



ATAR course examination, 2021

Question/Answer booklet

BIOLOGY

Place one of your candidate identification labels in this box.
Ensure the label is straight and within the lines of this box.

WA student number: In figures

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In words

Time allowed for this paper

Reading time before commencing work: ten minutes
Working time: three hours

Number of additional
answer booklets used
(if applicable):

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer booklet
Multiple-choice answer sheet

To be provided by the candidate

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: up to three calculators, which do not have the capacity to create or store programmes or text, are permitted in this ATAR course examination

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.



Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of examination
Section One Multiple-choice	30	30	40	30	30
Section Two Short answer	5	5	90	100	50
Section Three Extended answer Unit 3	2	1	50	20	10
Unit 4	2	1		20	10
Total					100

Instructions to candidates

- The rules for the conduct of the Western Australian external examinations are detailed in the *Year 12 Information Handbook 2021: Part II Examinations*. Sitting this examination implies that you agree to abide by these rules.
- Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.
- Answer the questions according to the following instructions.

Section One: Answer all questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Section Two: Write your answers in this Question/Answer booklet. Wherever possible, confine your answers to the line spaces provided.

Section Three: Consists of two parts, each with two questions. You must answer one question from each part. Tick the box next to the question you are answering. Write your answers in this Question/Answer booklet.

- You must be careful to confine your answers to the specific questions asked and to follow any instructions that are specific to a particular question.
- Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

See next page

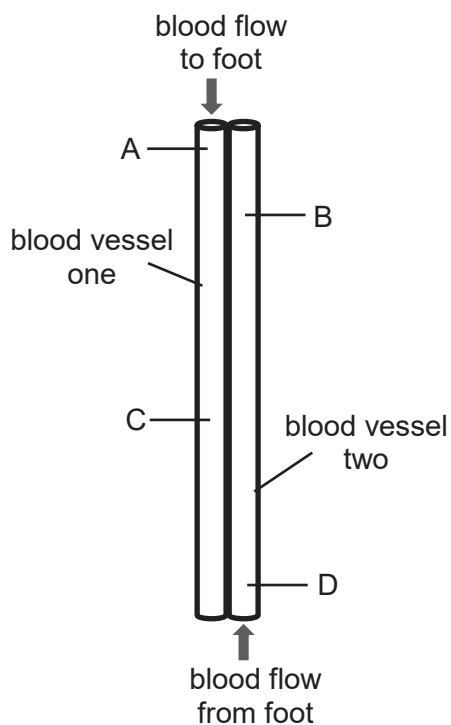
Section One: Multiple-choice**30% (30 Marks)**

This section has **30** questions. Answer **all** questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 40 minutes.

1. Which of the following organisms would be **least** likely to be found in fossil form?
- (a) frog
 - (b) jellyfish
 - (c) beetle
 - (d) pine tree
2. 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.
3. 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.
4. 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'.
5. Random assortment of chromosomes occurs in
- (a) binary fission.
 - (b) fertilisation.
 - (c) mitosis.
 - (d) meiosis.

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

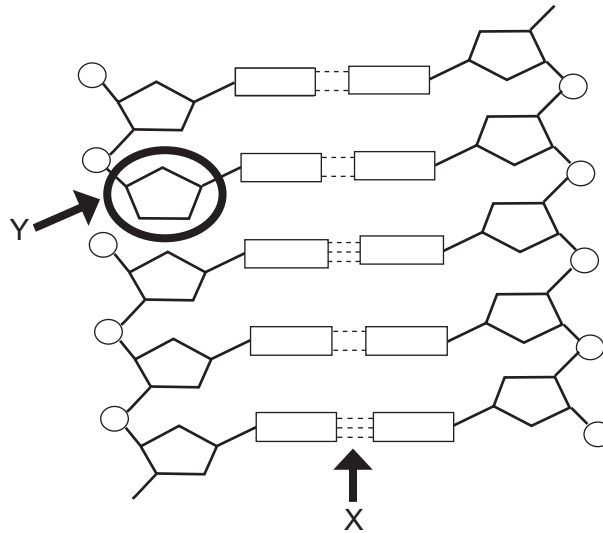
- (a) one to two by conduction.
- (b) one to two by convection.
- (c) two to one by conduction.
- (d) two to one by convection.

8. 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.

See next page

The figure below shows the structure of DNA. Use this figure to answer questions 9 and 10.

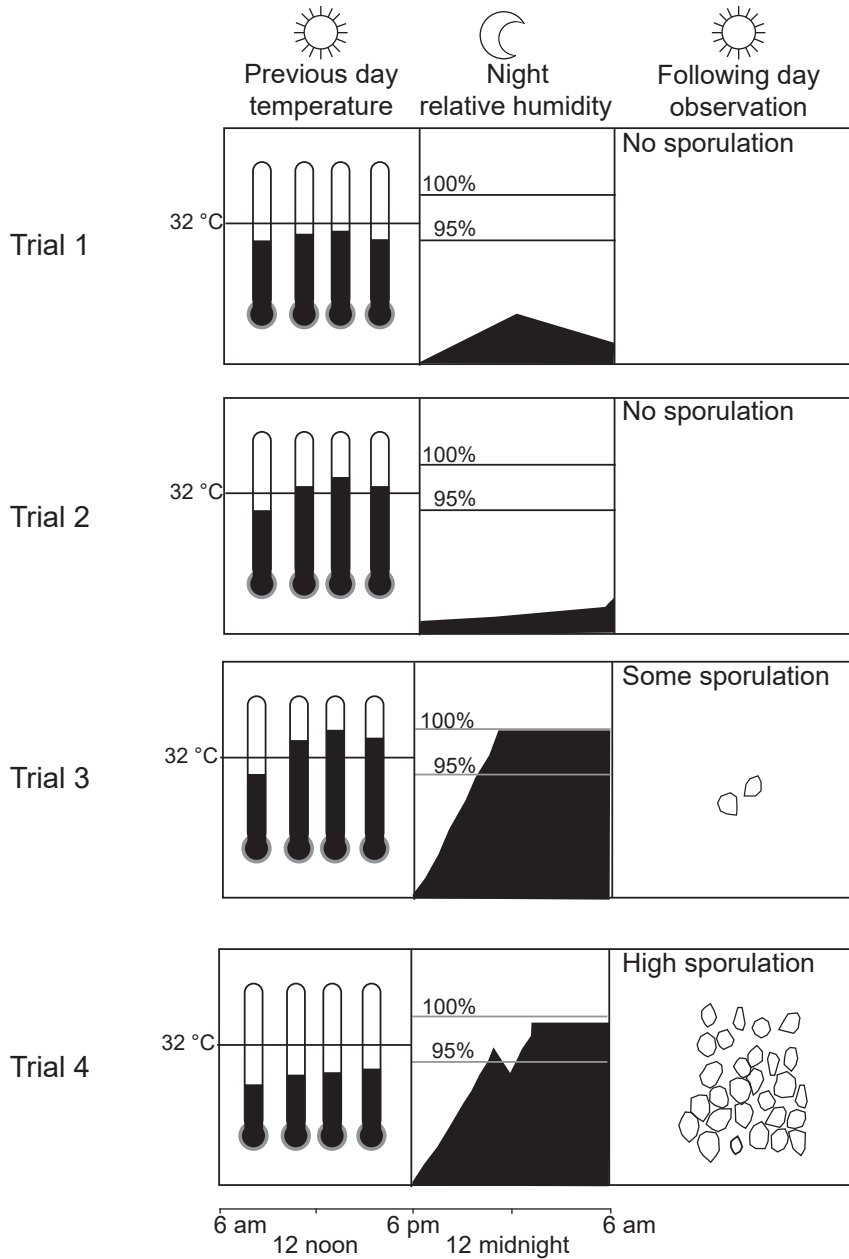


9. What type of chemical bond is indicated by X?
- oxygen
 - carbon
 - hydrogen
 - nitrogen
10. The structure indicated by Y is a
- deoxyribose sugar.
 - phosphate group.
 - nitrogenous base.
 - nucleotide.
11. The fossil record shows that the first reptiles evolved 305 million years ago. On this basis the first fish would have evolved
- later than 305 million years ago.
 - about 305 million years ago.
 - earlier than 305 million years ago.
 - about 3.5 billion years ago.
12. 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 response.
 - a sensor.
 - a stimulus.
 - an effector.

See next page

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.

See next page

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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.
15. 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
16. 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.
17. 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.
18. 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.
19. 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.

20. 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.

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.
24. Which of the following management strategies is effective in reducing the incidence of tetanus?
- (a) antiviral medication
 - (b) herd immunity
 - (c) vaccination
 - (d) quarantine

See next page

25. 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
26. 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.
27. 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.

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

28. In percentage terms, which species underwent the greatest decline in population growth between 1980 and 2019?
- (a) A
 - (b) B
 - (c) C
 - (d) D

See next page

29. 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.

30. 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?

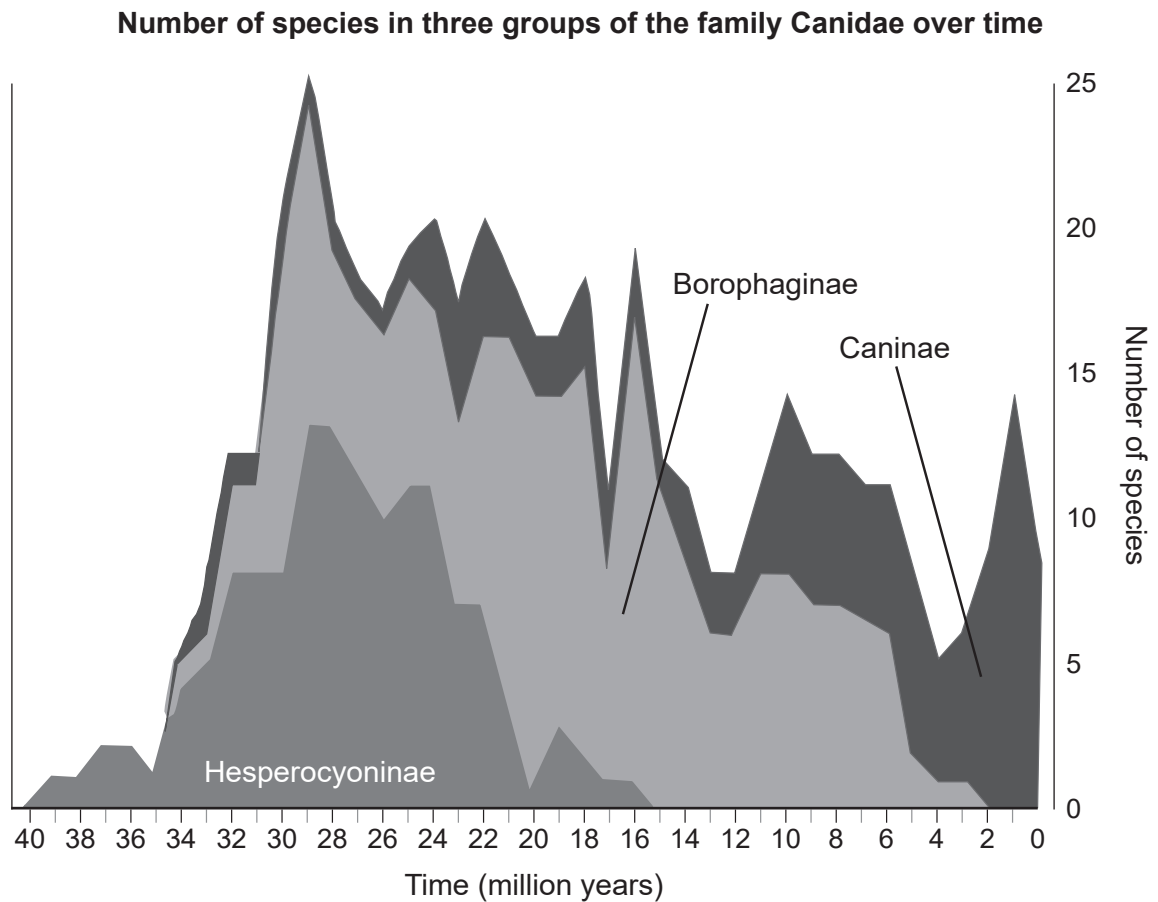
- (a) mutation
- (b) macroevolution
- (c) allopatric speciation
- (d) natural selection

End of Section One

See next page

Question 31 (continued)

- (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)

See next page

- (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)

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Question 32

(20 marks)

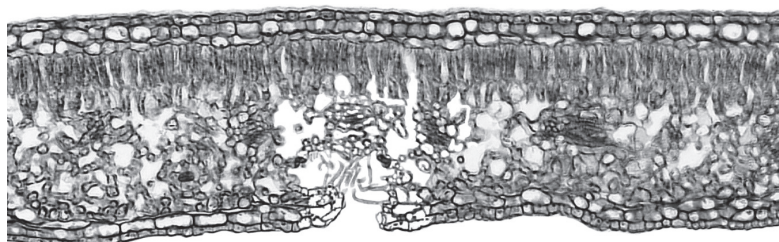
Many animal and plant species inhabit arid environments.

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

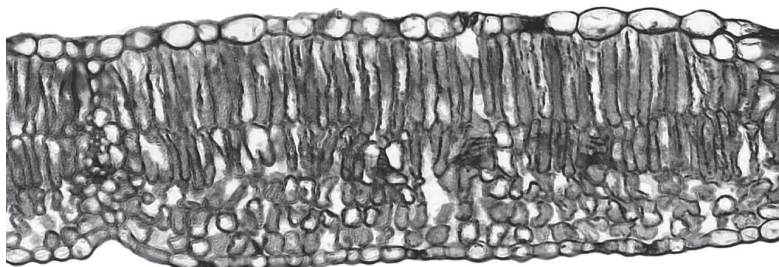
- (ii) Describe how these plants lose water to the environment. (2 marks)

- (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)

See next page

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Question 33

(19 marks)

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.

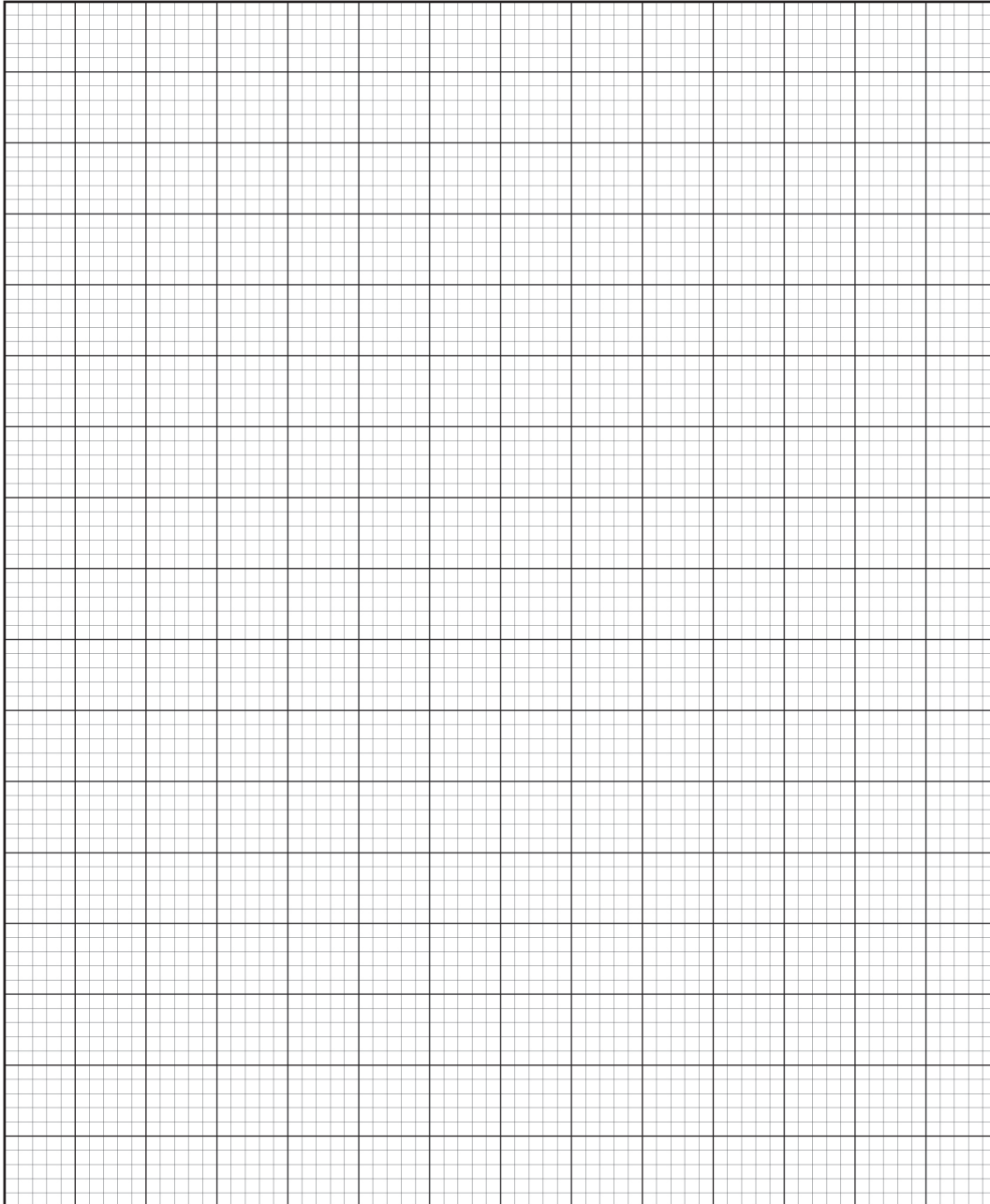
The table below shows the numbers of ponds, cages, tanks and lake sites in which each type of bacteria was found.

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

See next page

- (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)



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A spare grid is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare grid.

See next page

Question 33 (continued)

- (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)

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- (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: _____

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Question 34

(20 marks)

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.

See next page

- (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: _____

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Question 34 (continued)

- (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)

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Question 35

(20 marks)

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: _____

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Question 35 (continued)

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.

Character	Plant type			
	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)

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End of Section Two

See next page

Section Three: Extended answer**20% (40 Marks)**

Section Three consists of **four** questions.

Questions 36 and 37 are from Unit 3. Questions 38 and 39 are from Unit 4. Answer **one** question from Unit 3 and **one** question from Unit 4.

Use black or blue pen for this section. Do not use erasable or gel pens. Only graphs and diagrams may be drawn in pencil. Responses can include: labelled diagrams with explanatory notes; lists of points with linking sentences; labelled tables and/or graphs; and/or annotated flow diagrams with introductory notes.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 50 minutes.

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Unit 3

Choose **either** Question 36 **or** Question 37.

Indicate the question you will answer by ticking the box next to the question. Write your answer on pages 29–33. When you have answered your first question, turn to page 34 and indicate on that page the second question you will answer.

Question 36**(20 marks)**

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)

Question 37 is on the next page.

Question 37

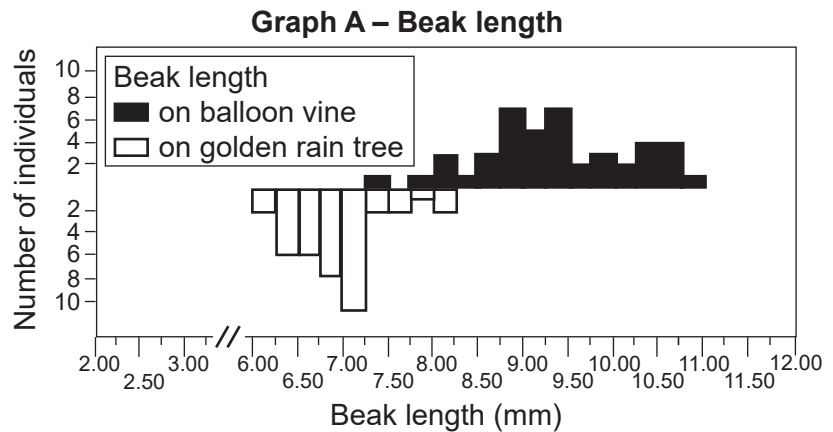
(20 marks)

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.

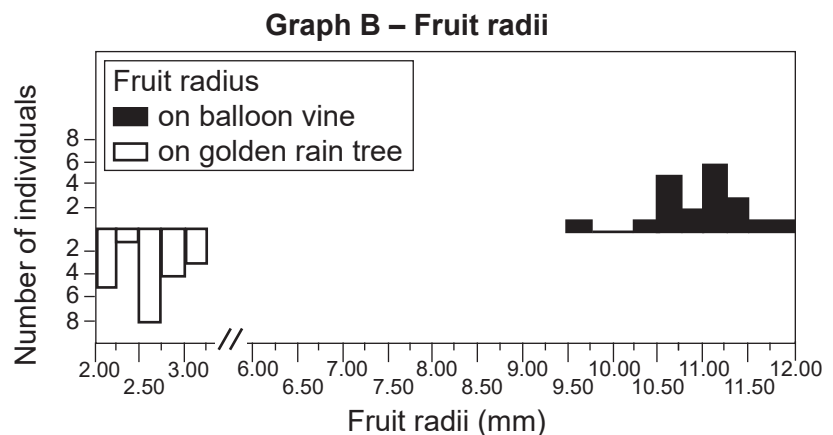
The soapberry bug feeds by inserting its beak through the fruit into the seed. A longer beak is required to reach the seed in larger fruit and vice versa. The graphs below show data collected in 1990 on:

- 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)

Unit 4

Choose **either** Question 38 **or** Question 39.

Indicate the question you will answer by ticking the box next to the question. Write your answer on the pages provided.

Question 38 **(20 marks)**

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)

Question 39 **(20 marks)**

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.

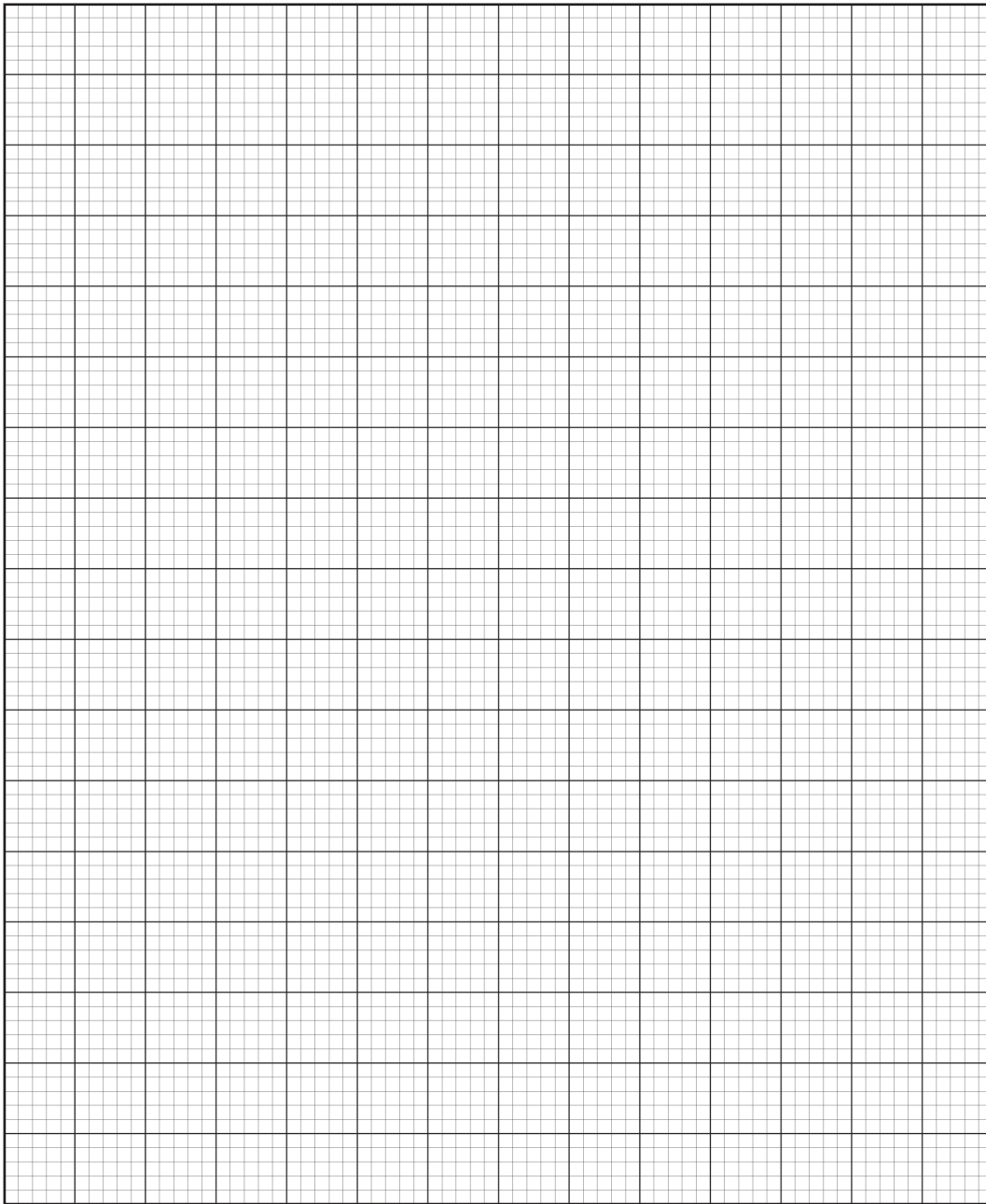
- (a) Discuss how the types of nitrogenous waste produced by different vertebrates are related to the availability of water in the environment and the ancestry (evolutionary history) of the vertebrate. (10 marks)

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)

End of questions

Spare grid



DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

ACKNOWLEDGEMENTS

- Questions 9 & 10** Adapted from: Francescabb. (2020). *DNA molecular structure, showing individual nucleotides and bonds* [Diagram]. Retrieved May, 2021, from https://commons.wikimedia.org/wiki/File:DNA_molecular_structure,_showing_individual_nucleotides_and_bonds.jpg
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