



Government of **Western Australia**
School Curriculum and Standards Authority



ATAR course examination, 2022

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 2022: 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. If 28% of the bases in a DNA molecule are cytosine, what percentage will be adenine?
 - (a) 22
 - (b) 28
 - (c) 44
 - (d) 56

2. Which of the following lists the five steps in the stimulus-response model in the correct order?
 - (a) receptor, stimulus, coordinating centre, effector, response
 - (b) receptor, stimulus, effector, coordinating centre, response
 - (c) stimulus, receptor, coordinating centre, effector, response
 - (d) stimulus, effector, coordinating centre, receptor, response

3. Tuberculosis is
 - (a) a viral disease of the nervous system.
 - (b) a fungal disease of the lungs.
 - (c) transmitted by a vector.
 - (d) transmitted by airborne particles.

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

5. In a plant cell, DNA occurs in the
 - (a) nucleus only.
 - (b) nucleus and chloroplasts only.
 - (c) nucleus, chloroplasts and mitochondria only.
 - (d) nucleus, chloroplasts, mitochondria and ribosomes.

The table below gives some information on osmoregulation for two species of bony fish in their natural environment. Use this information to answer Questions 6 and 7.

| Fish species | Exchange across skin | Exchange across gills |
|--------------|--|---|
| A | <ul style="list-style-type: none">• water diffuses in | <ul style="list-style-type: none">• water diffuses in• active uptake of ions |
| B | <ul style="list-style-type: none">• water diffuses out | <ul style="list-style-type: none">• water diffuses out• active secretion of ions |

6. Fish species

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

7. Which species will excrete ammonia?

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

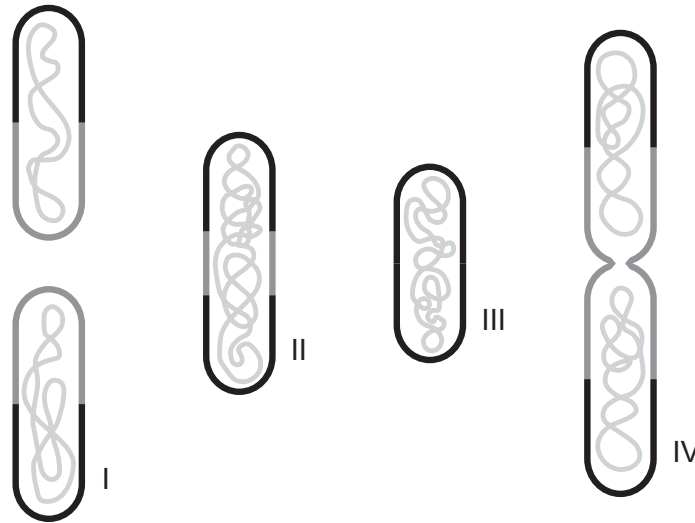
8. Halophytic plants can be used for

- (a) revegetating cleared rain forest.
- (b) stabilising coastal sand dunes.
- (c) reclaiming land at the edges of freshwater swamps.
- (d) lowering the water table on river floodplains.

9. Which one of the following is an example of a disease management strategy that disrupts the life cycle of the pathogen?

- (a) biosecurity at airports to prevent the entry of disease-carrying materials
- (b) immunisation to prevent tetanus infection from a puncture wound
- (c) prohibition of access to forest areas to control phytophthora dieback
- (d) application of insecticides to the indoor walls of houses to control malaria

The diagram below shows four steps in the division of a bacterial cell. The steps I to IV are not labelled in the correct order. Use this information to answer Questions 10 and 11.



10. The process shown in the diagram is
- mitosis.
 - independent assortment.
 - binary fission.
 - fertilisation.
11. Which of the following lists the steps in the diagram in the order in which they occur in the division of the bacterial cell?
- III, II, IV, I
 - II, III, I, IV
 - IV, III, II, I
 - I, IV, II, III
12. Select the correct statement about infectious diseases.
- All human diseases are caused by pathogens.
 - Antiviral medications destroy viruses.
 - Vectors do not transmit bacterial diseases.
 - A zoonosis is an animal disease that can infect humans.
13. Which of the following pathogens causes a zoonotic disease?
- Australian bat lyssavirus
 - Phytophthora*
 - Agrobacterium*
 - Ross River virus

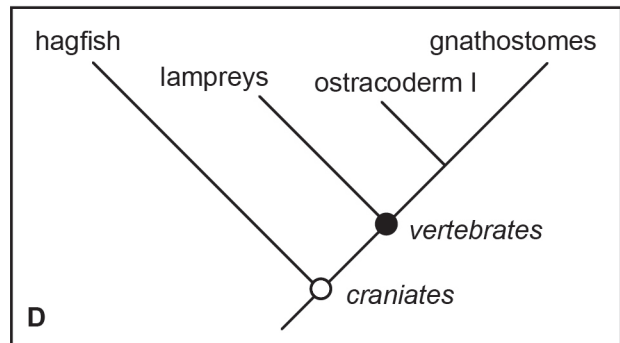
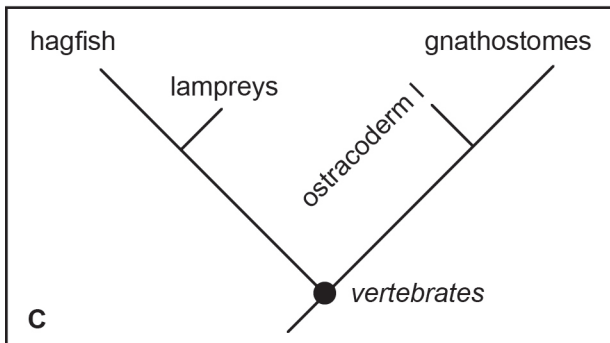
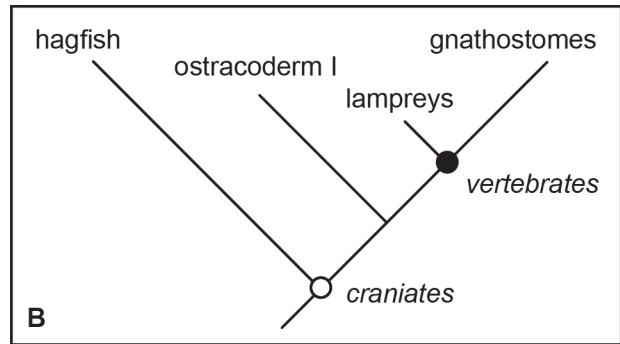
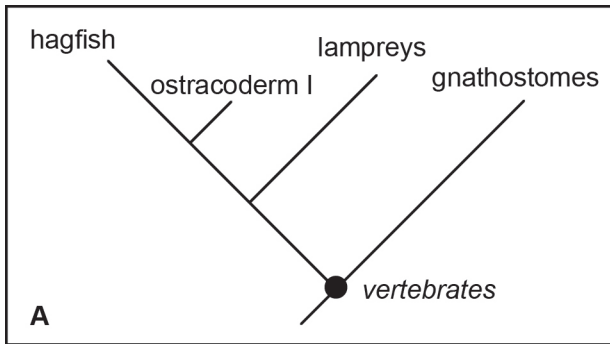
Biologists measured the body temperature of an animal and the air temperature in the animal's environment, every 4 hours over a 20-hour period. The results are shown in the table below. Use this information to answer Questions 14 and 15.

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

14. The median body temperature in the animal over the 20-hour period was
- (a) 37.30 °C.
 - (b) 37.25 °C.
 - (c) 37.22 °C.
 - (d) 37.20 °C.
15. The data suggest that the animal is an
- (a) ectotherm, because its body temperature is around 37 °C.
 - (b) endotherm, because its body temperature is around 37 °C.
 - (c) ectotherm, because its body temperature is independent of air temperature.
 - (d) endotherm, because its body temperature is independent of air temperature.
16. The haploid number of chromosomes in an orangutan is 24. How many chromosomes will be present in the sperm cell of an orangutan?
- (a) 12
 - (b) 24
 - (c) 48
 - (d) 60
17. Which of the following statements about meiosis is correct?
- (a) Both crossing over and independent assortment of chromosomes occur during meiosis I.
 - (b) Both crossing over and independent assortment of chromosomes occur during meiosis II.
 - (c) Crossing over occurs during meiosis I and independent assortment of chromosomes occurs during meiosis II.
 - (d) Crossing over occurs during meiosis II and independent assortment of chromosomes occurs during meiosis I.

See next page

The phylogenetic trees in the diagrams below show four different hypotheses about the early evolution of vertebrates. Use the information in this figure to answer Questions 18 and 19.



18. There is debate about the relationship between hagfish and lampreys. The so-called cyclostome hypothesis suggests that these two taxa are each other's closest relatives. Which phylogenetic tree displays the cyclostome hypothesis?

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

19. The information shown in the phylogenetic trees indicates that there is also debate about whether

- (a) hagfish are vertebrates.
(b) gnathostomes are vertebrates.
(c) lampreys are craniates.
(d) ostracoderm I are craniates.

20. Biologists have determined that ostracoderms became extinct about 420 million years ago. What type of evidence would they have used to support this conclusion?

- (a) bioinformatic
(b) fossil
(c) comparative anatomy
(d) comparative embryology

21. Viruses are
- (a) unicellular.
 - (b) multicellular.
 - (c) smaller than bacteria.
 - (d) larger than protists.
22. Birds excrete uric acid. The main disadvantage of this is that uric acid is
- (a) excreted as a semisolid.
 - (b) energetically expensive to produce.
 - (c) not very soluble in water.
 - (d) toxic to embryos in the eggs.
23. The enzyme tyrosinase determines the amount of melanin pigment in the fur of mice. Some individuals are unable to produce tyrosine due to a mutation. In other individuals, tyrosinase activity varies with temperature and is usually absent at temperatures above 25 °C. The amount of melanin in the fur of mice is an example of
- (a) an environmentally-determined trait.
 - (b) a genetically-determined trait.
 - (c) a genotype determined by a gene-environment interaction.
 - (d) a phenotype determined by a gene-environment interaction.
24. The application of computers and statistics to manage and interpret large biological data sets is called
- (a) bioinformatics.
 - (b) biochemistry.
 - (c) biotechnology.
 - (d) comparative genomics.
25. Antibiotic resistance evolves rapidly in pathogens because they have
- (a) small genomes.
 - (b) large genomes.
 - (c) short generation times.
 - (d) long generation times.

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

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

26. Which amino acid is specified by the DNA codon GTA?
- valine
 - asparagine
 - methionine
 - histidine
27. Plant breeders sometimes expose plant seeds to X-rays. This is done to
- remove the seed coat to stimulate seed germination.
 - induce mutations to create different plant varieties.
 - activate hormones to improve seedling growth.
 - preserve seeds for long-term storage in seed banks.
28. The level of expression in a gene in the bacterium *E. coli* varies. It depends on the amount of gene product in the bacterial cell, where the level of expression declines as the amount of product increases and vice-versa. This is an example of
- transcription.
 - translation.
 - positive feedback.
 - negative feedback.
29. A dog has an extra chromosome in all its cells. The mutation that caused this most likely occurred in a
- cell undergoing meiosis in the dog.
 - cell undergoing mitosis in the dog.
 - germ cell in one of the dog's parents.
 - somatic cell in one of the dog's parents.
30. Orchids grown in the laboratory were released into a wild population of the same species. The laboratory-grown orchids contained an allele that was not present in the wild population at the time of release. After the laboratory-grown orchids bred with the wild orchids, the allele became incorporated into the wild population. The incorporation of the allele from laboratory-grown orchids into the wild population is an example of
- gene flow.
 - genetic drift.
 - artificial selection.
 - natural selection.

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

(20 marks)

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

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

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

One: _____

Two: _____

Three: _____

All living organisms essentially use the same genetic code.

- (b) (i) Define the term 'genetic code'. (1 mark)

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

See next page

All cells need to synthesise proteins to function and reproduce.

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

RNA polymerase: _____

Transcription: _____

Anticodon: _____

Ribosome: _____

Amino acid: _____

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

- (d) (i) Define the term 'mutation'. (1 mark)

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

One: _____

Two: _____

Three: _____

Question 31 (continued)

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

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Question 32

(19 marks)

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

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

One: _____

Two: _____

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

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

* 1 kg = 1000 g

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

See next page

Question 32 (continued)

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

A range of bird species also live in hot deserts.

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

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

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Question 33

(20 marks)

Biologists studied the gene pool of two populations of a mosquito species.

The biologists estimated the frequency of a particular allele (Ace^R) at the acetylcholinesterase gene in the two populations over nine generations. The allele frequency data are given in the table below.

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

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



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

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

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

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

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

- (c) Propose an explanation for the increase in the frequency of the *Ace^R* allele in Population 2 during the study. (5 marks)

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Question 33 (continued)

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

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Question 34**(21 marks)**

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

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

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

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

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

See next page

Question 34 (continued)

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

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

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

Advantage: _____

Disadvantage: _____

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Question 35

(20 marks)

Population size in many frog species is declining. The disease chytridiomycosis is contributing to the decline in some species.

(a) (i) State the type of pathogen that causes chytridiomycosis. (1 mark)

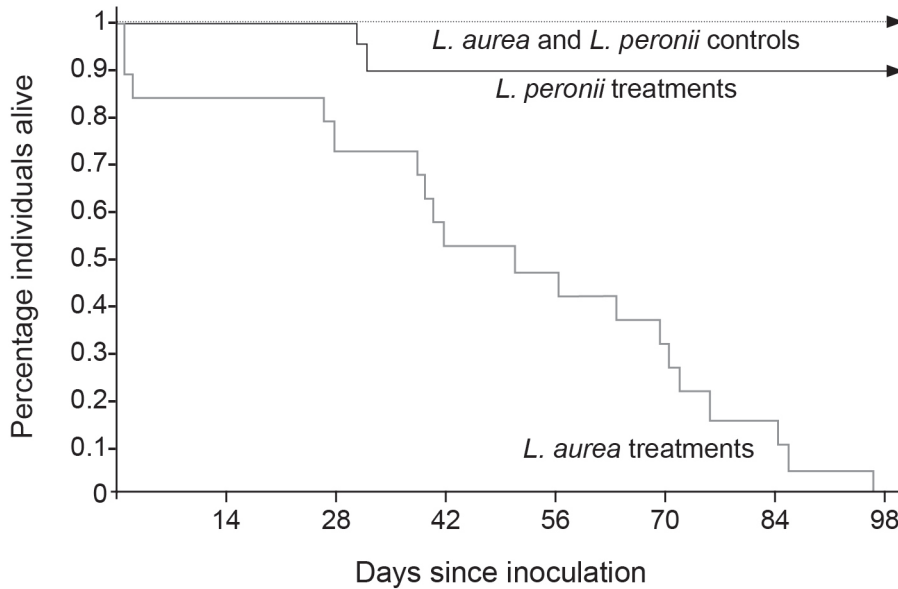
(ii) Chytridiomycosis disrupts homeostasis in the frog host. Define 'homeostasis'. (1 mark)

(iii) State the aspect of homeostasis in the frog host that is disrupted by chytridiomycosis. (1 mark)

(b) Outline how chytridiomycosis is transmitted between frogs. (3 marks)

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



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

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

Question 35 (continued)

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

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

One: _____

Two: _____

Three: _____

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

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 to 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)**

New species can arise via several processes, including allopatric speciation.

(a) Describe how new species can arise via allopatric speciation. (10 marks)

Proteins are essential to cell structure and functioning.

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

or

Question 37 **(20 marks)**

Cell reproduction is needed for growth and to replace damaged cells. It involves DNA replication followed by mitosis.

(a) Describe how a DNA molecule replicates itself **and** the process of mitosis. (10 marks)

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

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

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)

Bacteria and fungi are two types of organism that can cause disease.

(a) Distinguish between the structural characteristics of bacteria and fungi. (10 marks)

Some plants can survive in arid environments.

(b) Explain how shallow branching roots with a high salt content and opening stomata only at night can help a plant to survive in an arid environment. (10 marks)

or

Question 39 (20 marks)

Ectothermy is a type of thermoregulation.

(a) Explain how ectotherms obtain body heat. Include a specific example in your answer. (10 marks)

Like humans, pigs can suffer from influenza.

(b) Discuss how quarantine and immunisation are used to control the spread of influenza on a pig farm. (10 marks)

End of questions

Spare grid for Question 33(a)



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ACKNOWLEDGEMENTS

- Questions 10–11** Diagram adapted from: Guerin, L. (2016). [Diagram of ...]. Retrieved April, 2022, from <https://www.ck12.org/book/ck-12-biology-advanced-concepts/section/11.11/>
- Questions 18–19** Figure adapted from: Miyashita, T., Coates, M. I., Farrar, R., et al. (2019, January 22). Hagfish from the Cretaceous Tethys Sea and a reconciliation of the morphological–molecular conflict in early vertebrate phylogeny (Fig. 1) [Diagram]. *Proceedings of the National Academy of Sciences*, 116(6). Retrieved April, 2022, from <https://www.pnas.org/doi/full/10.1073/pnas.1814794116>
Used under Creative Commons Attribution 4.0 International licence.
- Question 32(b)** Table data from: Al-kahtani, M. A., Zuleta, C., Caviedes-Vidal, E., et al. (2004). Kidney mass and relative medullary thickness of rodents in relation to habitat, body size, and phylogeny (Table A1). *Physiological and Biochemical Zoology*, 77(3). Retrieved April, 2022, from <https://www.journals.uchicago.edu/doi/10.1086/420941>
- Question 35(c)** Paragraph 1 information from: Stockwell, M. P., Clulow, J., & Mahony, M. J. (2010). Host species determines whether infection load increases beyond disease-causing thresholds following exposure to the amphibian [...]. *Animal Conservation*, 13(s1), pp. 62–71. Retrieved April, 2022, from <https://zslpublications.onlinelibrary.wiley.com/doi/10.1111/j.1469-1795.2010.00407.x>
Figure adapted from: Stockwell, M. P., Clulow, J., & Mahony, M. J. (2010). Host species determines whether infection load increases beyond disease-causing thresholds following exposure to the amphibian [...] (Fig. 1) [Graph]. *Animal Conservation*, 13(s1). Retrieved April, 2022, from <https://zslpublications.onlinelibrary.wiley.com/doi/10.1111/j.1469-1795.2010.00407.x>

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