



Western Australian Certificate of Education ATAR course examination, 2016

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.

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: non-programmable calculators approved for use in this 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	40	20
Unit 4	2	1			
Total					100

Instructions to candidates

- The rules for the conduct of the Western Australian Certificate of Education ATAR course examinations are detailed in the *Year 12 Information Handbook 2016*. 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. 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.

- 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.
- Additional working space pages at the end of this Question/Answer booklet are for planning or continuing an answer. If you use these pages, indicate at the original answer, the page number it is planned/continued on and write the question number being planned/continued on the additional working space page.

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. 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. A xerophyte is
- (a) an animal adapted to a cold environment.
 - (b) a plant adapted to a dry environment.
 - (c) an animal adapted to a saltwater environment.
 - (d) a plant adapted to a freshwater environment.
2. Tuberculosis will spread most rapidly through a host population when the density of the host population is
- (a) high and herd immunity is low.
 - (b) high and herd immunity is high.
 - (c) low and herd immunity is low.
 - (d) low and herd immunity is high.
3. X-radiation (X-rays) is an agent that
- (a) repairs DNA and decreases the mutation rate.
 - (b) damages DNA and decreases the mutation rate.
 - (c) repairs DNA and increases the mutation rate.
 - (d) damages DNA and increases the mutation rate.
4. If 27% of the nucleotides in a DNA molecule contain guanine, what percentage will contain thymine?
- (a) 23
 - (b) 27
 - (c) 46
 - (d) 54
5. Transpiration refers to the
- (a) removal of nitrogenous waste from a plant.
 - (b) removal of nitrogenous waste from an animal.
 - (c) evaporation of water from the leaves of a plant.
 - (d) evaporation of water from the skin of an animal.

Question 6 relates to the information below.

A man's resting heart rate was measured at weekly intervals over a five-week period during which the man undertook fitness training. The data are tabulated below.

Week	Resting heart rate (beats per minute)
1	84
2	80
3	71
4	69
5	66

6. These data indicate that the man's resting heart rate
- (a) was above 90 beats per minute before the experiment began.
 - (b) will drop below 60 beats per minute if the fitness training continues.
 - (c) declined at the fastest rate between weeks 2 and 3.
 - (d) increased by 20 beats per minute over the five weeks.
7. Which of the following hypotheses **cannot** be tested using a scientific experiment?
- (a) Flies can breed in outer space.
 - (b) Fish evolved before birds.
 - (c) Dogs cannot see in colour.
 - (d) Salt solution kills weeds.
8. An outbreak of a serious new strain of influenza occurs on a cruise ship at sea. The best method of preventing the influenza from spreading to populations on land is to
- (a) keep all people on the ship until everyone has recovered.
 - (b) send crew members ashore to obtain antiviral medication.
 - (c) disinfect all eating and recreational areas on the ship.
 - (d) bring in medical personal to vaccinate people on the ship.
9. A mammal that is adapted to a desert environment will excrete
- (a) uric acid and have a large number of sweat glands.
 - (b) uric acid and have a small number of sweat glands.
 - (c) urine and have a large number of sweat glands.
 - (d) urine and have a small number of sweat glands.

10. Influenza is a zoonotic disease because it
- (a) is caused by a virus.
 - (b) can be transmitted from animals to humans.
 - (c) affects the respiratory system.
 - (d) cannot be treated with antibiotics.
11. In mitosis, a parent cell usually produces
- (a) four daughter cells, each of which has the same number of chromosomes as the parent cell.
 - (b) four daughter cells, each of which has half the number of chromosomes as the parent cell.
 - (c) two daughter cells, each of which has the same number of chromosomes as the parent cell.
 - (d) two daughter cells, each of which has half the number of chromosomes as the parent cell.
12. An increase in the sample size of an experiment will
- (a) increase the reliability and validity of the experiment.
 - (b) increase the reliability of the experiment but not the validity.
 - (c) increase the validity of the experiment but not the reliability.
 - (d) not affect the reliability or validity of the experiment.
13. In humans, the organism that causes malaria reproduces
- (a) sexually in liver cells and asexually in red blood cells.
 - (b) asexually in liver cells and sexually in red blood cells.
 - (c) sexually in liver and red blood cells.
 - (d) asexually in liver and red blood cells.
14. Which of the following is an example of a macroevolution?
- (a) The frequency of an allele in a weed population increased from 5% to 50%.
 - (b) Pea plants in nutrient-rich soil grew faster than pea plants in nutrient-poor soil.
 - (c) A species of elephant evolved into two new species.
 - (d) Black rats fed on warfarin poison evolved resistance to this poison.
15. A bony fish living in seawater actively
- (a) avoids drinking seawater and excretes a large volume of urine.
 - (b) avoids drinking seawater and excretes a small volume of urine.
 - (c) drinks seawater and excretes a large volume of urine.
 - (d) drinks seawater and excretes a small volume of urine.

16. A horticulturalist tested the hypothesis that watering tomato seedlings with an iron sulfate solution at the time of planting prevented iron deficiencies in mature plants. He prepared five different plots and planted 10 tomato seedlings into each plot and then watered them all with an iron sulfate solution. When the plants matured, he examined them for signs of iron deficiency. What essential feature of a scientific experiment is missing from the procedure?
- (a) a control
 - (b) replication
 - (c) a treatment
 - (d) an experimental subject

Question 17 relates to the table below, which shows the mRNA codons for four amino acids.

Amino acid	mRNA codon
Histidine	CAU
Arginine	CGU
Methionine	AUG
Alanine	GCA

17. On the basis of the data in the table, tRNA with the anti-codon GCA will carry
- (a) histidine.
 - (b) arginine.
 - (c) methionine.
 - (d) alanine.
18. The first known life forms on Earth were a type of
- (a) bacteria that evolved approximately 3.5 billion years ago.
 - (b) bacteria that evolved approximately 3.5 million years ago.
 - (c) protozoan that evolved approximately 3.5 billion years ago.
 - (d) protozoan that evolved approximately 3.5 million years ago.
19. The first known life forms on Earth were discovered from
- (a) comparative genomics.
 - (b) comparative anatomy.
 - (c) laboratory experiments.
 - (d) the fossil record.
20. An organism that causes an infectious disease is called a
- (a) parasite.
 - (b) vector.
 - (c) pathogen.
 - (d) host.

See next page

21. Artificial selection is the
- intentional reproduction of individuals with desirable characteristics that changes the frequency of alleles in the selected line.
 - intentional reproduction of individuals with desirable characteristics that does not change the frequency of alleles in the selected line.
 - unintentional reproduction of individuals with desirable characteristics that changes the frequency of alleles in the selected line.
 - unintentional reproduction of individuals with desirable characteristics that does not change the frequency of alleles in the selected line.

Questions 22 to 24 relate to the information below.

A biologist measured the amount of genetic diversity in five populations of the Australian platypus. The amount of genetic diversity in each population is indicated by the diversity index. Values of the diversity index range from 0 (no diversity) to 1 (maximum diversity).

Population	Diversity index
Central Victoria	0.597
Northwestern Tasmania	0.606
King Island	0.032
Kangaroo Island (wild)	0.419
Kangaroo Island (sanctuary)	0.431

22. The mean value of the diversity index in the five platypus populations is
- 0.346.
 - 0.417.
 - 0.236.
 - 0.504.
23. On the basis of the information in the table, which of the following platypus populations is at the **greatest** risk of extinction due to genetic factors?
- Kangaroo Island (wild)
 - Kangaroo Island (sanctuary)
 - Northwestern Tasmania
 - King Island
24. Which of the following processes could introduce a new allele into a platypus population?
- genetic drift
 - natural selection
 - mutation
 - meiosis

25. Antiviral medications usually
- (a) destroy toxins produced by viruses.
 - (b) disrupt the reproduction of viruses.
 - (c) kill viruses directly.
 - (d) produce antibodies that kill viruses.
26. Which of the following is a common feature of the leaves of plants in dry environments?
- (a) stomata in deep pits
 - (b) chloroplasts on the upper surface
 - (c) large surface area to volume ratios
 - (d) thin cuticles

Question 27 relates to the information below.

Biologists studying birds often divide the length of the wing by the length of the tarsus (part of the leg) to calculate the wing-to-tarsus ratio. Birds that are strong flyers have higher wing-to-tarsus ratios than birds that spend a lot of time on the ground. The wing length and tarsus length of six bird species are tabulated below.

Bird species	Wing length (mm)	Tarsus length (mm)
1	53.7	24.1
2	91.0	25.2
3	45.0	16.7
4	71.0	12.2
5	122.4	36.6
6	88.1	47.1

27. On the basis of the above information, which of the bird species is likely to be the strongest flyer?
- (a) 2
 - (b) 4
 - (c) 5
 - (d) 6
28. Two species of tortoises live on separate islands. These two species evolved from a common ancestor by allopatric speciation. The likely order of events in the speciation, from first to last, would have been
- (a) natural selection, reproductive isolation, geographical isolation.
 - (b) natural selection, geographical isolation, reproductive isolation.
 - (c) geographical isolation, natural selection, reproductive isolation.
 - (d) geographical isolation, reproductive isolation, natural selection.

See next page

29. Which of the following processes causes a random loss of alleles from a population?
- (a) genetic drift
 - (b) mutation
 - (c) natural selection
 - (d) gene flow
30. In domestic cats, a dominant allele at an autosomal gene results in extra toes, while a recessive allele results in a normal number of toes. Two cats with extra toes, both heterozygous for the allele that results in extra toes, are crossed and produce a litter of kittens. Cats have an XY system of sex determination like humans. What is the probability that the first-born kitten will be a male with a normal number of toes?
- (a) 0.750
 - (b) 0.375
 - (c) 0.250
 - (d) 0.125

End of Section One

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See next page

Section Two: Short answer

50% (100 Marks)

This section has **five (5)** questions. Answer **all** questions. Write your answers in the spaces provided in this Question/Answer booklet. Wherever possible, confine your answers to the line spaces provided. Use a blue or black pen for this section. Only graphs and diagrams may be drawn in pencil.

Additional working space pages at the end of this Question/Answer booklet are for planning or continuing an answer. If you use these pages, indicate at the original answer, the page number it is planned/continued on and write the question number being planned/continued on the additional working space page.

Suggested working time: 90 minutes.

Question 31

(20 marks)

- (a) Name and describe the process by which a bacterial cell reproduces. (4 marks)

- (b) Describe **two** differences between DNA and RNA molecules. (4 marks)

One: _____

Two: _____

In the maize plant, the texture of the seed is either smooth or wrinkled. Seed texture is determined by the alleles at a single gene. A plant with wrinkled seeds was crossed with a plant with smooth seeds (Parent generation). The parent plant with smooth seeds was a homozygote at the seed texture gene. All of the offspring of the cross had smooth seeds (F_1 generation). Individuals in the F_1 generation were crossed with each other to produce a second generation (F_2 generation).

- (c) On the basis of the above information, what seed phenotypes would be present in the F_2 generation and in what proportions would they occur? Show your workings. Use S_1 to indicate the allele that produces smooth seed and S_2 to indicate the allele that produces wrinkled seed. (5 marks)

- (d) The vinegar fly, *Drosophila melanogaster*, has an XY system of sex determination like humans. White eye, where the eyes lack pigment, is determined by a gene on the X chromosome. The allele that causes white eye is recessive to the allele for normal (pigmented) eyes. List all possible genotypes for the white eye gene for the following flies. Use 'w' to designate the white eye allele and '+' to indicate the allele that produces normal eyes. (4 marks)

1. A male with white eyes: _____
2. A male with normal eyes: _____
3. A female with white eyes: _____
4. A female with normal eyes: _____

See next page

Question 31 (continued)

(e) Explain what a polygenic trait is. Give a specific example.

(3 marks)

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Question 32

(20 marks)

(a) (i) Define homeostasis. (1 mark)

(ii) Negative feedback mechanisms are used to maintain homeostasis. Describe the main features of a negative feedback mechanism. (3 marks)

Indicate whether each of the statements below about thermoregulation in animals is true or false by circling the correct answer. Give a reason for your answer.

(b) (i) Ectothermic is a term used to describe an animal that regulates its body temperature independently of the external environment. (2 marks)

True

False

Reason:

(ii) A large body size will help a mammal to retain body heat in a cold environment. (2 marks)

True

False

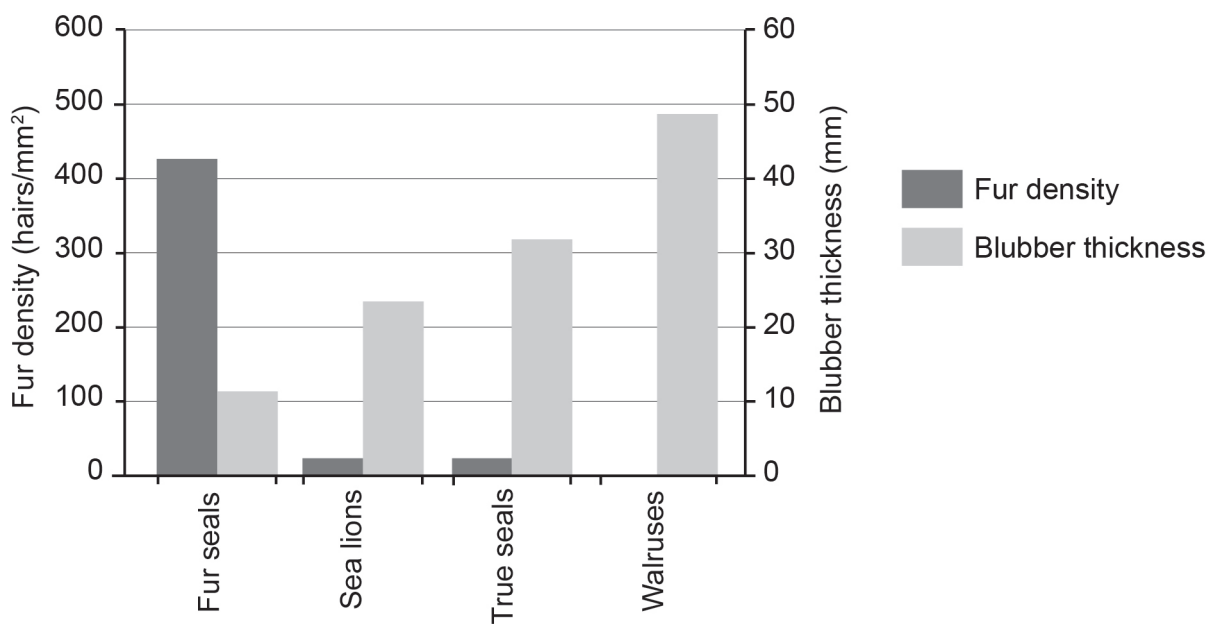
Reason:

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Question 32 (continued)

The figure below shows the mean fur density and mean blubber (fat) thickness for four groups of marine mammals.



- (c) Describe the relationship between mean fur density and mean blubber thickness in these four groups of marine mammals. Use data from the figure above to support your answer. (4 marks)

(d) (i) Name the process used by a mammal to generate body heat. (1 mark)

(ii) Explain how blubber helps a marine mammal to retain body heat in cold water. (3 marks)

(e) Many plants and animals use evaporative cooling in thermoregulation. Explain the main principles of evaporative cooling. (4 marks)

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Question 33

(20 marks)

Biologists calculated the home ranges (the maximum area over which an animal moves) of cats at a variety of housing densities in suburban Perth. The results are shown in the table below.

Cat's name	Housing density (dwellings/hectare)	Home range of the cat (hectares)
Angel	0.5	9.0
Blueberry	0.5	6.0
Bob	0.5	19.0
Boris	0.5	18.0
Comet	15.0	3.0
Elliot	15.0	1.0
Hazelnut	15.0	2.0
Jay	15.0	2.0
Misty	15.0	2.0
Rex	15.0	2.0
Scaboo	20.0	1.0
Sparkles	20.0	1.0
Timba	20.0	1.0
Toby	20.0	1.0
Widget	20.0	1.0
Zimba	20.0	1.0
Bobby	30.0	0.5
Casa	30.0	1.0
Hugo	30.0	0.5
Indigo	30.0	1.0

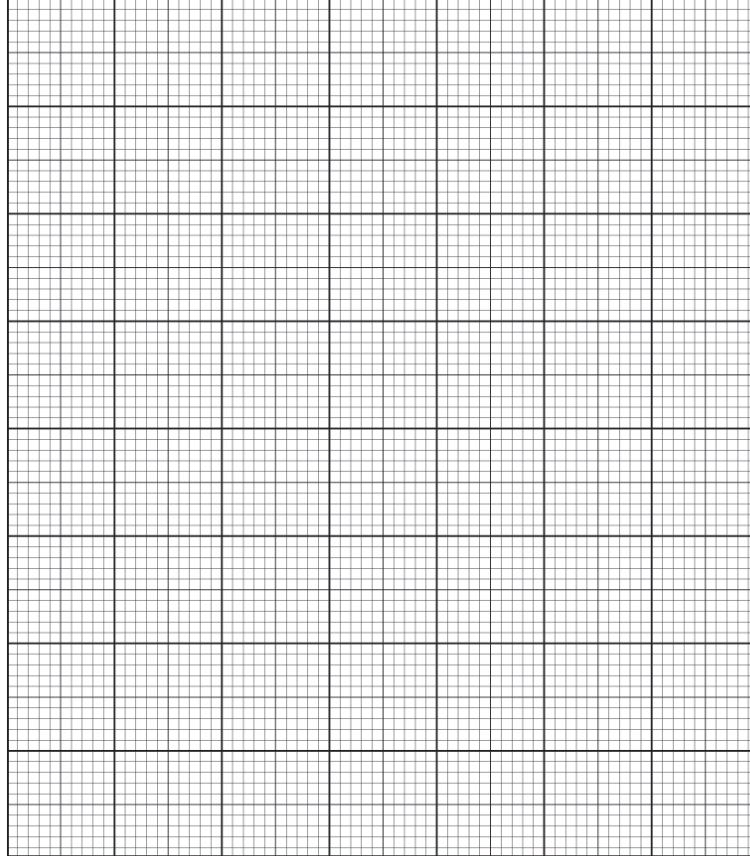
- (a) The table below was constructed to summarise the data. Some cells are filled in as examples. Complete the summary table by placing the requested data in the empty cells. (3 marks)

Housing density (dwellings/hectare)	Number of cats	Mean home range (hectare)	Median home range (hectare)	Range of home range (hectare)
0.5	4	13.0		6.0-19.0
15.0		2.0	2.0	
20.0	6	1.0	1.0	1.0-1.0
30.0	4	0.75	0.75	0.5-1.0

See next page

- (b) Graph the relationship between the mean home range (hectare) of cats and housing density (dwellings/hectare). (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.



- (c) (i) Using your graph, estimate the mean home range (hectare) of cats at the housing densities below. (2 marks)

8 dwellings/hectare

22 dwellings/hectare

Question 33(c) (continued)

- (ii) In which of the estimates should you have the greater confidence? Give a reason for your answer. (2 marks)

- (d) Does the study on home range in cats have an independent variable? Explain your answer. (3 marks)

Only 20 cats were used in the study on home range in cats.

- (e) (i) Explain an advantage of using more cats in the study. (2 marks)

- (ii) Explain a disadvantage of using more cats in the study. (2 marks)

Question 34**(20 marks)**

- (a) State how infectious diseases differ from other types of diseases. (2 marks)

- (b) Complete the table below by stating, for each of the listed diseases, the type of organism that causes the disease and a type of organism that is affected by the disease. The answer for tuberculosis has been completed for you as an example. (6 marks)

Disease	Type of organism causing the disease	Type of organism affected by the disease
Tuberculosis	bacterium	human
Crown gall		
Chytridiomycosis		
Phytophthora dieback		

- (c) Herd immunity is one strategy used to control the spread of some infectious diseases. Explain the main principles of herd immunity. (4 marks)

Question 34 (continued)

- (d) Malaria is common among people living at low altitudes in tropical regions but is much rarer at higher altitudes, where the temperature is cooler. Global climate change is predicted to increase the risk of malaria transmission at higher altitudes in tropical regions. Explain why. (4 marks)

- (e) Many strains of bacteria that cause diseases in humans are evolving resistance to antibiotics. Explain how a disease-causing strain of bacterium can evolve resistance to an antibiotic used to treat the associated disease. (4 marks)

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Question 35**(20 marks)**

- (a) A biologist calculated the percentage similarity in DNA sequence among four species of *Drosophila*. The results are presented in the table below.

Species	Percentage similarity with species 1
1	-
2	95
3	90
4	80

Use these data to construct a phylogenetic tree showing the evolutionary relationships among these species. Draw your tree in the space below. Include a title with your drawing.

(4 marks)

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Question 35 (continued)

- (b) List the main steps involved in producing a DNA profile for an organism. (4 marks)

- (c) A number of people who had visited a particular dental practice were later found to be infected with a hepatitis virus. Health authorities suspected that these people had contracted the virus through the dental practice. Explain how DNA profiling could be used to determine whether these people had contracted the virus through the dental practice. (4 marks)

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(d) State the role that the following factors play in gene cloning. (4 marks)

Restriction enzyme: _____

Ligase: _____

Plasmid: _____

Vector: _____

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Question 35 (continued)

A biologist wanted to create a herbicide-resistant strain of canola plant for farming.

- (e) (i) Explain an advantage of using DNA recombinant technology, rather than artificial selection, to produce a herbicide-resistant strain of canola. (2 marks)

- (ii) Explain a possible adverse environmental effect that could result from farming herbicide-resistant canola. (2 marks)

End of Section Two

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

Section Three consists of **four (4)** questions.

Questions 36 and 37 are from Unit 3. Questions 38 and 39 are from Unit 4. Answer **one (1)** question from Unit 3 and **one (1)** question from Unit 4.

Use black or blue pen for this section. 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.

Additional working space pages at the end of this Question/Answer booklet are for planning or continuing an answer. If you use these pages, indicate at the original answer, the page number it is planned/continued on and write the question number being planned/continued on the additional working space page.

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 the second question you will answer on that page.

Question 36**(20 marks)**

- (a) Describe the structure of DNA and the main steps in DNA replication in a cell. (10 marks)
- (b) Describe the process of meiosis and explain how this process produces genetic variation. (10 marks)

Question 37**(20 marks)**

- (a) Describe how a cell produces an enzyme. (10 marks)
- (b) Explain how an advantageous allele can arise and then spread through a population. (10 marks)

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)**

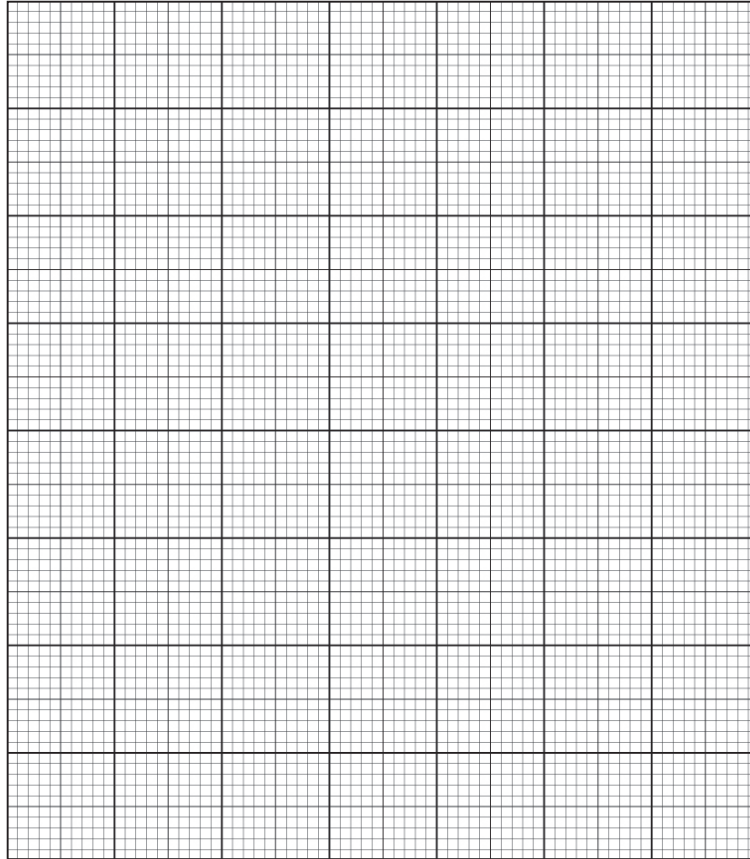
- (a) There are four main groups of organisms that cause infectious disease. Protists are one of these groups. Name the **three** other groups and describe their structural characteristics. (10 marks)
- (b) Explain how quarantine, disruption of the life cycle of a pathogen and antibiotics can be used to control the spread of an infectious disease. (10 marks)

Question 39**(20 marks)**

- (a) Name the type of nitrogenous waste produced by a freshwater fish, a dog and a desert lizard. Explain how these relate to the availability of water in each animal's environment and the benefits and costs of each type of waste to each animal. (10 marks)
- (b) Explain the problems that a plant experiences in obtaining water from soil with a high-salt content. Explain **two** distinctly different adaptations of halophytes to high-salt environments. (10 marks)

End of questions

Question 33(b)



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ACKNOWLEDGEMENTS

- Questions 22–24** Table data source: Furlan, E., Stoklosa, J., Griffiths, J., Gust, N., Ellis, R., Huggins, R. M., et al. (2012, April). Small population size and extremely low levels of genetic diversity in island populations of the platypus, *Ornithorhynchus anatinus*. *Ecology and Evolution*, 2(4), 844–857. Used under Creative Commons Attribution Non Commercial licence.
- Question 32(c)** Diagram from: Liwanag, H. E. M., Berta, A., Costa, D. P., Budge, S.M., & Williams, T. M. (2012, December). Morphological and thermal properties of mammalian insulation: The evolutionary transition to blubber in pinnipeds. *Biological Journal of the Linnean Society*, 107(4), 778, fig. 1.

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