



ATAR course examination, 2023

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	20
Unit 4	2	1		20	
Total					100

Instructions to candidates

- The rules for the conduct of the Western Australian external examinations are detailed in the *Year 12 Information Handbook 2023: Part II Examinations*. Sitting this examination implies that you agree to abide by these rules.
- 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.

- 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. *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.
2. 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.
3. 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.
4. 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
5. 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.

6. 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.
7. Which of the following is a type of physical mutagen?
- (a) alkylating agent
 - (b) base analogue
 - (c) UV light
 - (d) transposable element
8. Which of the following reduces genetic differences between populations?
- (a) genetic drift
 - (b) gene flow
 - (c) speciation
 - (d) mutation
9. 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.
10. 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.
11. In crown gall disease, the galls are made up of
- (a) bacterial cells.
 - (b) fungal cells.
 - (c) protist cells.
 - (d) host cells.
12. 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.

See next page

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
- 18.5.
 - 21.0.
 - 11.5.
 - 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?
- 274
 - 326
 - 357
 - 435
15. The Spinifex hopping mouse lives in deserts in Australia and obtains water by
- producing concentrated urine.
 - having a slow breathing rate.
 - metabolising fat and carbohydrates.
 - sheltering in a humid burrow.
16. The evolution of land plants from freshwater algae is an example of
- macroevolution.
 - microevolution.
 - artificial selection.
 - natural selection.
17. Muscle cells from a saltwater fish and from a freshwater fish are placed in a tube filled with distilled water. The cells from
- both the saltwater and freshwater fish will lose water.
 - both the saltwater and freshwater fish will gain water.
 - the saltwater fish will lose water and the freshwater fish will gain water.
 - the saltwater fish will gain water and the freshwater fish will lose water.

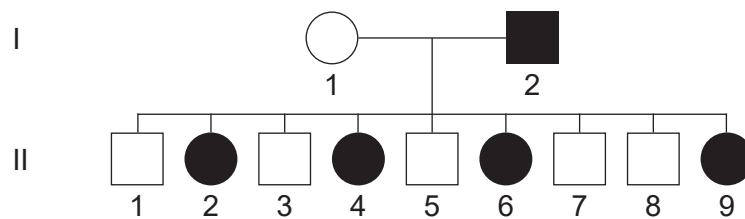
18. In Western Australia, permits are required to move honeybees, honey and bee-keeping equipment between regions within the State. The **main** reason for this regulation is to
- (a) reduce competition between honeybees and native bees.
 - (b) ensure that honeybees are available to pollinate crops.
 - (c) limit the spread of honeybee pathogens.
 - (d) regulate the number of honeybees present in a region.
19. 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.
20. 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
21. 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
22. 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.

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.

23. 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?
24. 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.
25. 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.
26. 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.
27. 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.

28. 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

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.



29. 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.
30. 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.

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**(19 marks)**

- (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: _____

Question 31 (continued)

- (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)

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

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Question 32

(21 marks)

- (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: _____

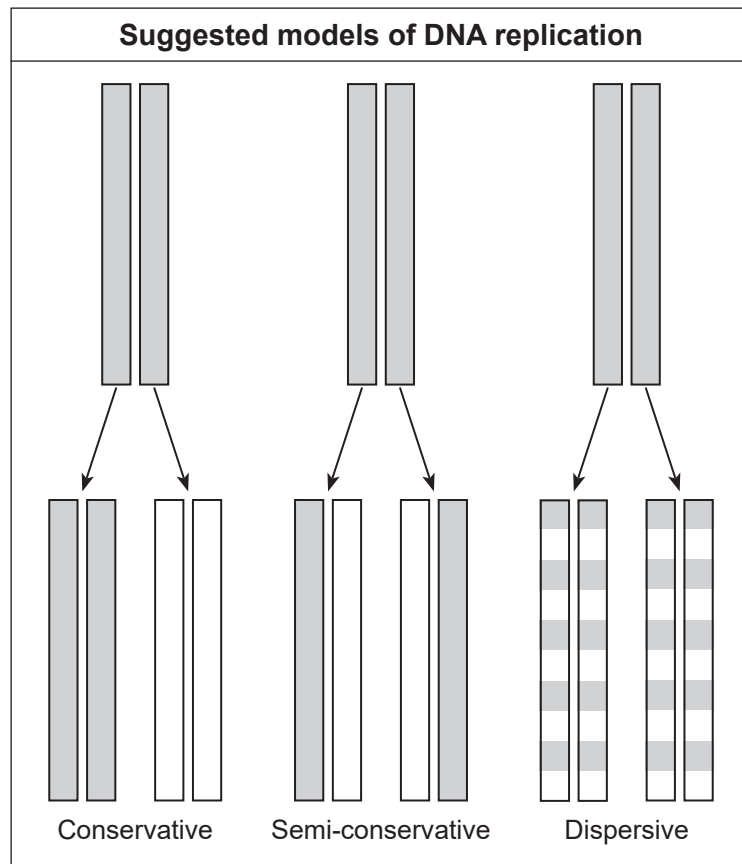
Two: _____

Three: _____

Four: _____

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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)

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

See next page

Question 32 (continued)

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)

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See next page

Question 33

(21 marks)

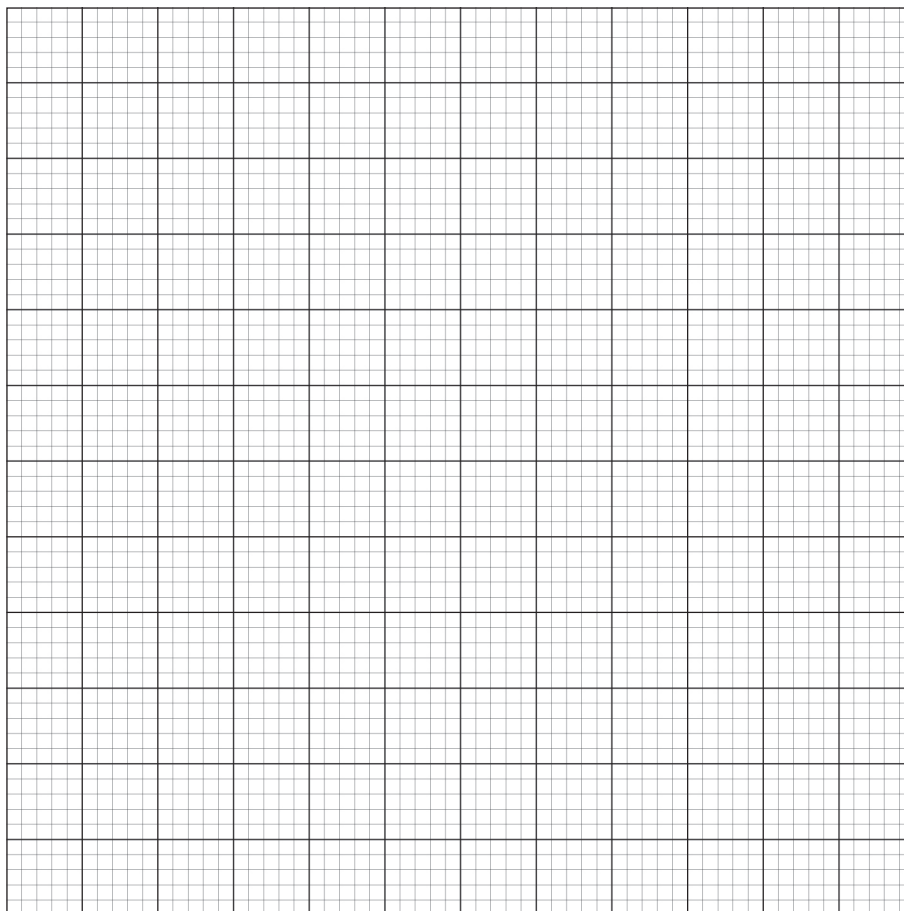
Biologists measured the duration of meiosis (in minutes) at different environmental temperatures in two plant species. The results are given in the table below.

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

For copyright reasons this table cannot be reproduced in the online version of this document

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)



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

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- (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: _____

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

Question 33 (continued)

- (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)

- (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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Question 34

(19 marks)

- (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.

- (b) State whether polycystic kidney is an infectious disease. Justify your response. (3 marks)

Bovine tuberculosis is an example of a zoonosis.

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

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

Question 34 (continued)

- (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)

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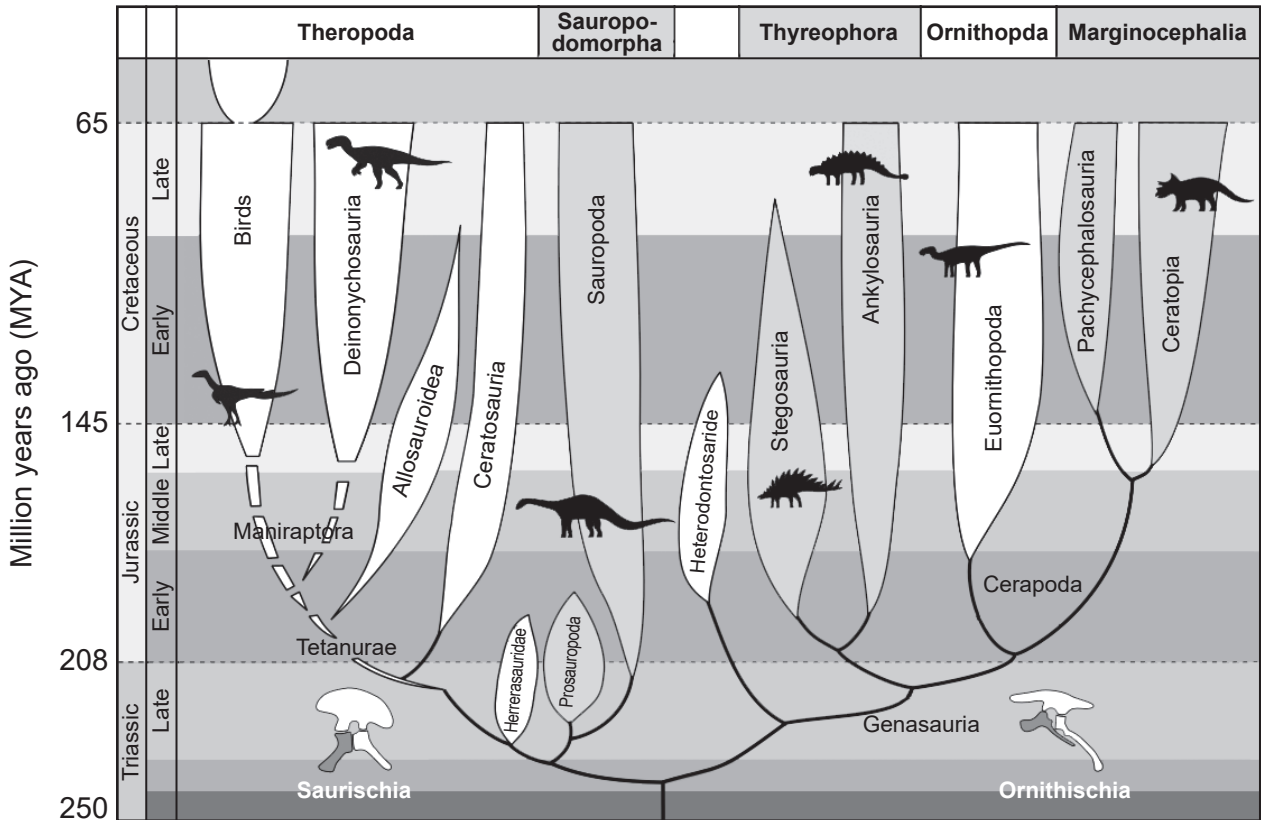
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Question 35

(20 marks)

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)

See next page

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- (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)

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Question 35 (continued)

- (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)

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.

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 27–31. When you have answered your first question, turn to page 32 and indicate on that page the second question you will answer.

Question 36**(20 marks)**

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)

or

 Question 37**(20 marks)**

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)

See next page

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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 the pages provided.

Question 38 **(20 marks)**

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)

or

Question 39 **(20 marks)**

Ross River disease is the most significant mosquito-borne disease in Australia.

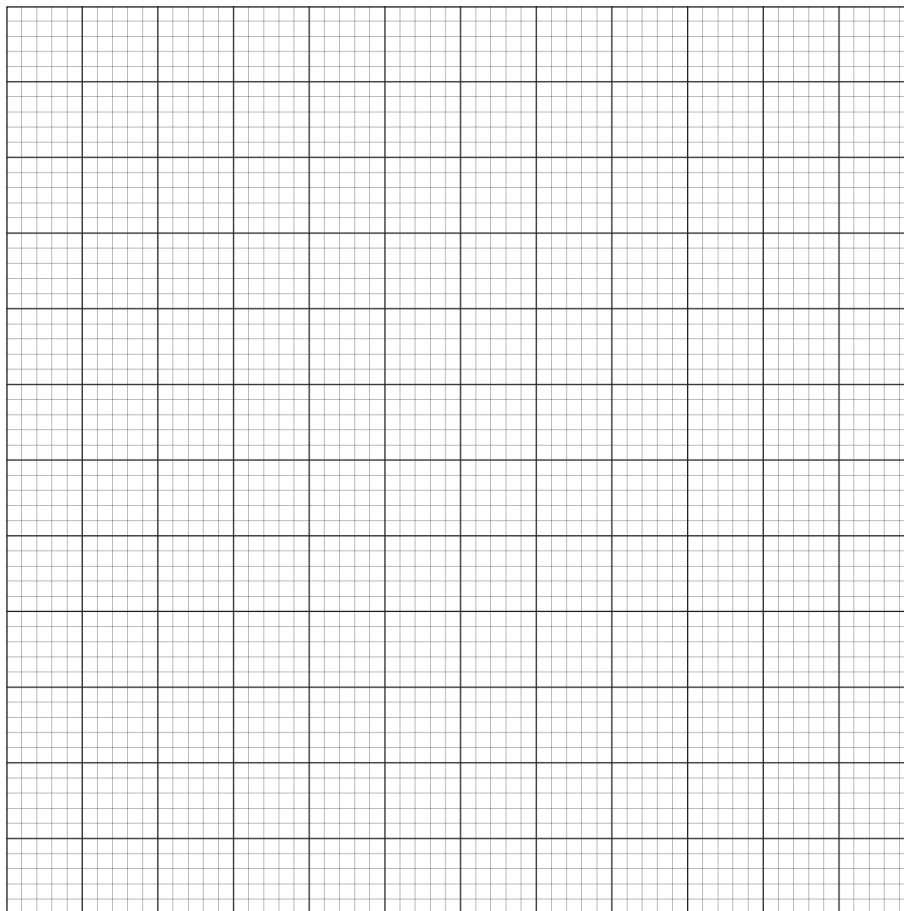
- (a) Discuss the management strategies available for the control of Ross River disease. (10 marks)

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)

End of questions

Spare grid for Question 33(a)



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ACKNOWLEDGEMENTS

- Questions 29–30** Pedigree diagram provided by courtesy of examining panel.
- Question 32** Adapted from: Rye, C., Wise, R., Jurukovski, V., et al. (2018). Figure 14.12 [Diagram]. In *Biology*. OpenStax. Retrieved May, 2023, from <https://openstax.org/books/biology/pages/14-3-basics-of-dna-replication>
Used under a Creative Commons Attribution 4.0 International licence.
- Question 33** Table adapted from: Bennett, M. D., Lewis, K. R. & Harberd, D. T. (1977). *The Time and Duration of Meiosis [and Discussion]* (Table 5) (Vol 277, No. 955.). The Royal Society, p. 211.
- Question 35** Adapted from: Zureks. (2009). *Evolution of Dinosaurs* [Diagram]. Retrieved May, 2023, from https://commons.wikimedia.org/wiki/File:Evolution_of_dinosaurs_EN.svg
- Question 37(b)** Photograph of a woylie provided by courtesy of examining panel.

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