five cages
  - two tanks
- 57 fish from eight sites in the lake.

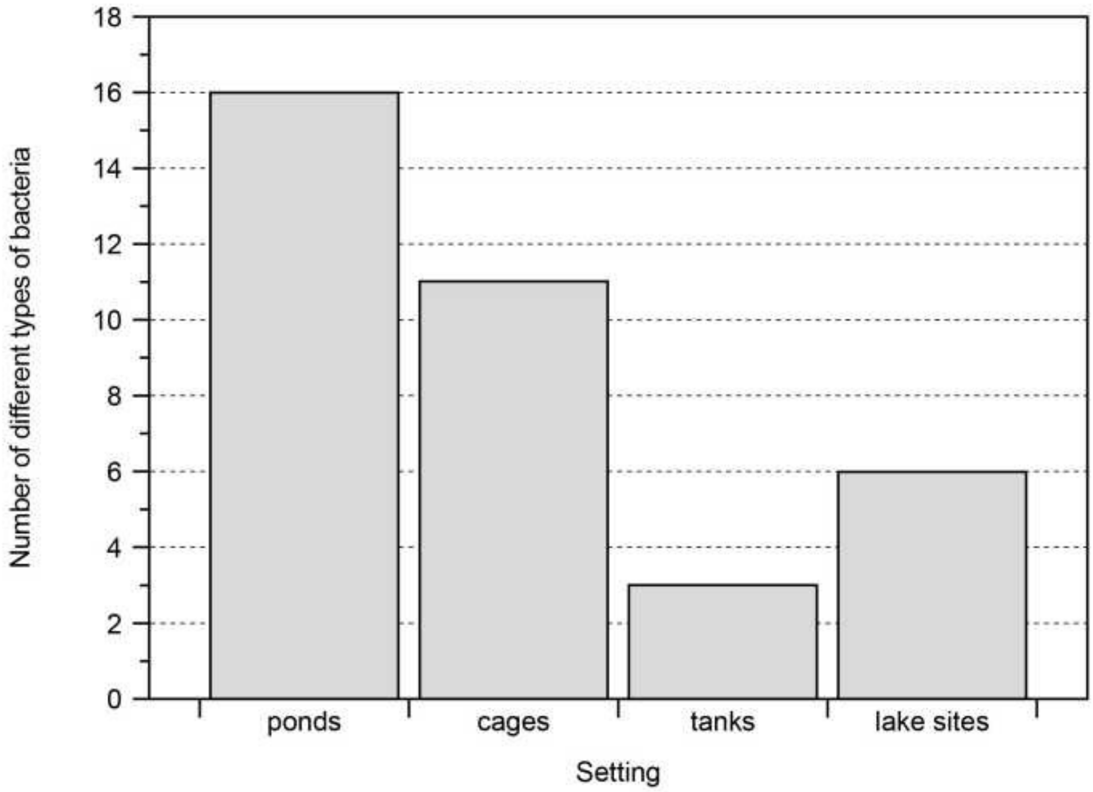
The table below shows the numbers of ponds, cages, tanks and lake sites in which each type of bacteria was found.

	Setting			
Type of bacteria	**Ponds (n = 33)**	**Cages (n = 5)**	**Tanks (n = 2)**	**Lake sites (n = 8)**
Aeromonas hydrophila	13	3	2	3
Aeromonas sobria	8	1	0	1
Edwardsiella tarda	2	1	1	0
Flavobacterium spp.	1	1	0	0
Streptococcus spp.	1	2	0	0
Pseudomonas aeruginosa	2	0	1	0
Pseudomonas fluorescens	3	1	0	1
Vibrio cholerae	5	0	0	0
Ralstonia picketti	1	0	0	0
Comamonas testosteroni	4	0	0	0
Citrobacter freundii	0	2	0	0
Plesiomonas shigelloides	9	2	0	1
Chryseobacterium indoligenes	5	1	0	0
Pseudomonas stutzeri	1	0	0	0
Burkholderia cepacia	1	0	0	0
Klebsiella spp.	1	0	0	1
Serratia marcescens	0	2	0	0
Proteus spp.	8	1	0	1
Number of different types of bacteria	16		3	6

(a) Complete the table by determining the number of different types of bacteria found in fish from cages. (1 mark)

Description	**Marks**
11	1
Total	**1**

(b) Draw a bar graph to show the number of different types of bacteria found in fish in each of the four settings. (5 marks)



Description	Marks
title - must include both variables	1
appropriate scale	1
y axis label	1
x axis label	1
plotting – data plotted accurately	1
Total	**5**

(c) (i) List the settings in which Pseudomonas fluorescens was found. (1 mark)

Description	Marks
ponds, cages and lake/lake sites	1
Total	**1**

(ii) Identify which type of bacteria was found in ponds, cages and tanks but not from lake sites? (1 mark)

Description	Marks
Edwardsiella tarda	1
Total	**1**

(d) A fish farmer reviewed the data and concluded that fish in tanks have fewer different types of bacteria than those in ponds, cages or the lake. Evaluate this conclusion. (4 marks)

Description	Marks
Any **four** of:	
• not correct **or** need more information to be sure • tanks had the lowest number of bacterial types however, (far) fewer tanks were sampled than was the case for other settings • need to correct data according to the number of each setting sampled **or** the number/percentage of bacterial types found per tanks/cages/lake sites sampled was less than that for tanks • the (two) sampled tanks may not have been representative of the number of bacterial types (due to chance) **or** need to sample more tanks (to be sure of the data for tanks) • unclear if other variables/number/types/condition of fish were controlled **or** influenced the results	1–4
Total	**4**

(e) Florfenicol is a type of antibiotic that is widely used to manage outbreaks of bacterial diseases in fish farming. It acts by inhibiting translation in bacterial cells. Explain how florfenicol can help to manage outbreaks of bacterial diseases in fish farming. (3 marks)

Description	Marks
Any **three** of:	
• translation is where mRNA is converted to a protein/polypeptide/ sequence of amino acids • florfenicol stops bacteria producing proteins • (without proteins) bacterial cells cannot survive/reproduce • fewer bacteria are present to cause disease/infect fish	1–3
Total	**3**

(f) DNA technology has been used to produce a line of fish with increased resistance to infection by certain bacteria. Outline the four main steps required to produce a line of transgenic fish with increased resistance to infection by certain bacteria. (4 marks)

Description	Marks
Step 1: identify gene from another organism that will confer resistance to bacterial infection	1
Step 2: isolate target gene **or** make gene construct (based on that gene) **or** make copies of target gene	1
Step 3: insert target gene into fish	1
Step 4: verify that fish is expressing gene **or** propagate modified/transgenic fish	1
Total	**4**

2021 Section 2 Question 34

Infection disease

Honey bees suffer from a range of viral diseases.

(a) (i) List the two main structural features of a virus. (2 marks)

Description	Marks
has a protein coat/protein layer/capsid	1
Any one of the following: • nucleic acid • RNA • DNA	1
Total	**2**

Many biologists do not regard a virus as a living organism.

(ii) List two characteristics of a virus that suggest that it is not a living organism. (2 marks)

Description	Marks
Any **two** of:	
• cannot reproduce without a host **or** requires host structures to reproduce • does not have a cellular structure/cell organelles • does not produce own energy/does not respire • does not grow	1–2
Total	**2**

One of these viruses, the deformed wing virus, causes shrunken and abnormal wings in honey bees as shown in the honey bee in the photograph below.

The *Varroa* mite (a type of arthropod) invades honey bee colonies, and attacks and feeds on the bees. It is a vector for this virus.

(b) (i) Is deformed wing in honey bees an infectious disease? Give reasons for your answer. (3 marks)

Description	Marks
Yes (must be a clear yes)	1
because it is caused by a pathogen (must say pathogen, not just virus)	1
and can be transmitted (from one host to another)	1
Total	**3**

(ii) State what is a disease vector. (2 marks)

Description	Marks
an organism/agent that transmits a pathogen	1
into another species/type of organism (e.g. mite to bee)	1
Total	**2**

(c) The Varroa mite is common in many countries but there is no established infestation in Australia. However, this mite has been detected in a bee colony in Queensland. Outline two measures that could be used to reduce the chances of this mite becoming established in Australia. (4 marks)

Description	Marks
Any **two** options (2 x 2 marks):	
Option one • check/prohibit import of bees/bee products (contaminated with mite) • stop mite entering Australia	1–2
Subtotal	**2**
Option two • monitor bees/bee colonies in Australia for mite infestation • destroy/treat infested bees/bee colonies (before mite can spread further)	1–2
Subtotal	**2**
Option three • limit movement of bees/bee colonies/bee products within Australia • infestations will remain localised	1–2
Subtotal	**2**
Option four • educate beekeepers **or** general public about mites • increase the chances of detecting mite **or** of people following/supporting biosecurity measures	1–2
Subtotal	**2**
Total	**4**

(d) The deformed wing virus is an RNA virus. Its genome is 10 140 nucleotides in length. One part of the genome, which is 450 nucleotides in length, codes for the VP1 protein. On this basis, how many amino acids are there in the VP1 protein? Justify your answer. (3 marks)

Description	Marks
150 **or** approximately 150 if there are start and stop codons	1
each amino acid is coded for by a codon **or** 3 nucleotides	1
therefore the number of amino acids is the number nucleotides divided by 3	1
Total	**3**

(e) The diploid number of chromosomes in honey bees is 32. Queen bees are diploid and produce eggs by meiosis. Female worker bees hatch from fertilised eggs whereas male bees hatch from unfertilised eggs. How many chromosomes will occur in male bees? Explain your answer. (4 marks)

Description	Marks
16	1
haploid number of chromosomes **or** half the number of diploid chromosomes **or** meiosis halves the (diploid) chromosome number	1
same number of chromosomes as unfertilised egg	1
the male parent does not contribute any chromosomes **or** only the female parent contributes chromosomes	1
Total	**4**

2020 Section 2 Question 31 Infection disease	The pathogen that causes jarrah dieback is a type of protist.

The pathogen that causes jarrah dieback is a type of protist.

(a) (i) List two structural features of protists that are not found in bacteria. (2 marks)

Description	Marks
Any **two** of:	
• protists are eukaryotes/have a nucleus • protists have membrane-bound organelles/mitochondria • cell walls of protists are made of cellulose (not peptidoglycan)	1–2
Total	**2**

(ii) List two structural features of protists that are not found in fungi. (2 marks)

Description	Marks
Any **two** of:	
• protists are (usually) unicellular • protists (often) have flagella (except in Chytrid zoospores)/cilia • cell walls of protists (when present) are made of cellulose (not chitin)	1–2
Total	**2**

In order to prevent the spread of jarrah dieback, vehicles are banned from driving on some tracks when the soil is wet.

(b) Explain how this can prevent the spread of jarrah dieback. (4 marks)

Description	Marks
disease is spread (from plant to plant) by spores/zoospores	1
spores/zoospores are more active when it is wet	1
vehicles pick up more (contaminated) soil when it is wet; (therefore) risk of transmission/spread is greater when the soil is wet	1
vehicles can spread disease/spores/zoospores over a large area	1
Total	**4**

(c) (i) Describe how the tuberculosis pathogen is transmitted to a new host. (2 marks)

Description	Marks
pathogen is in air/airborne **or** affected individuals breathe out pathogen/droplet	1
new host breathes in/inhales pathogen	1
Total	**2**

(ii) Describe the impact that the tuberculosis pathogen has on the host. (2 marks)

Description	Marks
Any **two** of:	
• infects lungs/respiratory system • causes coughing/lung irritation/breathing problems/tuberculosis • sometimes does not cause symptoms **or** takes time for symptoms to develop **or** can infect brain/nervous system/tissue other than the lungs	1–2
Total	**2**

(d) Explain how vaccination helps to control the spread of tuberculosis. (4 marks)

Description	Marks
Any **four** of:	
• vaccination introduces weakened/harmless version of a pathogen into body • this stimulates production of antibodies/stimulates an immune response • vaccinated individuals become immune **or** do not catch the disease • higher the proportion of the population that is immune, the greater the protection **or** the converse • because infected individuals do not/rarely come into contact with susceptible individuals **or** the converse • herd immunity/high immunity protects susceptible individuals	1–4
Total	**4**

(e) When travellers enter Australia from overseas, they are required to declare all plant and animal matter that they have brought with them. Explain why. (4 marks)

Description	Marks
Any **four** of:	
• quarantine/biosecurity measure • protects agricultural industry/the environment **or** stops spread of disease • stops the introduction of exotic pests/diseases/weeds found in other countries (but not in Australia) • plant and animal matter/declared items may carry pests/diseases • plant and animal matter found to be infected will either be treated with pesticides/insecticides **or** destroyed	1–4
Total	**4**

2019 Section 2 Question 34

Infection disease

(a) (i) Name a disease that is caused by a protist and can be spread by water. (1 mark)

Description	Marks
Phytophthora/jarrah dieback **or** another example	1
Total	**1**

(ii) Name a disease that is caused by a fungus and can be spread by water. (1 mark)

Description	Marks
Chytridiomycosis/amphibian chytrid disease **or** another example	1
Total	**1**

(iii) Name a human viral disease that is transmitted by an insect. (1 mark)

Description	Marks
Ross River fever **or** another example	1
Total	**1**

(iv) Name a human disease that is caused by a protist. (1 mark)

Description	Marks
Malaria **or** another example	1
Total	**1**

Crown gall is a disease of plants that is caused by some strains of *Agrobacterium* (sometimes called *Rhizobium*).

(b) Is crown gall an infectious disease? Give reasons for your answer. (3 marks)

Description	Marks
yes (must be a clear yes)	1
caused by a pathogen/bacterium	1
transmitted from one plant/host to another	1
Total	**3**

(c) Describe the method used by *Agrobacterium* to invade the plant host. (4 marks)

Description	Marks
Describes the method that *Agrobacterium* uses to invade plant host (any **four** of):	
• uses flagella to swim to plant • attracted by sugars/chemicals released by wound • (usually) invades through wounds/damaged tissue • bacteria attaches to (plant) cell • transfers (some) DNA/plasmid into plant cell • DNA (permanently) integrates into plant genome	1–4
Total	**4**

(d) Describe the impact that Agrobacterium has on the plant host. (5 marks)

Description	Marks
Describes the impact that *Agrobacterium* has on the plant host (any **five** of):	
• causes galls/growths/tumours • (usually) on roots **or** at ground level **or** on roots and stems • (galls/growths/tumours) can prevent the uptake/movement of water **or** nutrients • slows plant growth **or** plants become stunted/unproductive/unhealthy **or** plants can die • *Agrobacterium*/bacteria genes are expressed (in the plant) • (results in) production of some chemicals/hormones (cause the galls/growths/tumours) • also changes expression of (some) plant genes	1–5
Total	**5**

Agrobacterium is commonly used in the production of transgenic plants (its capacity to cause disease is deactivated first).

(e) Outline the role that *Agrobacterium* plays in the production of transgenic plants and explain why it is well-suited to this role. (4 marks)

Description	Marks
States that *Agrobacterium* is used as a vector or to transfer foreign genes/target DNA into the plants	1
Subtotal	**1**
Outlines why *Agrobacterium* is well suited to role (any **three** of):	
• because it naturally/normally transfers DNA/genes to plants (during disease production) • and because it can infect a broad range of host plants • this natural ability can be exploited **or** bacteria requires little modification to perform this role • plasmid/DNA contains sequence for integration into plant genome • can be used to clone target DNA	1–3
Total	**4**

Unit 4 - Section 3 Questions

Section 3

2023 Section 3 Question 38 **Unit 4 – Section 3**	All animals produce nitrogenous waste, which must be excreted. (a) Distinguish between how bony fish and land vertebrates excrete nitrogenous waste. (10 marks) Chytridiomycosis is a major disease of amphibians worldwide, threatening many species with extinction. (b) Discuss the impact that chytridiomycosis has on the host amphibian. (10 marks)

2023 Section 3 Question 39 **Unit 4 – Section 3**	Ross River disease is the most significant mosquito-borne disease in Australia. (a) Discuss the management strategies available for the control of Ross River disease. (10 marks) In some regions with very cold winters, salt is sprayed on roads to prevent ice forming and causing a traffic hazard. The salt may run off the road, killing roadside vegetation. Salt-tolerant (halophytic) plants are sometimes planted to restore this vegetation. (b) Explain why high salinity in the soil is harmful to many plants and how halophytic plants overcome the problems caused by high salinity. (10 marks)

2022 Section 3 Question 38 **Unit 4 – Section 3**	Bacteria and fungi are two types of organism that can cause disease. (a) Distinguish between the structural characteristics of bacteria and fungi. (10 marks) Some plants can survive in arid environments. (b) Explain how shallow branching roots with a high salt content and opening stomata only at night can help a plant to survive in an arid environment. (10 marks)

2022 Section 3 Question 39 **Unit 4 – Section 3**	Ectothermy is a type of thermoregulation. (a) Explain how ectotherms obtain body heat. Include a specific example in your answer. (10 marks) Like humans, pigs can suffer from influenza. (b) Discuss how quarantine and immunisation are used to control the spread of influenza on a pig farm. (10 marks)

2021 Section 3 Question 38 **Unit 4 – Section 3**	Whales are a type of marine mammal. They often occur in cold water. They have a large body size, a core body temperature of 35.5 °C (slightly lower than that of terrestrial mammals) and a thick layer of blubber (vascularised fat) beneath the skin. (a) Explain how each feature above helps whales to thermoregulate in cold water. (10 marks) Global climate change is altering the distribution of some human diseases. (b) Discuss the effects of global climate change on the distributions of human diseases by direct and by indirect transmission. Include a specific example in your answer of a disease, the distribution of which is likely to be affected by global climate change. (10 marks)

2021 Section 3 Question 39 **Unit 4 – Section 3**	The types of nitrogenous waste produced by different vertebrates are related to the availability of water in the environment and the ancestry (evolutionary history) of the vertebrate. (a) Discuss how the types of nitrogenous waste produced by different vertebrates are related to the availability of water in the environment and the ancestry (evolutionary history) of the vertebrate. (10 marks) Phytophthora dieback is a devastating disease that affects a broad range of plants. Various strategies are used to control the spread of this disease in the natural environment and in cultivated and garden plants, but success has been limited. (b) Discuss the reasons why it is difficult to control the spread of Phytophthora dieback in Australia. (10 marks)

2020 Section 3 Question 38 **Unit 4 – Section 3**	Crown gall is a common and economically-significant disease of plants. (a) Describe the impact that the crown gall pathogen has on the host and discuss the best strategy for managing this disease. (10 marks) Salmon are able to move between freshwater and seawater, despite the physiological challenges that this presents. (b) Explain the physiological challenges that fish, such as salmon, face when living in freshwater and in seawater. How have they overcome these challenges? (10 marks)

2020 Section 3 Question 39 **Unit 4 – Section 3**	Most plants are sensitive to salt stress, but a small number of species with special adaptations are able to survive in high salt environments. (a) Explain how halophytes obtain water and exclude and remove salt. (10 marks) Malaria is a significant public health problem in many parts of the world. (b) Assess the biological factors that make malaria a difficult disease to control. (10 marks)

2019 Section 3 Question 38 **Unit 4 – Section 3**	Most animals need to regulate their internal body temperature in order to survive and thrive. Endotherms and ectotherms use fundamentally different methods to achieve this. Each method is associated with particular costs and benefits to individuals. (a) Compare the methods that endotherms and ectotherms use to regulate their internal body temperature and discuss the costs and benefits of endothermy to individuals. (10 marks) Humans regularly come into contact with a range of companion, livestock and wild vertebrates. These vertebrates can transmit diseases to humans. Diseases that are transmitted from non-human vertebrates to humans are called zoonoses. (b) Discuss the risk that zoonoses pose to human populations throughout the world. (10 marks)

2019 Section 3 Question 39 **Unit 4 – Section 3**	In 1993 the World Health Organisation declared tuberculosis a 'global health emergency'. Since then considerable progress has been made in reducing the number of tuberculosis cases and deaths. It is, however, difficult to control the spread of this disease, which remains a serious threat to global health. (a) Explain why it is difficult to control the spread of tuberculosis. (10 marks) Some mammals, such as the spinifex hopping mouse and greater bilby, live in the hot deserts of central Australia. These mammals have to survive in extreme heat with little water. (b) Explain the physiological challenges that a mammal faces in maintaining its internal environment within tolerance limits in hot deserts. (10 marks)

Marking Guide – Section 3

2023 Section 3 Question 39 Unit 4 – Section 3	All animals produce nitrogenous waste, which must be excreted. (a) Distinguish between how bony fish and land vertebrates excrete nitrogenous waste. (10 marks)

Description	Marks
Bony fish: any five of (5 x 1 mark)	
• (mainly) excrete ammonia or via gills • ammonia is a by-product of metabolism or ammonia requires no/little energy to produce • it is toxic • fish can continuously excrete ammonia or do not need to store ammonia • because they live surrounded by water or in an aquatic environment • some marine fish excrete urea (due to need to conserve freshwater)	1–5
Subtotal	**5**
Land vertebrates: any five of (5 x 1 mark)	
• excrete either urea or uric acid (depending on vertebrate) or excrete via kidneys • ammonia is converted to urea/uric acid • conversion takes energy • urea/uric acid is less toxic than ammonia (and so can be stored for longer) • urea/uric acid needs less water to expel or reduces water needs or is more suitable for land where water is limited • comparison of uric acid and urea, e.g. excretion of uric acid requires less water than urea or other valid comparison	1–5
Subtotal	**5**
Total	**10**

Chytridiomycosis is a major disease of amphibians worldwide, threatening many species with extinction.

(b) Discuss the impact that chytridiomycosis has on the host amphibian. (10 marks)

Description	Marks
Any 10 of (10 x 1 mark)	
• disrupts skin function or disrupts breathing/respiration and osmoregulation/water exchange • because pathogen infects/damages skin/outer layer of skin/keratin layer or causes skin lesions/skin discolouration or causes skin to thicken/slough • breathing/respiration is disrupted because amphibians exchange gas or CO_2/O_2 through skin • osmoregulation/water exchange is disrupted because ions are transported across skin or hosts lose ions/sodium/potassium through skin • disrupted ion balance can cause heart failure • neurological effects such as lethargy/loss of balance/abnormal posture/loss of flight response • neurological problems can reduce foraging efficiency or susceptible to predators • often fatal • amphibians susceptible to skin disease because of the importance of skin in maintaining homeostasis • effects vary among individuals of a species or effects vary between species or some species are more susceptible/resistant/tolerant • a lot is unknown about impact/emerging disease/more research required (e.g. why susceptibility varies/pain/cytology of disease) • huge impact on amphibian biodiversity/populations or has caused local extinctions	1–10
Total	**10**

2023 Section 3 Question 39 Unit 4 – Section 3	Ross River disease is the most significant mosquito-borne disease in Australia. (a) Discuss the management strategies available for the control of Ross River disease. (10 marks)

Description	Marks
Management strategies to control Ross River disease	
disrupt life cycle of pathogen	1
reduce chance of being bitten by mosquito	1
Subtotal	2
Mosquito control: any three of (3 x 1 mark)	
• control mosquito populations • remove breeding sites or reduce amount of standing water • use insecticide or biological control agent • discussion point – e.g. cannot remove all standing water or health/environmental concerns about applying insecticides or other relevant point	1–3
Subtotal	**3**
Avoid mosquito bites: any three of (3 x 1 mark)	
• alter behaviour to avoid mosquitoes or do not go outside at dawn/dusk/peak mosquito activity • wear protective clothing or use insect repellent when outdoors • use screens on windows/doors or use mosquito nets • discussion point – e.g. will be most effective if used in combination with mosquito control or other relevant point	1–3
Subtotal	**3**
Other (2 x 1 mark)	
• educate people about disease and management strategies • people more likely to support strategies if aware of them/disease	1–2
Subtotal	**2**
Total	**10**

In some regions with very cold winters, salt is sprayed on roads to prevent ice forming and causing a traffic hazard. The salt may run off the road, killing roadside vegetation. Salt-tolerant (halophytic) plants are sometimes planted to restore this vegetation.

(b) Explain why high salinity in the soil is harmful to many plants and how halophytic plants overcome the problems caused by high salinity. (10 marks)

Description	Marks
Why high salinity is harmful	
normally water enters plants via the roots	1
because concentration of solutes/salts is higher in the roots	1
if concentration of salts is higher in soil, then water will leave the roots	1
plant will dehydrate/dies/increased concentration of salts can be toxic	1
water moves in and out of roots by process of osmosis	1
Subtotal	**5**
How halophytes overcome problem	
secrete excess salt through salt glands	1
concentrate salt in old leaves (which are shed)	1
sequester excess salt in vacuoles	1
tolerate high internal salt concentration	1
keep salt concentration in roots about that in soil (so water will flow in)/ultrafiltration in roots prevents uptake of salt	1
Subtotal	**5**
Total	**10**

2022 Section 3 Question 38

Unit 4 – Section 3

Bacteria and fungi are two types of organism that can cause disease.

(a) Distinguish between the structural characteristics of bacteria and fungi. (10 marks)

Description	Marks
Any five of following showing differences (5 x 2 marks):	
• bacteria: unicellular/surge cell, fungi: (usually) multicellular/filamentous • bacteria: microscopic/small, fungi: (usually) macroscopic/large • bacteria: prokaryote/nucleus is absent, fungi: eukaryote/nucleus present • bacteria: membrane bound, organelles absent, fungi: membrane bound organelles present • bacteria: cell wall made of protein and carbohydrate/peptidoglycan, fungi: cell wall made of chitin • bacteria: single/circular chromosomes, fungi: paired/linear/multiple chromosomes • bacteria: flagella/pilli present, fungi: flagella absent (except for some spores)	1–10
Total	**10**

Some plants can survive in arid environments.

(b) Explain how shallow branching roots with a high salt content and opening stomata only at night can help a plant to survive in an arid environment. (10 marks)

Description	Marks
Roots: Any five of	
• branching increases root surface area/surface area to volume ratio • increases the chances of roots contacting water • shallow means that roots are close to surface • where the water is/to take advantage of surface water/rainfall before evaporation • water uptake is via osmosis • high salt means that there is (much) more salt in roots than in soil or a steep concentration • this increases the rate of water uptake/osmosis	1–5
Subtotal	**5**
Stomata: Any five of	
• stomata must be open sometimes (for gas exchange) • water is lost through open stomata • water is lost via evaporation/transpiration • rate of evaporation is lower if environment is cooler/more humid or higher if environment is warmer/drier • environment is likely to be cooler/more humid at night **or** warmer/drier during the day • plants will lose less water if they open stomata at night **or** plants would lose more water if they opened stomata during the day	1–5
Subtotal	**5**
Total	**10**

2022 Section 3 Question 39 **Unit 4 – Section 3**	Ectothermy is a type of thermoregulation. (a) Explain how ectotherms obtain body heat. Include a specific example in your answer. (10 marks)

Description	Marks
Ectotherms predominantly rely on external sources for heat (unlike endotherms).	1
Specific example, e.g. honeybees vibrate flight muscles to generate metabolic heat before flying or other relevant example.	1
Subtotal	**2**
Any eight of	
• metabolism produces heat • animals can increase activity to increase metabolism/heat output • radiation/solar radiation (is the main source of heat) • animals bask in sun to obtain heat • some are black/dark coloured to increase heat absorption • may orient body/body parts to sun or occupy locations with high exposure (to solar radiation, when they want to warm) • rocks/ground/objects absorb solar radiation • become warmer than air/animal • animals lie on these warm rocks/ground/objects to obtain heat • via conduction • which is heat transfer between objects in direct contact with other	1–8
Subtotal	**8**
Total	**10**

Like humans, pigs can suffer from influenza.

(b) Discuss how quarantine and immunisation are used to control the spread of influenza on a pig farm. (10 marks)

Description	Marks
Quarantine: Any five of	
• infected pigs or pigs suspected of being infected would need to be separated from healthy pigs • influenza is spread by close contact/aerosols/infected surfaces • separated pigs would need to be far enough apart to prevent close contact or spread via aerosols/would need to decrease population density • equipment/clothing/objects would need to be disinfected before moving from quarantine to non-quarantine area • will not be effective unless all infected pigs are identified/separated • new arrivals should be placed in quarantine for a precautionary period	1–5
Subtotal	**5**
Immunisation: Any five of	
• give pigs (influenza) vaccine • to induce immunity or to stimulate pigs' immune system • all/most of herd will need to be vaccinated/need to create herd immunity • to reduce chances of an infected pig contacting an unvaccinated pig • immunity may not be lifelong, regular vaccination may be required • immunisation may prevent illness but not stop infection/transmission or may not be effective against some influenza strains	1–5
Subtotal	**5**
Total	**10**

2021 Section 3 Question 38 **Unit 4 – Section 3**	Whales are a type of marine mammal. They often occur in cold water. They have a large body size, a core body temperature of 35.5 °C (slightly lower than that of terrestrial mammals) and a thick layer of blubber (vascularised fat) beneath the skin. (a) Explain how each feature above helps whales to thermoregulate in cold water. (10 marks)

Description	Marks
General • heat will be lost to the environment because the water is colder than core body temperature **or** because the core body temperature is warmer than water	1
Subtotal	**1**
Any **three** of:	
Large size • heat is lost to environment/water via the surface of whale/body parts in contact with water • large size means low surface area to volume ratio • less surface area per unit volume in contact with the water to lose heat • large size also allows for more insulating blubber	1–3
Subtotal	**3**
Lower core temperature	
the rate of heat loss to the environment depends on temperature difference between whale and water	1
reduced core temperature reduces the amount of the difference between the body temperature and water/environment	1
hence heat is lost at a reduced rate (must say rate)	1
Subtotal	**3**
Any **three** of:	
Blubber • blubber is an insulator **or** a poor conductor of heat **or** stops the transfer of heat • provides a barrier between the (warm) core of the body and surface of the whale **or** separates the (warm) core of the body from the (cold) water • heat is trapped in the core of the body **or** ensures that the surface/part of the whale in contact with the water is cooler than body core • can constrict blood vessels/limit blood flow in blubber to reduce amount of warm blood flowing to surface of whale (where the heat could be lost)	1–3
Subtotal	**3**
Total	**10**

Global climate change is altering the distribution of some human diseases.

(b) Discuss the effects of global climate change on the distributions of human diseases by direct and by indirect transmission. Include a specific example in your answer of a disease, the distribution of which is likely to be affected by global climate change. (10 marks)

Description	Marks
Any **eight** of:	
Climate change • climate change could allow the emergence of new (zoonotic) diseases by changing interactions between humans and animals (direct) • for a newly emerged disease, global travel will impact the distribution of this disease • if the distribution of the vector is affected by global climate change, then it is likely that the distribution of the disease will also be impacted (indirect) Direct transmission • disease/pathogen is transferred directly from one human to another • distribution tends to match the distribution of humans and has the potential to reflect distribution of humans • humans are already distributed across globe and global climate change is unlikely to affect this distribution or distribution of disease with direct transmission Indirect transmission • disease is transmitted to humans via a vector • distribution of disease is influenced by distribution of vector **or** cannot spread to regions where vector does not occur Others • standard of health care/degree of urbanisation/quality of environment is important in determining distribution of some diseases (irrespective of mode of transmission or climate) • ease of transmission of disease/degree of resistance in human population will impact on how widespread a disease is (irrespective of mode of transmission or climate)	1–8
Subtotal	**8**
Specific example	
• specific example that includes disease and mode of transmission (e.g. malaria has indirect transmission) • illustrates how the distribution of the disease is or is not changing (e.g. in Africa malaria is now extending to higher altitudes, along with the distribution of the (*Anopheles*) mosquito vector)	1–2
Subtotal	**2**
Total	**10**

2021 Section 3 Question 39 **Unit 4 – Section 3**	The types of nitrogenous waste produced by different vertebrates are related to the availability of water in the environment and the ancestry (evolutionary history) of the vertebrate. (a) Discuss how the types of nitrogenous waste produced by different vertebrates are related to the availability of water in the environment and the ancestry (evolutionary history) of the vertebrate. (10 marks)

Description	Marks
ammonia is only suitable for vertebrates living in an aquatic environment	1
because it is very toxic and requires large amounts of water to excrete	1
uric acid is suitable for terrestrial environment **or** a dry/arid environment or for a vertebrate with (non-aquatic) eggs	1
because it is not toxic/has low toxicity/is not soluble in water and requires no negligible water to excrete	1
all birds and reptiles excrete uric acid	1
urea has medium toxicity and requires some water for excretion but not large amounts	1
suitable for terrestrial environments **or** can be suitable for arid environments if urine is highly concentrated	1
all mammals excrete urea	1
Subtotal	**8**
Any **two** of:	
• type of nitrous waste depends on type of vertebrate • amphibians can excrete a range of types **or** amphibians can excrete urea or uric acid or ammonia • type excreted by amphibians largely depends on water availability of environment **or** aquatic tadpoles excrete urea whereas the terrestrial/desert frogs excrete urea/uric acid • any example that shows that the waste excreted may not be ideal in environment because of ancestry e.g. dolphin excretes urea desert mammal excretes urea	1–2
Subtotal	**2**
Total	**10**

Phytophthora dieback is a devastating disease that affects a broad range of plants. Various strategies are used to control the spread of this disease in the natural environment and in cultivated and garden plants, but success has been limited.

(b) Discuss the reasons why it is difficult to control the spread of Phytophthora dieback in Australia. (10 marks)

Description	Marks
Any **five** of:	
Cure/treatment • no cure/treatment/method for killing pathogen • multiple means of transmission • phosphite can limit impact/growth of pathogen in an infected plant • but phosphite does not stop plant from getting infection in first place **or** does not eliminate the pathogen **or** may only have a temporary effect **or** symptoms are often overlooked in the early stages (so treatment is delayed) • unrealistic to treat all infected plants in wild/natural environment • spreads by (mobile) microscopic spores/remains dormant in soil	1–5
Subtotal	**5**
Any **five** of:	
Managing spread In natural environment • *Phytophthora* pathogen is introduced/not native • native plants do not have resistance **or** have not had enough time to evolve resistance **or** *Phytophthora* does not have its own pathogens/diseases/biological controls • affects many native (plant) species so easy to find new host • *Phytophthora*/dieback is widespread **or** was already widely spread before attempts to control it were started • can be spread over (large) distance by water **or** animals **or** human activities **or** plant to plant • common in areas frequented by humans • humans may be unaware of/unwilling to follow protocols for preventing spread For cultivated/garden plants • can treat soil **or** remove affected plants or buy plants from reputable nursery • but labour intensive **or** is only effective on local scales **or** unrealistic strategy for natural environment	1–5
Subtotal	**5**
Total	**10**

2020 Section 3 Question 38 **Unit 4 – Section 3**	Crown gall is a common and economically-significant disease of plants. (a) Describe the impact that the crown gall pathogen has on the host and discuss the best strategy for managing this disease. (10 marks)

Description	Marks
Impact on host	
Any **five** of:	
• causes galls/growths/tumours • (usually) on roots **or** at ground level **or** on roots and stems • (galls/growths/tumours) can prevent the uptake/movement of water **or** nutrients • slows plant growth **or** plants become stunted/unproductive/unhealthy **or** plants can die • *Agrobacterium*/pathogen genes are expressed (in the plant) • some chemicals/hormones cause the galls/growths/tumours **or** changes expression of (some) plant genes	1–5
Subtotal	**5**
Management strategy	
• best strategy is disruption of pathogen life cycle/disease prevention (because there is no cure)	1
Any **four** of:	
• plants should be monitored for signs of disease • affected plants should be destroyed/isolated • soil around affected plants should be removed/heated/treated (because the disease is caused by soil-borne bacterium) • (garden) tools should be disinfected (because the bacterium can be spread via these tools) • treat plants with biological control agent to prevent infection	1–4
Subtotal	**5**
Total	**10**

Salmon are able to move between freshwater and seawater, despite the physiological challenges that this presents.

(b) Explain the physiological challenges that fish, such as salmon, face when living in freshwater and in seawater. How have they overcome these challenges? (10 marks)

Description	Marks
Freshwater	
• salt concentration is higher/hypertonic in fish compared to freshwater **or** lower/hypotonic in freshwater compared to fish • fish tends to gain water and/or lose salt • kidneys produce large volumes of dilute urine to remove excess water • actively gain salt from water through gills • do not drink water	1–5
Subtotal	**5**
Seawater	
• salt concentration is lower/hypotonic in fish compared to seawater **or** higher/hypertonic in seawater compared to fish • fish tends to lose water and/or gain salt • fish drinks seawater to gain water • actively expel excess salt through gills • produce concentrate urine to reduce water loss	1–5
Subtotal	**5**
Total	**10**

2020 Section 3 Question 39 **Unit 4 – Section 3**	Most plants are sensitive to salt stress, but a small number of species with special adaptations are able to survive in high salt environments. (a) Explain how halophytes obtain water and exclude and remove salt. (10 marks)

Description	Marks
Obtain water • accumulate salt/NaCl/solutes (proline, glycine betaine) in roots • concentration of salt/NaCl/solutes is higher in roots/root cells than in soil/external environment • water therefore flows from soil/external environment into roots by osmosis **or** water flows from high salt to low salt solution • uptake water during periods when salt concentration in soil/external environment is reduced (and store water for later use)	1–4
Subtotal	**4**
Exclude salt • root cells that impermeable to (some) salts **or** roots that filter salt out of water • accumulate salt in vacuoles/tissues/glands/bladders so salt is excluded from other parts of cell/plant	1–2
Subtotal	**2**
Remove salt • accumulate salt in leaves/tissue • leaves/tissue detach from plant (removing salt) • (salt) glands/bladders that accumulate and then expel salt • root cells actively pump salt into soil	1–4
Subtotal	**4**
Total	**10**

Malaria is a significant public health problem in many parts of the world.

(b) Assess the biological factors that make malaria a difficult disease to control. (10 marks)

Description	Marks
Overall • the lifecycle of the pathogen is complex **or** the lifecycle of the pathogen involves a (mosquito) vector and a (human) host • (therefore) difficult to disrupt life-cycle of pathogen	1–2
Subtotal	**2**
Any **three** of:	
Mosquito/vector • mosquitoes evolve resistance to insecticides/pesticides/chemicals • mosquitoes can breed quickly **or** build up population numbers quickly • mosquitoes can breed in small/inaccessible places **or** often difficult to remove/treat mosquito breeding grounds • mosquito has a wide range **or** range of mosquito is increasing with climate change • Mosquitoes are asymptomatic therefore presence in new areas will not be obvious until host display symptoms	1–3
Subtotal	**3**
Any **three** of:	
Plasmodium/protist/pathogen • plasmodium/protist/pathogen evolve drug resistance or anti-malarial drugs are not always effective • no vaccine/difficult to develop a vaccine • multiple strains of plasmodium/protist/pathogen make it harder to develop vaccine/effective drug • long incubation/pathogen can be dormant/affected individuals can be symptomless • multiple phases/stages that reproduce/increase the number of infectious particles	1–3
Subtotal	**3**
Human factors/host • common in areas with limited healthcare/equipment/resources to buy medicine/supplies to reduce mosquito bites • hard to prevent mosquito bites	1–2
Subtotal	**2**
Total	**10**

2019 Section 3 Question 38

Unit 4 – Section 3

Most animals need to regulate their internal body temperature in order to survive and thrive. Endotherms and ectotherms use fundamentally different methods to achieve this. Each method is associated with particular costs and benefits to individuals.

(a) Compare the methods that endotherms and ectotherms use to regulate their internal body temperature and discuss the costs and benefits of endothermy to individuals. (10 marks)

Description	Marks
Compares endotherms and ectotherms	
Endotherms generate their own body heat	1
Ectotherms rely on external environment for temperature control	1
Endotherms • (body heat is generated) from metabolism **or** biochemical/chemical reactions in cells • maintain (relatively) constant internal/body temperature • have adaptations/features/behaviour to control heat loss/gain to ensure internal body temperature remains constant	1–2
Ectotherms • (ultimately) obtain heat from sun/object warmed by sun **or** rely on external sources of heat • body temperature fluctuates with external environment • use adaptations/features/behaviour to control heat loss/gain	1–2
Subtotal	**6**
Discusses the costs of endothermy (any **two** of):	
• endotherms have a higher metabolic rate (compared to ectotherms of same size) • need to expend more energy (to fuel metabolism) or have higher energy requirements • have greater food demands or need to spend more time obtaining food	1–2
Subtotal	**2**
Discusses the benefits of endothermy (any **two** of):	
• less dependent on environmental temperatures (compared to ectotherms) or body temperature is independent of external temperature • can live in very cold environments or in a broader range of environments • active at night or at more times during a day (in places where night-time temperatures are low) • being active at night may help to reduce predation • (higher internal temperatures) may provide protection against some pathogens	1–2
Subtotal	**2**
Total	**10**

Humans regularly come into contact with a range of companion, livestock and wild vertebrates. These vertebrates can transmit diseases to humans. Diseases that are transmitted from non-human vertebrates to humans are called zoonoses.

(b) Discuss the risk that zoonoses pose to human populations throughout the world. (10 marks)

Description	**Marks**
Discusses the general risks that zoonoses poses to human populations (any six of):	
(Zoonoses pose a risk because) • no/limited prior exposure • little immunity in the population • limited medical treatment/medicines/vaccines • therefore the disease could spread rapidly (once acquired from the vertebrate) • a major/important source of new/emerging diseases/pathogens **or** source of disease is unknown • environmental change/expansion of human populations/human actions could increase the risk of transmission of zoonoses • increased contact between humans and wildlife species (that could transfer disease) increases risk **or** contact made with asymptomatic animal • higher risk when there is a higher impact on host**or** vice versa • higher risk in low socio-economic countries with limited options for treatment	1–6
Subtotal	**6**
Discusses how the risk varies according to the mode of transmission (any **four** of):	
• risk varies according to mode of transmission among humans **or** between humans and other vertebrate/animal Transmission among humans • high risk from disease that can be easily transferred among people • because it could spread rapidly/widely • gives specific details of zoonotic disease being transferred among humans (or vice versa from a low risk perspective) Transmission from animal to human • high risk when disease is transmitted from vertebrate/animal in regular contact with humans **or** from domestic/food animals • high risk when disease can is easily transmitted (from vertebrate to human) **or** when the disease can be transmitted (from vertebrate to human) through droplets in the air **or** touching contaminated surfaces (e.g. as in avian influenza) • gives specific details of zoonotic disease being transferred from animal/s to human/s (or vice versa from a low risk perspective)	1–4
Subtotal	**4**
Total	**10**

2019 Section 3 Question 39 **Unit 4 – Section 3**	In 1993 the World Health Organisation declared tuberculosis a 'global health emergency'. Since then considerable progress has been made in reducing the number of tuberculosis cases and deaths. It is, however, difficult to control the spread of this disease, which remains a serious threat to global health. (a) Explain why it is difficult to control the spread of tuberculosis. (10 marks) Some mammals, such as the spinifex hopping mouse and greater bilby, live in the hot deserts of central Australia. These mammals have to survive in extreme heat with little water.

Description	Marks
Any **ten** of:	
No more than four marks from any one heading to a maximum of ten: Explains the role of disease transmission • transmitted from human to human/by inhaling droplets (from infected individuals) **or** easily transmitted from one human to another • infected individuals may survive for a long time (so more opportunity to transmit disease) **or** be asymptomatic • increased contact between infected and uninfected individuals will spread the disease • can be transmitted from livestock Explains the role of antibiotic resistance • caused by a bacterium • was treated with antibiotics **or** treated individuals did not complete a course of antibiotics • evolved resistance to antibiotics • by natural selection/because susceptible bacteria dies/did not reproduce **or** resistant bacteria survived/did reproduce • limits ability to treat infected people Explains the role of globalisation/urbanisation • humans are very mobile/travel long distances/across regions or across the globe • this can introduce disease can into regions where does not usually occur • people may live in urban areas/areas with high population density/in unhygienic conditions Explains the role of disease management • provision of healthcare is limited/unaffordable in some places • many individuals are not immunised • hence no herd immunity **or** large numbers of susceptible people (so the disease spreads) • (infected) individuals are not treated • limited opportunity for education **or** limited facilities for quarantine of infected individuals (in some places)	1–10
Total	**10**

(b) Explain the physiological challenges that a mammal faces in maintaining its internal environment within tolerance limits in hot deserts. (10 marks)

Description	Marks
Explanation includes statement about the importance of water/access to water in hot deserts (any **one** of):	
• access to water is a challenge/problem • water is needed for multiple aspects of homeostasis **or** to maintain different aspects of the internal environment • competing demand for water among different functions	1
Subtotal	**1**
Explains the physiological challenges of temperature regulation in a hot desert (any of **four** of):	
• (mammals are) endotherms **or** need to maintain body temperature within (narrow) limits **or** avoid overheating (in hot temperatures) • (mainly) use evaporative cooling (to avoid overheating) • most evaporation occurs through breathing/respiration/panting/sweating • inhale dry air which collects water from (moist) respiratory passages • evaporation of water/changing water from liquid to gas requires energy or heat from body • results in a loss of water (so less is available for other functions)	1–4
Subtotal	**4**
Explains the physiological challenges of other types of homeostasis (any **five** of):	
Excretion • nitrogenous waste is toxic • needs to be (regularly) removed/excreted/maintained within tolerance limits • excreted as urea • (urea) can be stored for longer **or** requires less water to excrete than ammonia • (but still) need some water to excrete nitrogenous waste/urea Salt-water balance • cells/body fluids require certain balance of salts and water • important for movement/transport of water/solutes/ions (into and out of cells/across membranes) **or** for chemical/biochemical metabolic reactions • movements depend on concentration gradients **or** osmosis **or** diffusion • water is needed to maintain balance **or** lack of water will disrupt balance	1–5
Subtotal	**5**
Total	**10**

Unit 3 and 4 – Science Inquiry Skills

Section 1

2023 Section 1 Question 3 Science Inquiry Skills	The purpose of a 'control' in an experiment is to (a) determine the reliability of the experiment. (b) provide a comparison for the experimental treatment. (c) reduce the sample sizes needed for the experiment to be valid. (d) minimise the number of variables to be tested.

2023 Section 1 Question 13-14 Science Inquiry Skills	A captive population of a frog species contained four females. The number of eggs and tadpoles produced by each female in a breeding season is shown in the table below. Use this information to answer Questions 13 and 14.

	Female			
	1	2	3	4
Number of eggs	24	18	0	31
Number of tadpoles	15	13	0	18

13. The median number of eggs produced by the four female frogs is

(a) 18.5.
(b) 21.0.
(c) 11.5.
(d) 14.0.

14. Biologists are assessing whether it is possible to release 5000 captive-breed tadpoles into the wild in the next breeding season. Approximately how many captive females would be needed to produce 5000 tadpoles in a breeding season?

(a) 274
(b) 326
(c) 357
(d) 435

2023 Section 1 Question 23 Science Inquiry Skills	Most vinegar flies have wild type (reddish-brown) eyes. However, some mutants have white eyes and cannot see. Biologists conducted a laboratory experiment to compare the fitness of flies with wild type and white eyes. Use this information to answer questions 23 and 24. Which of the following is the **best** hypothesis for the experiment? (a) Is there a difference in the fitness of flies with wild type and white eyes? (b) There is a difference in the fitness of flies with wild type and white eyes. (c) If flies cannot see, then they will have reduced fitness. (d) Do flies that cannot see have reduced fitness?

2023 Section 1 Question 24 Science Inquiry Skills	The dependent variable in the experiment is the (a) laboratory conditions. (b) eye colour of the flies. (c) vision of the flies. (d) fitness of the flies.

2021 Section 1 Question 28 **Science Inquiry Skills**	Biologists monitored population growth in four species of bird over several decades. An estimate of the number of breeding pairs for each species, in each decade, is given in the table below. Use this information to answer question 28.

	Decade			
	1980–1989	**1990–1999**	**2000–2009**	**2010–2019**
Species A	1660	1425	1100	900
Species B	8552	6789	5788	5675
Species C	112	108	75	62
Species D	670	550	475	315

In percentage terms, which species underwent the greatest decline in population growth between 1980 and 2019?

(a) A
(b) B
(c) C
(d) D

2020 Section 1 Question 19 **Science Inquiry Skills**	Female redback spiders sometimes eat their mates (cannibalistic mating) but not always (non-cannibalistic mating). A biologist determined the size (maximum width) of female redback spiders in cannibalistic and non-cannibalistic matings. The results are shown in the table below. Use this information to answer Questions 19 to 21.

Maximum width (mm) of female redback spiders	
Cannibalistic mating	**Non-cannibalistic mating**
2.8	2.8
2.8	2.7
3.2	3.3
3.3	2.8
2.8	2.9
3.0	3.0
3.1	3.3
2.7	2.9
2.9	2.9

19. Which of the following would be a suitable hypothesis for the investigation?

(a) Female redback spiders in cannibalistic mating are the same size as those in non-cannibalistic mating.
(b) Does the size of female redback spiders affect whether they will eat their mate?
(c) If female redback spiders are large, then they are more likely to cannibalise their mate.
(d) Small female redback spiders cannibalise their mate to gain energy for egg production.

20. The mean maximum width (in mm) for female redback spiders in non-cannibalistic mating is

(a) 2.80.
(b) 2.86.
(c) 2.90.
(d) 2.96.

21. The median maximum width (in mm) for female redback spiders in cannibalistic mating is

(a) 2.80.
(b) 2.86.
(c) 2.90.
(d) 2.96.

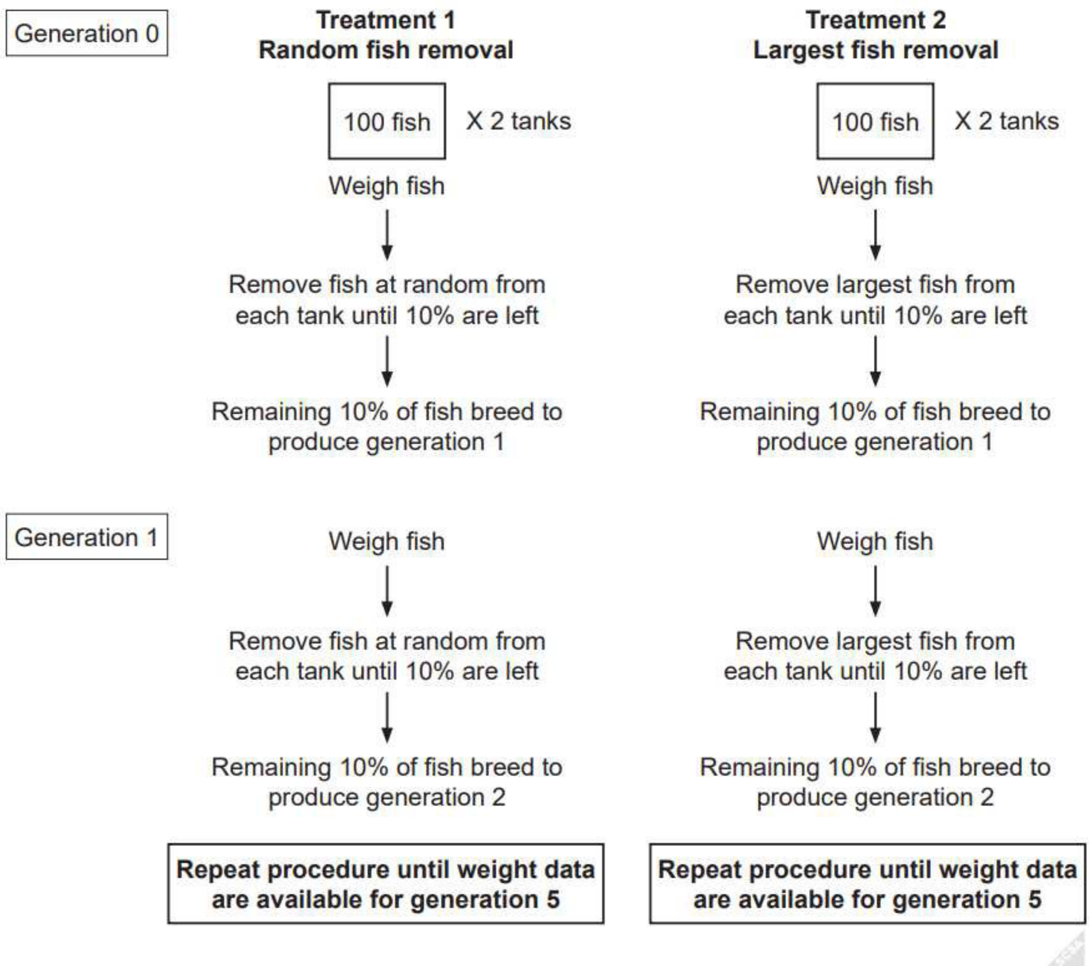
2019 Section 1 Question 27 **Science Inquiry Skills**	27. Which of the following hypotheses would be the most difficult to test with a scientific experiment? (a) radiation changes DNA structure (b) longevity in elephants is a polygenic trait (c) doses of vitamin C prevent viral infections (d) aquatic dinosaurs were ectothermic

Section 2

2020 Section 2 Question 32

Science Inquiry Skills

A team of biologists conducted a laboratory experiment to investigate whether removing the largest individuals from a fish population would affect the size (weight) of individuals in subsequent generations. The experiment is described in the diagram below.



The results of the experiment are shown in the table below.

	Mean weight of fish (g)	
Generation number	**Treatment 1 Random fish removal**	**Treatment 2 Largest fish removal**
0	3.3	3.4
1	3.5	3.4
2	3.6	3.3
3	3.4	3.2
4	3.5	3.0
5	3.4	3.0

(a) Graph the mean weight of fish for both the random fish removal treatment and the largest fish removal treatment against generation. (6 marks)

(b) (i) Identify the dependent variable in the experiment. Give a reason for your answer. (2 marks)

(ii) Would conducting the experiment for more generations improve the reliability or validity of the experiment? Give a reason for your answer. (2 marks)

(iii) Why did the biologists remove fish at random from the two tanks in Treatment 1. (2 marks)

(c) Explain why the mean weight of the fish declined over generations in Treatment 2. (4 marks)

(d) Predict what would have happened if the biologists had removed the largest fish until 50% (rather than 10%) of the fish remained. Explain your answer. (4 marks)

2019 Section 2 Question 32

Science Inquiry Skills

The water flea, *Daphnia*, is a small crustacean that lives in freshwater. When *Daphnia* are examined under low magnification with a microscope, the heart is clearly visible and the beats can be counted. A biologist wanted to study the influence of temperature on the heart rate of *Daphnia*. He collected 50 *Daphnia*, randomly assigned 10 individuals to each of five temperatures and measured the heart rate of each individual after 15 minutes at the assigned temperature. The results are shown in the table below.

	Heart rate of 10 *Daphnia* (beats per 20 seconds)	
Temperature °C	**Mean**	**Range**
2	59	39–85
10	119	82–151
20	142	92–234
30	257	178–328
40	401	206–596

(a) Graph the mean heart rate of the *Daphnia* against temperature. (6 marks)

(b) (i) Estimate the heart rate for *Daphnia* at 15 °C. (1 mark)

(ii) Estimate the heart rate for *Daphnia* at 45 °C. (1 mark)

(iii) In which estimate do you have the greater confidence? Give a reason for your answer. (2 marks)

(c) (i) What is the independent variable in this study? Give a reason for your answer. (2 marks)

(ii) State **one** way of improving the reliability of the study. (1 mark)

(iii) Propose an hypothesis for the study. (1 mark)

(d) Explain why the biologist waited for 15 minutes before measuring the heart rate of the *Daphnia* at the assigned temperature. (3 marks)

	(e) One of the *Daphnia* had a heart rate of 208 beats per 20 seconds. A biologist concluded that this *Daphnia* must have been assigned to a temperature of 30 °C. Evaluate this conclusion. (4 marks)

Marking Guide – Section 1

2023 Section 1 Question 3 **Science Inquiry Skills**	The purpose of a 'control' in an experiment is to (a) determine the reliability of the experiment. **(b) provide a comparison for the experimental treatment. – Answer** (c) reduce the sample sizes needed for the experiment to be valid. (d) minimise the number of variables to be tested.

2023 Section 1 Question 13-14 **Science Inquiry Skills**	A captive population of a frog species contained four females. The number of eggs and tadpoles produced by each female in a breeding season is shown in the table below. Use this information to answer Questions 13 and 14.

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	1	**2**	**3**	**4**
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The median number of eggs produced by the four female frogs is

(a) 18.5.
(b) 21.0. – Answer
(c) 11.5.
(d) 14.0.

Biologists are assessing whether it is possible to release 5000 captive-breed tadpoles into the wild in the next breeding season. Approximately how many captive females would be needed to produce 5000 tadpoles in a breeding season?

(a) 274
(b) 326
(c) 357
(d) 435 – Answer

2023 Section 1 Question 23 **Science Inquiry Skills**	Most vinegar flies have wild type (reddish-brown) eyes. However, some mutants have white eyes and cannot see. Biologists conducted a laboratory experiment to compare the fitness of flies with wild type and white eyes. Use this information to answer questions 23 and 24. Which of the following is the **best** hypothesis for the experiment? (a) Is there a difference in the fitness of flies with wild type and white eyes? **(b) There is a difference in the fitness of flies with wild type and white eyes. – Answer** (c) If flies cannot see, then they will have reduced fitness. (d) Do flies that cannot see have reduced fitness?

2023 Section 1 Question 24 **Science Inquiry Skills**	The dependent variable in the experiment is the (a) laboratory conditions. (b) eye colour of the flies. (c) vision of the flies. **(d) fitness of the flies. – Answer**

2021 Section 1 Question 28 **Science Inquiry Skills**	Biologists monitored population growth in four species of bird over several decades. An estimate of the number of breeding pairs for each species, in each decade, is given in the table below. Use this information to answer question 28.

	Decade			
	1980–1989	**1990–1999**	**2000–2009**	**2010–2019**
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Species D	670	550	475	315

In percentage terms, which species underwent the greatest decline in population growth between 1980 and 2019?

(a) A
(b) B
(c) C
(d) D – Answer

2020 Section 1 Question 19 **Science Inquiry Skills**	Female redback spiders sometimes eat their mates (cannibalistic mating) but not always (non-cannibalistic mating). A biologist determined the size (maximum width) of female redback spiders in cannibalistic and non-cannibalistic matings. The results are shown in the table below. Use this information to answer Questions 19 to 21.

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19. Which of the following would be a suitable hypothesis for the investigation?

(a) Female redback spiders in cannibalistic mating are the same size as those in non-cannibalistic mating. – Answer
(b) Does the size of female redback spiders affect whether they will eat their mate?
(c) If female redback spiders are large, then they are more likely to cannibalise their mate.
(d) Small female redback spiders cannibalise their mate to gain energy for egg production.

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(d) 2.96. – Answer

21. The median maximum width (in mm) for female redback spiders in cannibalistic mating is

(a) 2.80.
(b) 2.86.
(c) 2.90. – Answer
(d) 2.96.

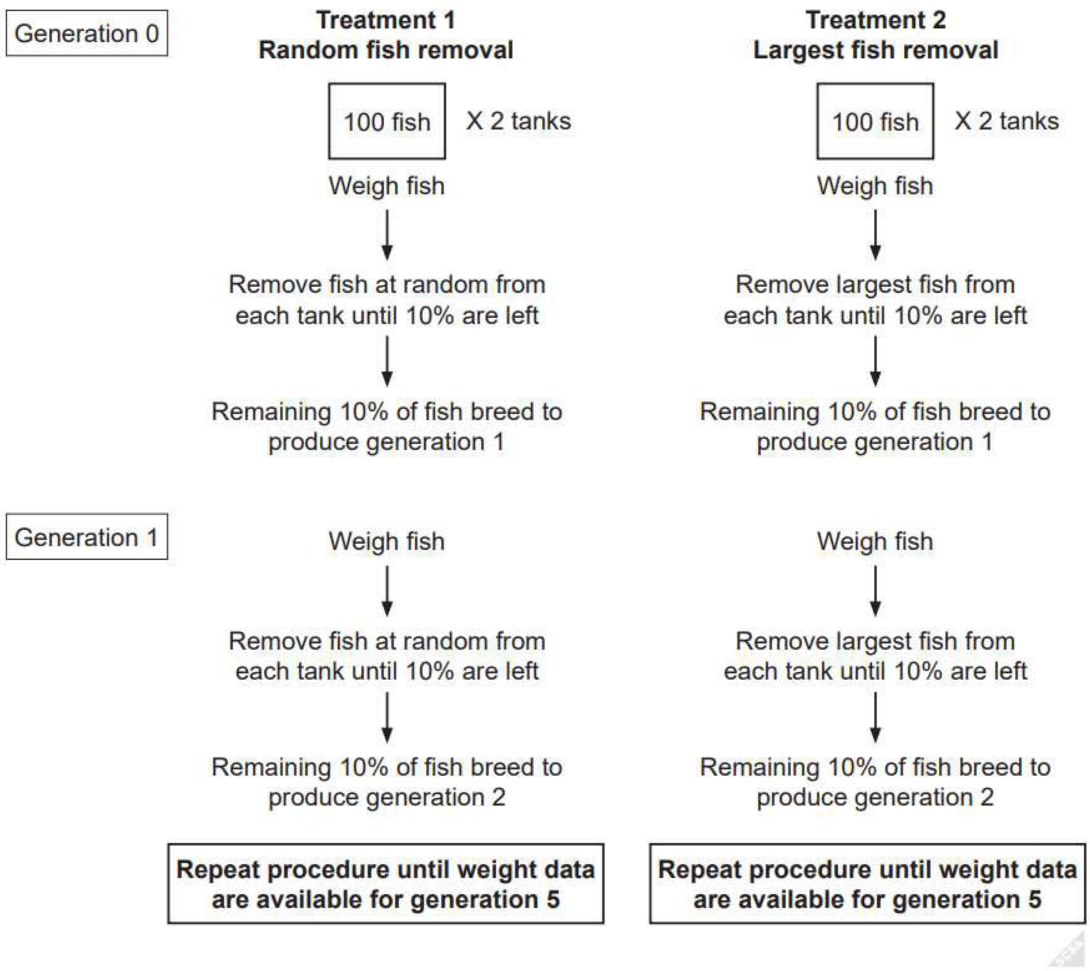
2019 Section 1 Question 27 **Science Inquiry Skills**	27. Which of the following hypotheses would be the most difficult to test with a scientific experiment? (a) radiation changes DNA structure (b) longevity in elephants is a polygenic trait (c) doses of vitamin C prevent viral infections **(d) aquatic dinosaurs were ectothermic – Answer**

[Marking Guide – Section 2](#)

2020 Section 2 Question 32

Science Inquiry Skills

A team of biologists conducted a laboratory experiment to investigate whether removing the largest individuals from a fish population would affect the size (weight) of individuals in subsequent generations. The experiment is described in the diagram below.

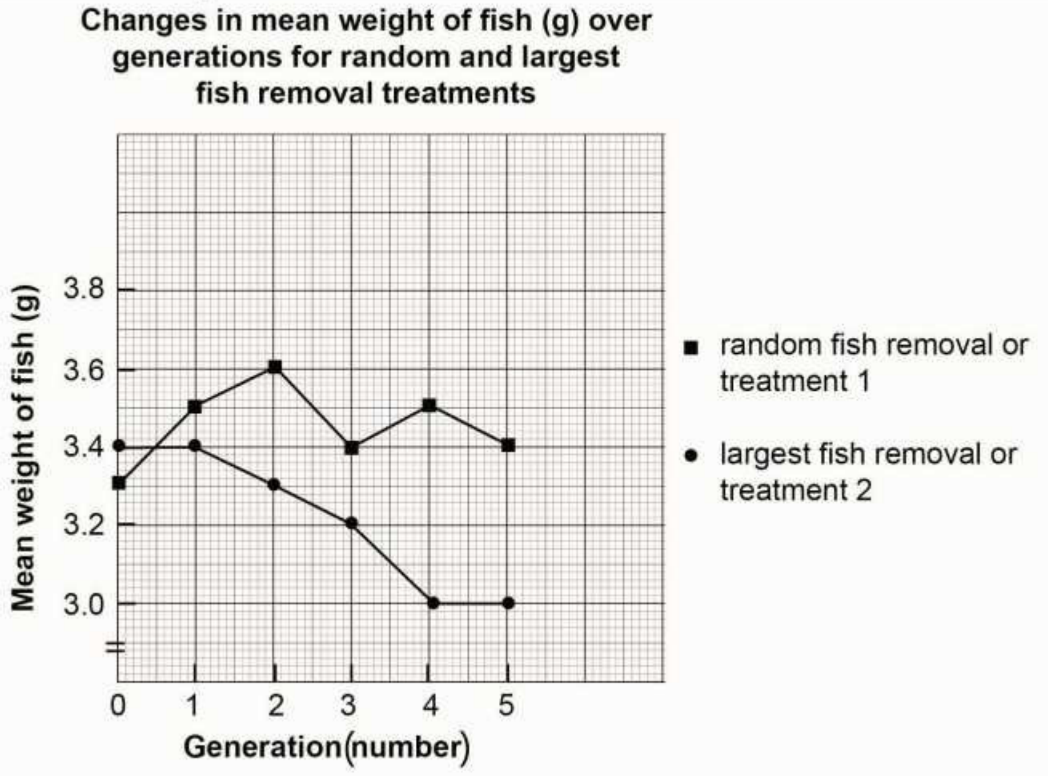


The results of the experiment are shown in the table below.

	Mean weight of fish (g)	
Generation number	**Treatment 1 Random fish removal**	**Treatment 2 Largest fish removal**
0	3.3	3.4
1	3.5	3.4
2	3.6	3.3
3	3.4	3.2
4	3.5	3.0
5	3.4	3.0

(a) Graph the mean weight of fish for both the random fish removal treatment and the largest fish removal treatment against generation. (6 marks)

Description	Marks
title must include both variables	1
data plotted separately for treatments 1 and 2 including key	1
correct axes (X and Y)	1
appropriate scale	1
labelling – accurate labelling on both axes including units	1
plotting – data plotted accurately and joined (line graph)	1
Total	**6**
Note: 'mean' is required in Y axis label	



(b) (i) Identify the dependent variable in the experiment. Give a reason for your answer. (2 marks)

Description	Marks
mean weight/size of fish left in tank	1
this is the variable that was measured/depends on the independent variable	1
Total	**2**

(ii) Would conducting the experiment for more generations improve the reliability or validity of the experiment? Give a reason for your answer. (2 marks)

Description	Marks
validity	1
this would improve accuracy of experiment **or** the ability to determine whether removing largest fish had an effect	1
Total	**2**

(iii) Why did the biologists remove fish at random from the two tanks in Treatment 1. (2 marks)

Description	Marks
control	1
so the only difference between treatments was the size of the fish that were removed **or** to determine what would happen if fish were removed from tank regardless of weight/size	1
Total	**2**

(c) Explain why the mean weight of the fish declined over generations in Treatment 2. (4 marks)

Description	Marks
natural selection **or** selection **or** environment favours small fish	1
only the smallest/lightest fish were left to breed **or** larger/heavier fish did not breed	1
smaller/lighter fish passed alleles/trait for small size/weight to offspring **or** larger/heavier fish did not pass on alleles/traits for large size/weight to offspring	1
the frequency of alleles for small size/weight (progressively) increased over generations (hence mean weight declined)	1
Total	**4**

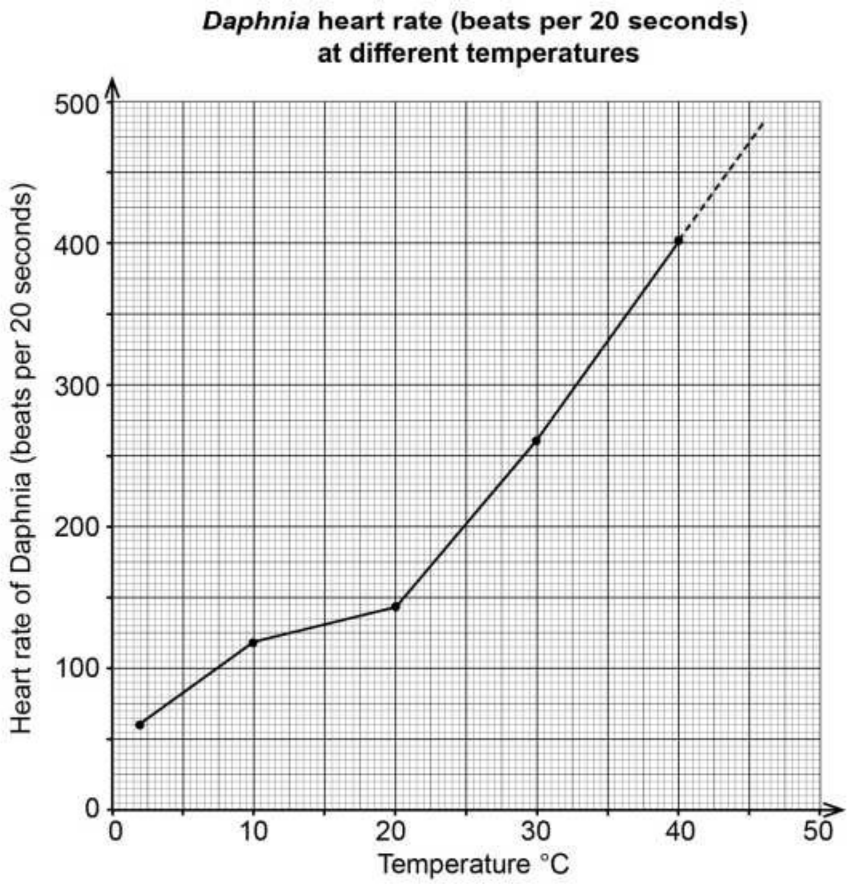
(d) Predict what would have happened if the biologists had removed the largest fish until 50% (rather than 10%) of the fish remained. Explain your answer. (4 marks)

Description	Marks
Either • mean size/weight of fish would (still) decline • but at a slower rate • (natural) selection would still favour smaller/lighter fish • but the strength of selection would be less **or** the remaining/breeding fish would be larger compared to experiment **or** less alleles for smaller size/weight **or** more alleles for larger size/weight **or** • might not have detected an effect **or** a reduction in size/weight • because rate of increase of alleles favouring small size/weight would be slower • but (natural) selection would still be favouring smaller/lighter fish • would expect to see an effect if experiment was conducted for more generations/a longer period of time	1–4
Total	**4**

2019 Section 2 Question 32 **Science Inquiry Skills**	The water flea, *Daphnia*, is a small crustacean that lives in freshwater. When *Daphnia* are examined under low magnification with a microscope, the heart is clearly visible and the beats can be counted. A biologist wanted to study the influence of temperature on the heart rate of *Daphnia*. He collected 50 *Daphnia*, randomly assigned 10 individuals to each of five temperatures and measured the heart rate of each individual after 15 minutes at the assigned temperature. The results are shown in the table below.

	Heart rate of 10 *Daphnia* (beats per 20 seconds)	
Temperature °C	Mean	Range
2	59	39–85
10	119	82–151
20	142	92–234
30	257	178–328
40	401	206–596

(a) Graph the mean heart rate of the *Daphnia* against temperature. (6 marks)



Description	Marks
accurate title that includes both variables	1
choose appropriate graph/line graph	1
correctly allocates independent/dependent variables to X and Y axes respectively	1
scale uses correct intervals and graph size is appropriate for grid size	1
correct labelling of both axes including units	1
data points are accurate and accurately joined	1
Total	**6**

(b) (i) Estimate the heart rate for *Daphnia* at 15 °C. (1 mark)

Description	Marks
135 beats/20 seconds (accept 130–140, must have units)	1
Total	**1**

(ii) Estimate the heart rate for *Daphnia* at 45 °C. (1 mark)

Description	Marks
470 beats/20 seconds (accept 460–480, must have units)	1
Total	**1**

(iii) In which estimate do you have the greater confidence? Give a reason for your answer. (2 marks)

Description	Marks
heart rate at 15 °C or first estimate or (i)	1
this is an interpolation/within the range of the data **or** heart rate at 45 °C is an extrapolation/outside of range of data	1
Total	**2**

(c) (i) What is the independent variable in this study? Give a reason for your answer. (2 marks)

Description	Marks
temperature	1
it is the variable that the investigator controls/changes	1
Total	**2**

(ii) State **one** way of improving the reliability of the study. (1 mark)

Description	Marks
increase the sample size **or** use more *Daphnia* **or** repeating experiment	1
Total	**1**
Note to markers: Must have only one statement to improve reliability.	

(iii) Propose an hypothesis for the study. (1 mark)

Description	Marks
heart rate in *Daphnia* is affected by temperature **or** heart rate in *Daphnia* is not affected by temperature **or** *Daphnia* heart rate increases with increasing temperature **or** increasing water temperature increases heart rate in *Daphnia*	1
Total	**1**

(d) Explain why the biologist waited for 15 minutes before measuring the heart rate of the *Daphnia* at the assigned temperature. (3 marks)

Description	Marks
heart rate depends on temperature	1
(when first added to assigned temperature) heart rate will reflect previous temperature **or** heart rate needs time to adjust to assigned temperature	1
improve accuracy/validity of experiment **or** (not doing so) would lead to inaccurate/invalid results	1
Total	**3**

(e) One of the *Daphnia* had a heart rate of 208 beats per 20 seconds. A biologist concluded that this *Daphnia* must have been assigned to a temperature of 30 °C. Evaluate this conclusion. (4 marks)

Description	Marks
Evaluates the conclusion:	
conclusion is wrong **or** partly wrong **or** only partly right	1
• there is a range of hearts beats for each temperature that is broad **or** overlap those of other temperatures • 208 beats/20 seconds is also within the range of heart rate for 20 °C and 40 °C (can also mention 30 °C) • any accurate quote of data that includes range in heart rate for a particular temperature	1–3
Total	**4**