2025/4222
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Government of **Western Australia**
School Curriculum and Standards Authority

ATAR course examination, 2024

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 | | | | | | | | | |

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.

Ref: 24-008
BLY

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	20
Unit 4	2	1		20	
				Total	100

Instructions to candidates

1. The rules for the conduct of the Western Australian external examinations are detailed in the *Year 12 Information Handbook 2024: Part II Examinations.* Sitting this examination implies that you agree to abide by these rules.

2. 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 preferably using a blue/black pen. Do not use erasable or gel pens. 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 preferably using a blue/black pen. Do not use erasable or gel pens.

3. 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.

4. 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.

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1. A DNA molecule includes

   (a) thymine and deoxyribose sugar.
   (b) uracil and deoxyribose sugar.
   (c) guanine and ribose sugar.
   (d) adenine and ribose sugar.

2. Phylogeny is the study of

   (a) comparative embryology.
   (b) comparative anatomy.
   (c) evolutionary relationships.
   (d) fossils and the fossil record.

The Galapagos Islands have a tropical climate but are surrounded by cold seas. The marine iguana (a type of lizard) lives on these islands. These lizards feed in the sea and spend a lot of time lying on rocks on land. Use this information to answer Questions 3 and 4.

3. Marine iguanas are mostly black or dark grey. The main advantage of this colouration is that it aids the lizards in

   (a) absorbing radiant heat while on the land.
   (b) reducing heat loss by convection while in the water.
   (c) increasing evaporative cooling while on the land.
   (d) insulating against heat loss while in the water.

4. Male marine iguanas are larger than females. Compared to females, the surface area to volume ratio of males is

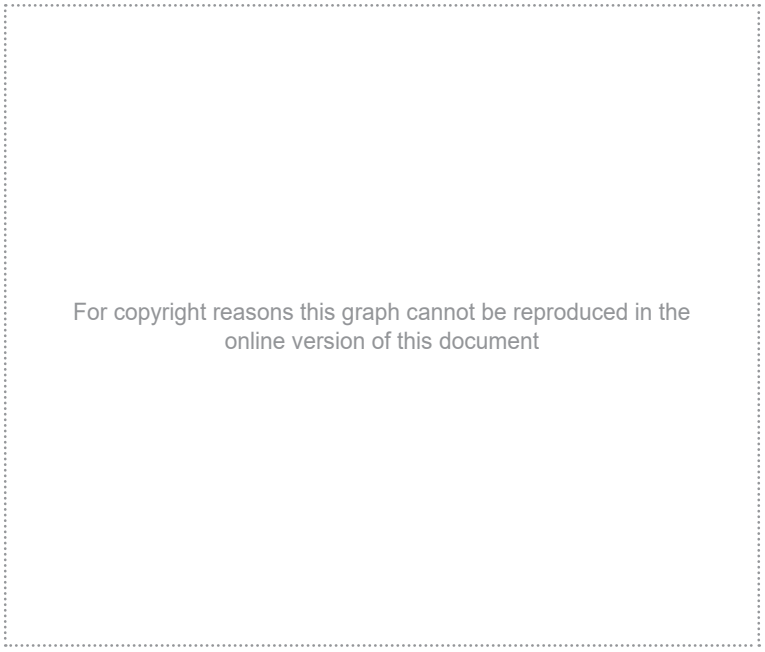
   (a) lower, meaning the males are more susceptible to heat loss when feeding.
   (b) lower, meaning the males are less susceptible to heat loss when feeding.
   (c) higher, meaning the males are more susceptible to heat loss when feeding.
   (d) higher, meaning the males are less susceptible to heat loss when feeding.

5. Most pathogens can evolve rapidly because they have

   (a) complex life cycles.
   (b) simple life cycles.
   (c) long generation times.
   (d) short generation times.

See next page

The figure below shows the numbers of families of two groups of marine invertebrates, trilobites and ammonites, over evolutionary time. Use this figure to answer Questions 6 and 7.



6. According to the figure,

   (a) ammonites never existed at the same time as trilobites.
   (b) ammonites evolved about 300 million years ago.
   (c) trilobites went extinct about 250 million years ago.
   (d) most trilobite families existed about 100 million years ago.

7. The change in the numbers of trilobite and ammonite families over evolutionary time is an example of

   (a) macroevolution.
   (b) microevolution.
   (c) diversifying selection.
   (d) directional selection.

8. High soil salinity affects a plant's ability to obtain

   (a) water via active transport.
   (b) water through osmosis.
   (c) carbon dioxide via diffusion.
   (d) oxygen via passive transport.

See next page

9. The following steps occur in DNA replication:

I. DNA uncoils
II. DNA is proofread
III. DNA is synthesised
IV. DNA unzips

Which of the following lists these steps in the order in which they occur?

(a) II, I, IV, III
(b) IV, II, III, I
(c) III, II, I, IV
(d) I, IV, III, II

Use the information below to answer Questions 10 to 12.

Column 1	Column 2	Column 3	Column 4
Disease	Type of pathogen	Is there a vector in the life cycle? (yes/no)	Can be treated with antibiotics? (yes/no)
Chytridiomycosis			
Tuberculosis			
Ross River fever			
Influenza			

10. The correct entries for Column 2, from top to bottom, are

(a) bacterium, virus, fungus, bacterium.
(b) fungus, fungus, protist, virus.
(c) protist, bacterium, protist, virus.
(d) fungus, bacterium, virus, virus.

11. The correct entries for Column 3, from top to bottom, are

(a) no, yes, no, no.
(b) no, no, yes, no.
(c) yes, yes, yes, no.
(d) no, yes, yes, yes.

12. The correct entries for Column 4, from top to bottom, are

(a) no, yes, no, no.
(b) yes, yes, yes, no.
(c) no, no, yes, yes.
(d) no, yes, yes, yes.

See next page

13. A primary function of structural proteins is to

(a) regulate gene expression.
(b) maintain cell shape.
(c) transmit information between cells.
(d) catalyse metabolic reactions.

14. A key difference between binary fission and mitosis is that

(a) binary fission is a type of nuclear division, but mitosis is not.
(b) homologous chromosomes pair during mitosis, but not in binary fission.
(c) DNA replication occurs during binary fission, but not during mitosis.
(d) binary fission produces two daughter cells, but mitosis does not.

15. 'Super weeds' are **most** likely to emerge via

(a) a novel mutation in a weed species.
(b) gene flow from a transgenic crop to a weed species.
(c) natural selection in a weed population.
(d) artificial selection in a weed population.

16. Homeostasis occurs in

(a) plants but not animals.
(b) animals but not plants.
(c) animals and plants.
(d) neither animals nor plants.

17. A cat leg and a seal flipper are examples of

(a) embryological structures.
(b) vestigial structures.
(c) analogous structures.
(d) homologous structures.

18. In a double-stranded DNA molecule, nucleotides on

(a) the same DNA strand are connected by sugar-phosphate bonds.
(b) the same DNA strand are connected by nitrogen bonds.
(c) complementary DNA strands are connected by sugar-phosphate bonds.
(d) complementary DNA strands are connected by nitrogen bonds.

19. Fish evolved before

(a) marine invertebrates but after land vertebrates.
(b) land vertebrates but after marine invertebrates.
(c) multicellular eukaryotes but after protists.
(d) protists but after multicellular eukaryotes.

See next page

20. The polymerase chain reaction (PCR)

(a) extracts DNA from organic samples.
(b) prevents DNA degradation in seed banks.
(c) amplifies minute amounts of DNA.
(d) transfers genes from one species to another.

21. Freshwater fish, in their natural environment, excrete large volumes of urine because they

(a) excrete nitrogenous waste as ammonia.
(b) excrete nitrogenous waste as urea.
(c) are hypotonic to their surroundings.
(d) are hypertonic to their surroundings.

22. The transmission of malaria is likely to be reduced by

(a) drought.
(b) floods.
(c) global air travel.
(d) a warm climate.

23. Which of the following statements about the genetic code is correct?

(a) One codon can code for multiple amino acids.
(b) Different codons may code for the same amino acid.
(c) The genetic code differs between plants and animals.
(d) Codons consist of four nucleotides.

24. Mutation is the ultimate source of genetic variation because mutation

(a) results from errors in DNA replication.
(b) can be caused by environmental factors.
(c) can create new alleles.
(d) changes allele frequencies.

25. An outbreak of a previously unknown infectious disease causes illness and some deaths among poultry on a farm. An immediate measure that could be applied to limit the spread of the disease would be to

(a) put all the poultry on antibiotics.
(b) immunise the poultry.
(c) kill potential insect vectors.
(d) quarantine the poultry farm.

26. DNA occurs in the

(a) ribosomes of prokaryote cells.
(b) nuclei of prokaryote cells.
(c) mitochondria of eukaryote cells.
(d) vacuoles of eukaryote cells.

See next page

27. Marine fish excrete their nitrogenous waste as ammonia, whereas dolphins excrete their nitrogenous waste as urea. This is because dolphins

(a) are a type of mammal, but fish are not.
(b) are endothermic, but fish are not.
(c) generate more nitrogenous waste than fish.
(d) breathe air, but fish do not.

28. The number of individuals in a frog population in an isolated swamp declined from 80 to 12 during a ten-year period. During this time, the population likely experienced

(a) an increase in genetic diversity and no change in extinction risk.
(b) a decrease in genetic diversity and an increase in extinction risk.
(c) an increase in inbreeding and no change in extinction risk.
(d) a decrease in inbreeding and an increase in extinction risk.

29. Antiviral drugs are used to manage some viral diseases because they can

(a) destroy the cell wall of the virus.
(b) disrupt the metabolism of the virus.
(c) kill the host cells containing the virus.
(d) prevent the virus from reproducing.

30. In some parts of Australia, duck hunting is allowed but only during the duck season, which lasts for about 30 days per year. Information on which of the following is crucial for ensuring that duck season is timed so that hunting will have a minimal impact on the duck populations?

(a) number of duck populations
(b) gene pool of duck populations
(c) reproductive biology of ducks
(d) abundance of duck predators

End of Section One

See next page

Section Two: Short answer **50% (100 Marks)**

This section has **five** questions. Answer **all** questions. Write your answers in the spaces provided.

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: 90 minutes.

Question 31 **(22 marks)**

(a) (i) A negative feedback loop has **five** main components. Construct a diagram that shows these components. Use arrows to show the flow of information among the components. (6 marks)

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

_____

_____

Question 31 (continued)

Infectious diseases often disrupt homeostasis in the host.

(b) State the name of an infectious disease that disrupts homeostasis in the host, and identify the aspect of homeostasis that is disrupted by this disease. (2 marks)

Penguins are a type of seabird.

(c) (i) State the type of nitrogenous waste excreted by penguins. (1 mark)

(ii) State **one** advantage to penguins of excreting this type of nitrogenous waste. (1 mark)

(iii) State **one** disadvantage to penguins of excreting this type of nitrogenous waste. (1 mark)

Penguins live in cold environments. They have several adaptations to help reduce heat loss, including a counter-current heat exchange system in their feet.

(d) Describe the main features of a counter-current heat exchange system. (5 marks)

Penguins mate and breed on islands. Approximately one-third of penguin species are found only on geologically young islands (islands that arose within the last five million years). These species generally diverged into distinct species soon after the islands emerged from the water. Biologists have suggested that allopatric speciation is responsible for the relationship between the formation of islands and the evolution of new penguin species.

(e) Explain how allopatric speciation could result in the evolution of a new penguin species on a new island. (5 marks)

See next page

Question 32 **(20 marks)**

Lake Erie water snakes live on the mainland around Lake Erie and on islands in the lake. These snakes have variable banding patterns – some are banded, some are partially banded (intermediate) and some are unbanded. The figure below shows the percentages of snakes with different banding patterns at two mainland and two island sites.

N = number of snakes.

(a) Compare the banding patterns of snakes between mainland and island sites. Include a specific data quote in your answer. (4 marks)

See next page

The frequency of banded, intermediate and unbanded Lake Erie water snakes on an island depends on a combination of natural selection, genetic drift and gene flow.

(b) (i) State **one** similarity between natural selection and genetic drift. (1 mark)

(ii) Identify **two** differences between natural selection and genetic drift. (4 marks)

One:

Two:

(c) (i) Define 'gene flow'. (1 mark)

(ii) State how gene flow influences allele frequencies within a population. (1 mark)

(iii) State how gene flow influences allele frequencies between populations. (1 mark)

See next page

Question 32 (continued)

The Lake Erie water snake colonised islands from mainland sites. Nevertheless, allele frequencies differ between mainland and island populations of this snake.

(d) Explain how a founder effect could contribute to the allele frequency differences between a mainland and an island population of this snake. (4 marks)

The Lake Erie water snake is listed as an endangered species by some management bodies. Plans to conserve this species require information on the amounts of genetic diversity in its populations.

(e) Describe how biotechnology could be used to determine the amount of genetic diversity in a population. (4 marks)

See next page

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See next page

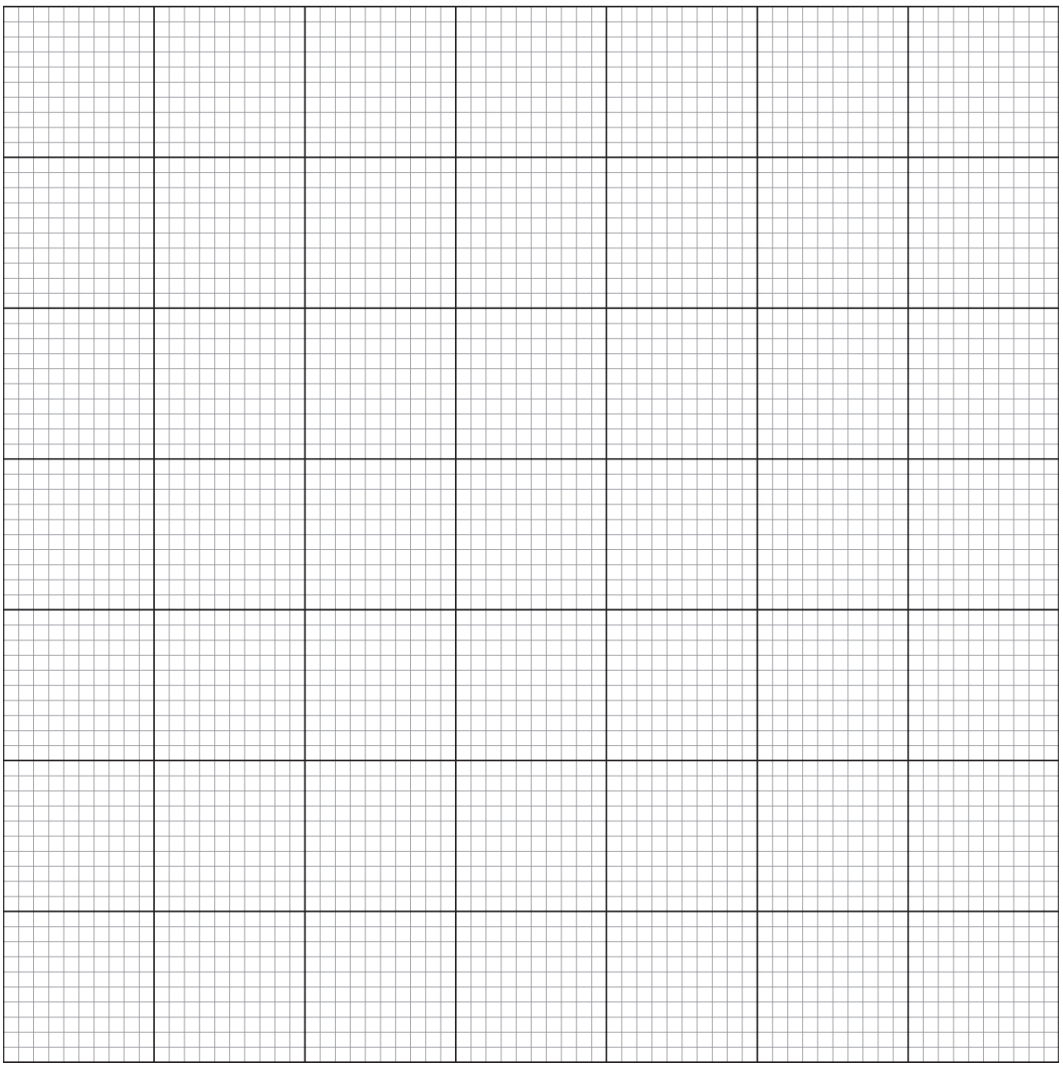
Question 33 **(21 marks)**

The crested lizard, *Anolis cristatellus*, lives in shaded forests and in open plains. Biologists monitored the body temperature of a crested lizard from a shaded forest and the body temperature of a crested lizard from an open plain over a six-hour period on the same day. The two sites were 3 km apart and experienced the same weather. The data are shown in the table below.

Time of day (24-hour clock)	Body temperature in °C of crested lizard in a shaded forest	Body temperature in °C of crested lizard in an open plain
10:00	24	29
11:00	25	30
12:00	26	30
13:00	27	29
14:00	28	30
15:00	29	30
16:00	29	30

See next page

(a) Graph the relationship between time of day and the body temperature of the crested lizard in the shaded forest and the crested lizard in the open plain. (6 marks)



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

See next page

Question 33 (continued)

(b) (i) Calculate the mean body temperature of the crested lizard in the shaded forest during the study. (1 mark)

(ii) Calculate the median body temperature of the crested lizard in the open plain during the study. (1 mark)

(iii) State the range in body temperature of the crested lizard in the shaded forest during the study. (1 mark)

(iv) State the time/s with the greatest temperature difference between the two lizards. (1 mark)

(c) State whether you can use the graph to accurately estimate the body temperature of the crested lizard in the open plain at time 24:00. Justify your answer. (3 marks)

See next page

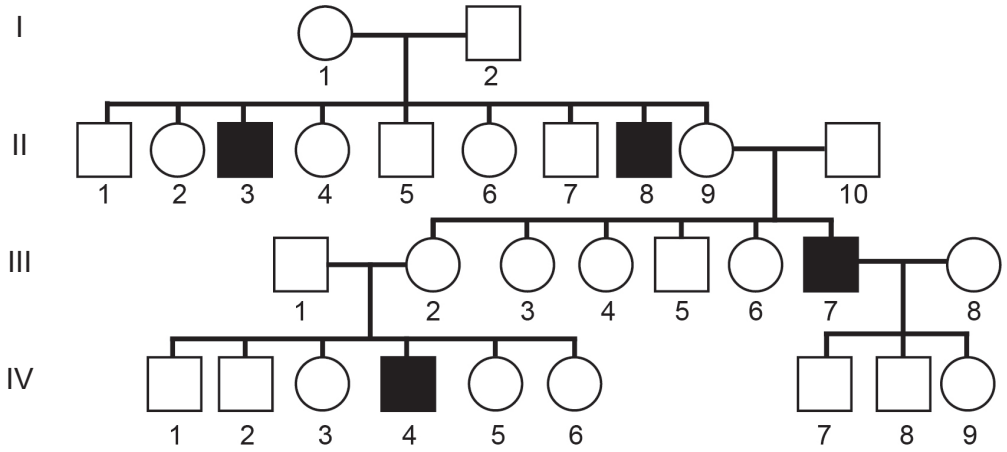
(d) Explain why the body temperature of the crested lizard in the open plain is consistently higher than the crested lizard in the shaded forest. (4 marks)

The biologists measured the body temperature of one crested lizard in a shaded forest and one crested lizard in an open plain.

(e) Explain why it would be an improvement to measure more than one lizard at each location. (4 marks)

Question 34 **(17 marks)**

The pedigree below shows an inherited disorder in dogs.



(a) (i) Identify a male in the pedigree that shows the disorder. (1 mark)

(ii) Identify a female in the pedigree that is not a descendant of individual I-2. (1 mark)

(b) State whether the disorder is caused by a recessive or dominant allele. Justify your answer, with reference to specific individuals in the pedigree. (3 marks)

(c) State whether the disorder is more likely to be caused by alleles at an X linked or autosomal gene. Justify your answer. (2 marks)

Coat colour in Cocker Spaniel dogs is determined by two alleles at a gene. One type of homozygote has a black coat, the other has a white coat and heterozygotes are roan (black and white hairs).

(d) Two roan coloured Cocker Spaniels are crossed and the offspring include white, black and roan puppies. State the probability of producing a roan puppy. Use an annotated Punnett square to show your workings. (6 marks)

Question 34 (continued)

(e) Identify **three** characteristics of a 'polygenic trait' and state a specific example of a polygenic trait. (4 marks)

One: _____

_____

Two: _____

_____

Three: _____

_____

Example: _____

_____

See next page

Question 35 **(20 marks)**

Phytophthora dieback is a plant disease that affects a range of agricultural crop species as well as plants in natural ecosystems.

(a) (i) State the major group of organisms to which the *Phytophthora* dieback pathogen belongs. (1 mark)

(ii) Identify **two** major structural characteristics of the pathogen that causes *Phytophthora* dieback. (2 marks)

One:

Two:

(b) (i) List **two** symptoms of *Phytophthora* dieback. (2 marks)

One:

Two:

(ii) Describe how the *Phytophthora* dieback pathogen causes disease. (3 marks)

See next page

Question 35 (continued)

Humans have played a major role in spreading *Phytophthora* dieback disease.

(c) Explain how humans spread *Phytophthora* dieback disease. (4 marks)

Biologists researching chemical treatments to control *Phytophthora* dieback in avocado orchards carried out the following experiment.

They germinated avocado seedlings in glasshouses and divided them into seven equal treatment groups. They recorded the survival of the seedlings one month after the treatments. The results are shown in the table below.

Treatment code	Treatment description	Number of seedlings in the treatment	Number of seedlings alive after one month
1	Watered daily only	50	48
2	Watered daily + infected with *Phytophthora* pathogen	50	12
3	Watered daily + infected with *Phytophthora* pathogen + treated with fluopicolide	50	38
4	Watered daily + infected with *Phytophthora* pathogen + treated with mandipropamid	50	42
5	Watered daily + infected with *Phytophthora* pathogen + treated with mefenoxam	50	38
6	Watered daily + infected with *Phytophthora* pathogen + treated with oxathiapiprolin	50	46
7	Watered daily + infected with *Phytophthora* pathogen + phosphite	50	27

See next page

The experiment has two controls.

(d) State the treatment code numbers corresponding to the **two** controls and describe the function of each control. (4 marks)

One: _____

Two: _____

(e) (i) Based on the experimental results, recommend a treatment for the *Phytophthora* dieback pathogen in avocados and justify your answer with reference to the data. (2 marks)

(ii) State whether the treatment you recommended for *Phytophthora* dieback in avocado orchards would also be suitable for natural ecosystems. Justify your answer. (2 marks)

End of Section Two

See next page

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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.

See next page

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)**

Proteins are present in all living organisms and are essential to cell structure and function.

(a) Describe the roles of DNA, messenger RNA (mRNA) and transfer RNA (tRNA) in protein synthesis. (10 marks)

Life on earth is very old.

(b) Describe **four** characteristics of the oldest known life forms and explain how the fossil record and comparative genomics have helped to determine the characteristics of early life forms. (10 marks)

or

☐ **Question 37** **(20 marks)**

Artificial selection has been used for thousands of years to produce crop varieties with desirable characteristics.

(a) Describe how artificial selection can be used to produce a crop variety with desirable characteristics and **three** advantages and **three** disadvantages of using artificial selection to produce a new crop variety. (10 marks)

Sexual reproduction, through the processes of meiosis and fertilisation, produces genotypic variation.

(b) Explain the **two** main ways in which the process of meiosis results in variation in genotypes. (10 marks)

Question number: _____

See next page

See next page

See next page

See next page

See next page

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 pages provided.

☐ **Question 38** **(20 marks)**

Xerophytic plants need to maintain water balance while allowing for gas exchange, and have a variety of adaptations to achieve this.

(a) Explain why plants lose water to the environment during gas exchange and **three** distinctly different ways in which xerophytic plants minimise water loss from gas exchange. (10 marks)

The chance of an epidemic occurring depends on several factors.

(b) Using influenza as an example, explain why urban areas are susceptible to epidemics and how vaccination and **three** other healthcare provisions can reduce disease transmission. (10 marks)

or

☐ **Question 39** **(20 marks)**

Crown gall is an infectious disease of plants that can cause significant economic losses.

(a) For crown gall disease, explain how the pathogen invades the host and causes disease, and **two** distinctly different management strategies to prevent the spread of the disease. (10 marks)

Animals have a variety of behavioural, physiological and structural adaptations to maintain water and salt balance.

(b) Explain what would happen to a desert mammal if it drank saltwater and explain **one** physiological and **one** behavioural adaptation that desert mammals use to maintain water-salt balance. State which adaption is physiological and which is behavioural. (10 marks)

End of questions

Question number: _____

Supplementary page

Question number: _____

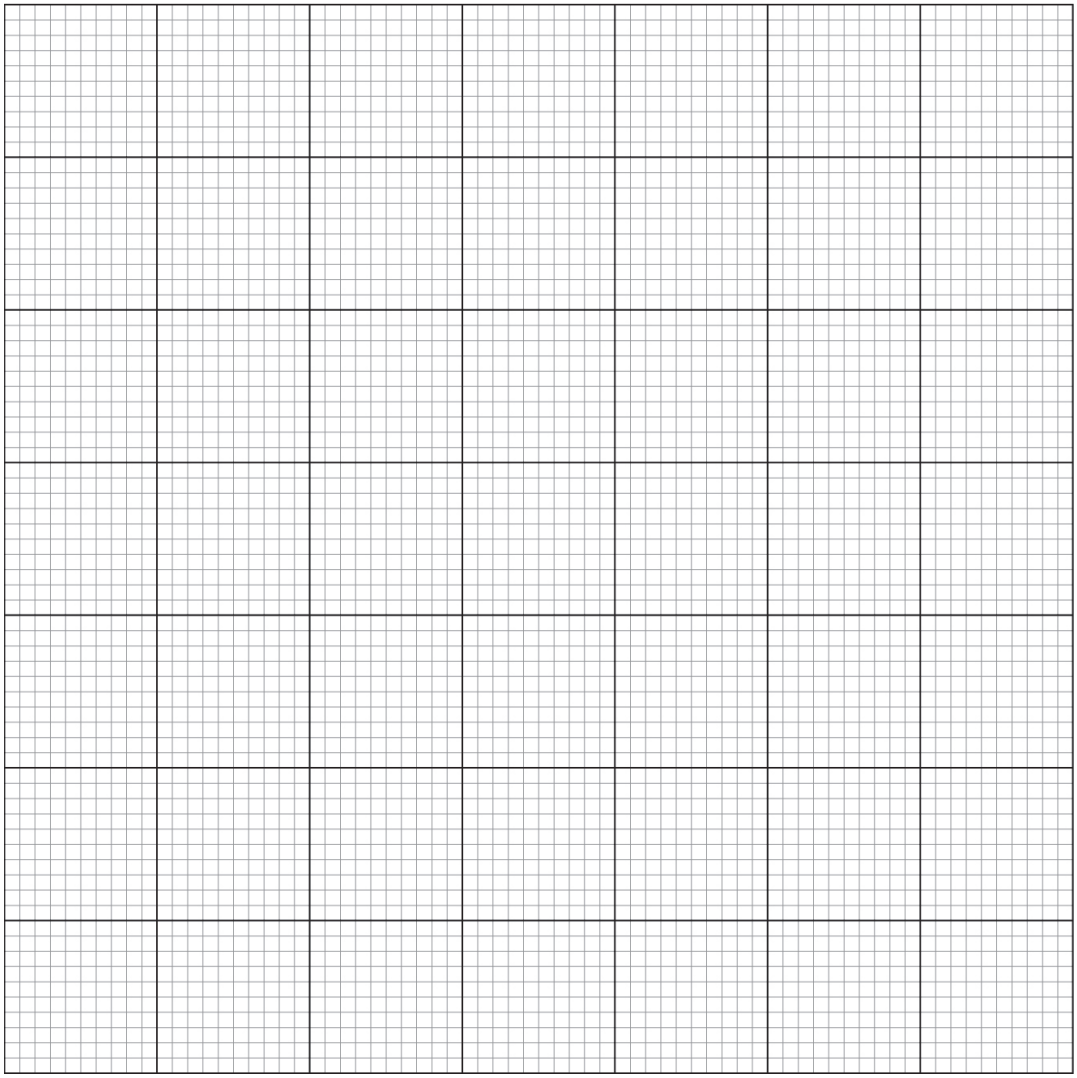
Supplementary page

Question number: _____

Supplementary page

Question number: _____

Spare grid for Question 33(a)



ACKNOWLEDGEMENTS

Questions 6–7 Adapted from: University of California Museum of Paleontology. (n.d). *Extinction and Diversification – Trilobites and Ammonites* [Graph]. Retrieved April, 2024, from https://evolution.berkeley.edu/teach-resources/extinction-and-diversification-trilobites-and-ammonites/

Question 32(a) Adapted from: Freeman, S., Herron, J.C. (2007). *Evolutionary Analysis* (4 ed.). Pearson Education, p. 228, fig. 7.7.

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