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

# ATAR course examination, 2020

## 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

Number of additional answer booklets used (if applicable):

## Time allowed for this paper

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

## 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.

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## Structure of this paper

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

## Instructions to candidates

1. The rules for the conduct of the Western Australian external examinations are detailed in the *Year 12 Information Handbook 2020: Part II Examinations.* Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.

3. Answer the questions according to the following instructions.

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

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

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

4. 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.

5. 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**

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**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. Which of the following lists the main types of nitrogenous waste from least toxic to most toxic?

   (a) uric acid, ammonia, urea
   (b) uric acid, urea, ammonia
   (c) urea, uric acid, ammonia
   (d) urea, ammonia, uric acid

2. A virus consists of a

   (a) protein coat and a nucleic acid.
   (b) protein coat and ribosomes.
   (c) cell wall and a nucleic acid.
   (d) cell wall and ribosomes.

3. A biologist kept four beetle populations in a laboratory. The number of beetles in each population is shown in the table below. The populations were identical except for the number of beetles.

| Population | Number of beetles |
|---|---|
| A | 54 |
| B | 84 |
| C | 72 |
| D | 36 |

   The effects of genetic drift will be greatest in population

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

4. A zoonotic disease is transmitted

   (a) by an animal pathogen.
   (b) by a mosquito vector.
   (c) between animals and humans.
   (d) between animals and plants.

**See next page**

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5. Fur colour in rabbits is determined by four alleles of the *C* gene. Himalayan rabbits are homozygous for the $c^h$ allele at this gene. This allele produces an enzyme that results in black fur. However, this enzyme is inactivated if the skin temperature exceeds 20 °C, resulting in white fur. Fur colour in Himalayan rabbits is an example of

   (a) a polygenic trait.
   (b) a recessive mutation.
   (c) an interaction between two genes.
   (d) a gene-environment interaction.

6. Most xerophytes have

   (a) fewer stomata open in the day than in the night.
   (b) more stomata open in the day than in the night.
   (c) the same number of open stomata in the day and night.
   (d) no stomata open during either the day or the night.

7. Transpiration in xerophytes results in a

   (a) gain of water and heat.
   (b) loss of water and heat.
   (c) gain of water and loss of heat.
   (d) loss of water and gain of heat.

8. Crown gall in plants is caused by

   (a) a DNA virus.
   (b) an RNA virus.
   (c) *Agrobacterium.*
   (d) *Phytophthora*.

9. A biologist observed small changes in the allele frequencies of a gene in a population of paper daisies for three generations. These changes are an example of

   (a) microevolution.
   (b) macroevolution.
   (c) stasis.
   (d) speciation.

10. Excreting uric acid instead of ammonia

   (a) saves energy and water.
   (b) costs energy and water.
   (c) saves energy but costs water.
   (d) costs energy but saves water.

**See next page**

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11. A mRNA molecule has the following sequence – CUUUCUGAAAUU.
The number of codons in this molecule is

(a) 0.
(b) 3.
(c) 4.
(d) 12.

The table below shows the amino acid that corresponds to each mRNA codon. Use this code to answer Questions 12 to 14.

| 1st position | 2nd position U | 2nd position C | 2nd position A | 2nd position G | 3rd position |
|---|---|---|---|---|---|
| U | Phe | Ser | Tyr | Cys | U |
| | Phe | Ser | Tyr | Cys | C |
| | Leu | Ser | stop | stop | A |
| | Leu | Ser | stop | Trp | G |
| C | Leu | Pro | His | Arg | U |
| | Leu | Pro | His | Arg | C |
| | Leu | Pro | Gln | Arg | A |
| | Leu | Pro | Gln | Arg | G |
| A | Ile | Thr | Asn | Ser | U |
| | Ile | Thr | Asn | Ser | C |
| | Ile | Thr | Lys | Arg | A |
| | Met | Thr | Lys | Arg | G |
| G | Val | Ala | Asp | Gly | U |
| | Val | Ala | Asp | Gly | C |
| | Val | Ala | Glu | Gly | A |
| | Val | Ala | Glu | Gly | G |
| | | Amino Acids | | | |

Ala: Alanine
Arg: Arginine
Asn: Asparagine
Asp: Aspartic acid
Cys: Cysteine
Gln: Glutamine
Glu: Glutamic acid
Gly: Glycine
His: Histidine
Ile: Isoleucine
Leu: Leucine
Lys: Lysine
Met: Methionine
Phe: Phenylalanine
Pro: Proline
Ser: Serine
Thr: Threonine
Trp: Tryptophane
Tyr: Tyrosine
Val: Valine

12. The sequence of amino acids in a protein that is made from the mRNA molecule in Question 11 is

(a) leucine, serine, glutamic acid, isoleucine.
(b) leucine, proline, histidine, arginine.
(c) phenylalanine, serine, tyrosine, cysteine.
(d) phenylalanine, leucine, methionine, valine.

13. Which of the following anticodons on a tRNA molecule would add the amino acid 'histidine' to a protein?

(a) CAU
(b) CAG
(c) GUA
(d) GUU

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See next page

14. A mutation changes the sequence of a DNA molecule from GAA AGA CTT TAA to GAA AGA CTC TAA. This mutation will change

    (a) the sequence of nucleotides in the mRNA molecule and of amino acids in the protein.
    (b) the sequence of nucleotides in the mRNA molecule but not of amino acids in the protein.
    (c) the sequence of amino acids in the protein but not of nucleotides in the mRNA.
    (d) neither the sequence of nucleotides in the mRNA nor amino acids in the protein.

15. The amphibian chytrid pathogen causes disease in frogs by invading the

    (a) lungs and reducing the ability of the frog to breathe.
    (b) mouth and reducing the ability of the frog to breathe.
    (c) kidneys and reducing the ability of the frog to exchange water and gases.
    (d) skin and reducing the ability of the frog to exchange water and gases.

16. Muscular dystrophy in golden retriever dogs is caused by a mutation of the dystrophin gene. It is much more common in male golden retrievers than females. On this basis, what type of condition is muscular dystrophy in golden retrievers?

    (a) sex-linked dominant
    (b) sex-linked recessive
    (c) autosomal dominant
    (d) autosomal recessive

17. Climate change is affecting the distribution of Ross River virus through its effects on activity and reproduction in the

    (a) viral pathogen.
    (b) bacterial pathogen.
    (c) human host.
    (d) mosquito vector.

18. The pathogen that causes tetanus

    (a) is directly transmitted from host to host.
    (b) invades a host through a wound.
    (c) cannot survive outside of the host.
    (d) reproduces by mitosis.

**See next page**

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Female redback spiders sometimes eat their mates (cannibalistic mating) but not always (non-cannibalistic mating). A biologist determined the size (maximum width) of female redback spiders in cannibalistic and non-cannibalistic matings. The results are shown in the table below. Use this information to answer Questions 19 to 21.

| Maximum width (mm) of female redback spiders | |
|---|---|
| **Cannibalistic mating** | **Non-cannibalistic mating** |
| 2.8 | 2.8 |
| 2.8 | 2.7 |
| 3.2 | 3.3 |
| 3.3 | 2.8 |
| 2.8 | 2.9 |
| 3.0 | 3.0 |
| 3.1 | 3.3 |
| 2.7 | 2.9 |
| 2.9 | 2.9 |

19. Which of the following would be a suitable hypothesis for the investigation?

(a) Female redback spiders in cannibalistic mating are the same size as those in non-cannibalistic mating.
(b) Does the size of female redback spiders affect whether they will eat their mate?
(c) If female redback spiders are large, then they are more likely to cannibalise their mate.
(d) Small female redback spiders cannibalise their mate to gain energy for egg production.

20. The mean maximum width (in mm) for female redback spiders in non-cannibalistic mating is

(a) 2.80.
(b) 2.86.
(c) 2.90.
(d) 2.96.

21. The median maximum width (in mm) for female redback spiders in cannibalistic mating is

(a) 2.80.
(b) 2.86.
(c) 2.90.
(d) 2.96.

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**See next page**

22. During mating, many male redback spiders position themselves above the jaws of the female even though they are more likely to be eaten than males in other positions. These males are, however, able to copulate for longer and fertilise more eggs. On this basis, male positioning above the jaws of the female likely evolved by

(a) natural selection.
(b) sexual selection.
(c) artificial selection.
(d) directional selection.

23. Which of the following processes generates genetic variation in bacteria and viruses?

(a) binary fission
(b) fertilisation
(c) meiosis
(d) mutation

24. Which of the following combination of factors makes a population most vulnerable to extinction?

(a) low levels of inbreeding and a changing environment
(b) low levels of inbreeding and a stable environment
(c) low levels of genetic diversity and a changing environment
(d) low levels of genetic diversity and a stable environment

25. Some desert mammals obtain water from fat metabolism. What type of adaptation is this?

(a) physiological
(b) immunological
(c) behavioural
(d) structural

26. A camel can obtain 1.12 mL of water from each gram of fat stored in its hump. On this basis, how many millilitres of water would a camel obtain from 36 kg of stored fat?

(a) 32.142
(b) 40.320
(c) 32 142
(d) 40 320

27. The genetic material of a virus contains 1996 adenine, 2131 guanine, 1642 uracil and 2365 cytosine bases. This suggests that the genetic material of the virus is

(a) single-stranded DNA.
(b) single-stranded RNA.
(c) double-stranded DNA.
(d) double-stranded RNA.

**See next page**

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Two alleles, *Y1* and *Y2*, are present for the agouti gene in mice. Mice that are homozygous for the *Y1* allele have black fur, mice that have both the *Y1* and *Y2* alleles (i.e. heterozygotes) have yellow fur, and mice that are homozygous for the *Y2* allele die before being born. Two yellow mice were mated repeatedly to produce multiple litters. Use this information to answer Questions 28 and 29.

28. The proportion of offspring that die before being born is expected to be

(a) 0.25.
(b) 0.33.
(c) 0.50.
(d) 0.67.

29. The proportion of surviving offspring that have yellow fur is expected to be

(a) 0.25.
(b) 0.33.
(c) 0.50.
(d) 0.67.

30. Antibiotics are effective in treating the

(a) virus that causes influenza.
(b) bacterium that causes influenza.
(c) secondary bacterial infections in people with influenza.
(d) secondary viral infections in people with influenza.

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**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.

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**Question 31** **(20 marks)**

The pathogen that causes jarrah dieback is a type of protist.

(a) (i) List **two** structural features of protists that are **not** found in bacteria. (2 marks)

One: _____

_____

Two: _____

_____

(ii) List **two** structural features of protists that are **not** found in fungi. (2 marks)

One: _____

_____

Two: _____

_____

In order to prevent the spread of jarrah dieback, vehicles are banned from driving on some tracks when the soil is wet.

(b) Explain how this can prevent the spread of jarrah dieback. (4 marks)

_____

_____

_____

_____

_____

_____

_____

_____

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(c) (i) Describe how the tuberculosis pathogen is transmitted to a new host. (2 marks)

(ii) Describe the impact that the tuberculosis pathogen has on the host. (2 marks)

(d) Explain how vaccination helps to control the spread of tuberculosis. (4 marks)

(e) When travellers enter Australia from overseas, they are required to declare all plant and animal matter that they have brought with them. Explain why. (4 marks)

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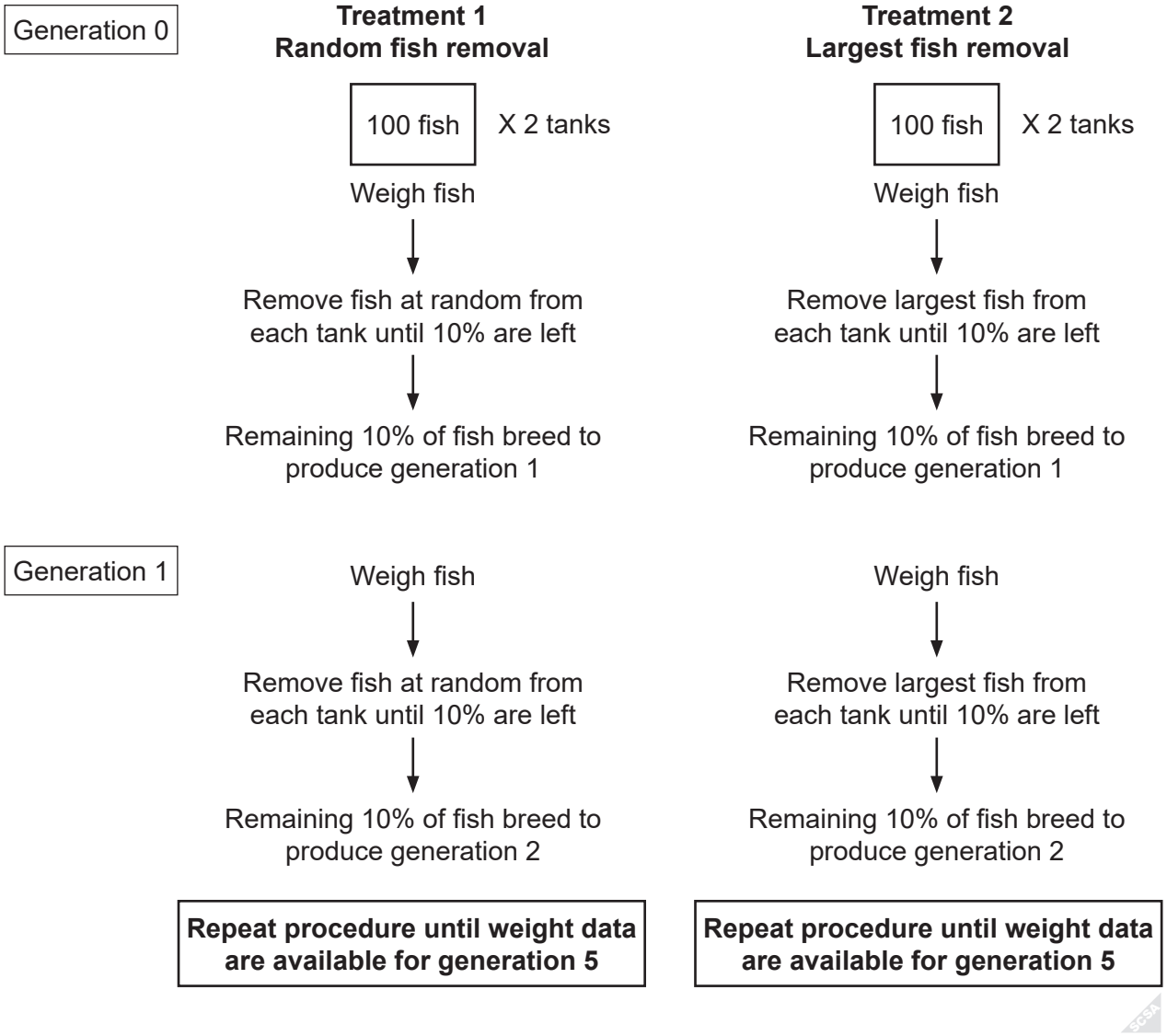
See next page

**Question 32** **(20 marks)**

A team of biologists conducted a laboratory experiment to investigate whether removing the largest individuals from a fish population would affect the size (weight) of individuals in subsequent generations. The experiment is described in the diagram below.




The results of the experiment are shown in the table below.

| | Mean weight of fish (g) | |
|---|---|---|
| **Generation number** | **Treatment 1 Random fish removal** | **Treatment 2 Largest fish removal** |
| 0 | 3.3 | 3.4 |
| 1 | 3.5 | 3.4 |
| 2 | 3.6 | 3.3 |
| 3 | 3.4 | 3.2 |
| 4 | 3.5 | 3.0 |
| 5 | 3.4 | 3.0 |

**See next page**

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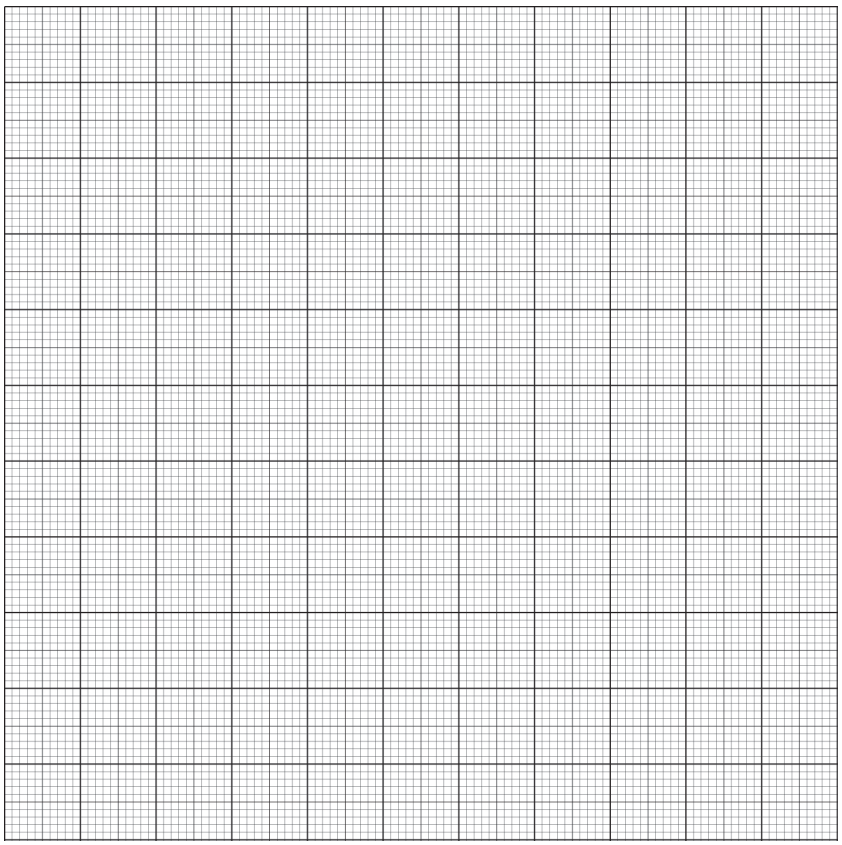
(a) Graph the mean weight of fish for both the random fish removal treatment and the largest fish removal treatment against generation. (6 marks)



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.

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**Question 32** (continued)

(b) (i) Identify the dependent variable in the experiment. Give a reason for your answer. (2 marks)

(ii) Would conducting the experiment for more generations improve the reliability or validity of the experiment? Give a reason for your answer. (2 marks)

(iii) Why did the biologists remove fish at random from the two tanks in Treatment 1. (2 marks)

(c) Explain why the mean weight of the fish declined over generations in Treatment 2. (4 marks)

**See next page**

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(d) Predict what would have happened if the biologists had removed the largest fish until 50% (rather than 10%) of the fish remained. Explain your answer. (4 marks)

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**Question 33** **(20 marks)**

The malleefowl (*Leipoa ocellata*) is a ground-dwelling bird that is found in scrubland in southern Australia. It is vulnerable to extinction.

(a) The following terms are relevant to developing conservation plans for the malleefowl. Define each term.

(i) Gene pool (1 mark)

(ii) Population dynamics (1 mark)

(iii) Biogeography (1 mark)

(iv) Reproductive behaviour (1 mark)

(b) To investigate genetic diversity, biologists produced DNA profiles for malleefowl. List the main steps involved in producing a DNA profile. (4 marks)

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(c) Biologists are breeding malleefowl in captivity to assist in the recovery of wild populations. Describe **two** ways in which captive breeding can assist in the recovery of wild populations. (4 marks)

One: _____

Two: _____

(d) Explain how a consideration of population dynamics can assist conservation planning to maintain viable gene pools in a vulnerable species, such as the malleefowl. (4 marks)

(e) Habitat destruction has reduced the opportunity for gene flow between malleefowl populations. Explain how gene flow affects the gene pool of a population. (4 marks)

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**See next page**

**Question 34** **(20 marks)**

The greater bilby (*Macrotis lagotis*) lives in desert and grassland areas in northern Australia.

(a) (i) Thermoregulation in the greater bilby is an example of homeostasis. Define homeostasis. (1 mark)

(ii) The greater bilby uses a negative feedback mechanism to thermoregulate. State the defining feature of a negative feedback mechanism. (1 mark)

The greater bilby's body temperature is normally 37 °C.

(iii) Indicate whether a rise in the body temperature above 37 °C would be a stimulus or a response in a negative feedback mechanism. Give a reason for your answer. (2 marks)

**See next page**

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(b) Explain how a greater bilby's ears could help it to thermoregulate. (4 marks)

The thorny lizard (*Moloch horridus*) lives in desert areas in Australia. Scientists measured the rate of oxygen consumption in thorny lizards at rest at four different environmental temperatures in the laboratory. The results are shown in the table below.

| Environmental temperature (°C) | Mean rate of oxygen consumption at rest ($cm^3g^{-1}hr^{-1}$) |
|---|---|
| 15 | 0.3 |
| 20 | 0.6 |
| 25 | 1.1 |
| 35 | 1.5 |

(c) (i) State the relationship between environmental temperature and mean rate of oxygen consumption in thorny lizards at rest. (1 mark)

(ii) Explain the reason for the relationship described in part (c)(i). (3 marks)

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**Question 34** (continued)

(d) The colour of the scales on a thorny lizard changes from pale during warmer months to darker during cooler months. Explain how this helps the lizard to thermoregulate. (4 marks)

(e) There are approximately 55 species of true sea snakes. These snakes are common in warm tropical waters but do not occur in colder waters. Provide a plausible explanation for this distribution. (4 marks)

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**See next page**

**Question 35** **(20 marks)**

*Glossopteris* is a genus of flowerless seed ferns, common 250 million years ago, it is now extinct. Many species of *Glossopteris* have been identified from leaf fossils.

(a) (i) Define the term 'fossil'. (1 mark)

(ii) Outline how fossils can provide evidence for evolution. (3 marks)

It has not been possible to determine the total number of *Glossopteris* species because the fossil record is incomplete.

(b) List **four** reasons why the fossil record is incomplete. (4 marks)

One:

Two:

Three:

Four:

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**Question 35** (continued)

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

(ii) Describe the first life forms on Earth. (3 marks)

The table below shows the number of amino acid differences in a protein molecule in five different types of monkey.

| | Saki | Macaque | Colobus | Squirrel | Woolly |
|---|---|---|---|---|---|
| Saki | | | | | |
| Macaque | 6 | | | | |
| Colobus | 8 | 2 | | | |
| Squirrel | 4 | 7 | 9 | | |
| Woolly | 1 | 8 | 8 | 4 | |

(d) Use these data to describe the evolutionary relationships of these monkeys. (4 marks)



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(e) Explain how differences in the amino acid sequence of a protein can provide evidence of evolutionary relationships between organisms. (4 marks)

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**End of Section Two**

**See next page**

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

Section Three consists of **four** questions.

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

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

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

Suggested working time: 50 minutes.

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**Unit 3**

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

Indicate the question you will answer by ticking the box next to the question. Write your answer on pages 25–29. When you have answered your first question, turn to page 30 and indicate on that page the second question you will answer.

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☐ **Question 36** **(20 marks)**

A DNA molecule has the capacity to replicate itself.

(a) Describe the structure of a double-stranded DNA molecule and explain how the structural properties allow for replication. (10 marks)

Both artificial selection and transgenesis can be used to produce organisms with desirable traits.

(b) Compare artificial selection and transgenesis. (10 marks)

☐ **Question 37** **(20 marks)**

There are more species of rock wallaby than of any other type of wallaby or kangaroo. Rock wallabies live in small populations on isolated rocky outcrops in a range of environments across Australia. Interactions between populations on different outcrops are non-existent or very rare.

(a) Explain why there are so many species of rock wallaby. (10 marks)

Mitosis and meiosis are important cellular processes.

(b) Compare mitosis and meiosis. (10 marks)

**See next page**

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**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.

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☐ **Question 38** **(20 marks)**

Crown gall is a common and economically-significant disease of plants.

(a) Describe the impact that the crown gall pathogen has on the host and discuss the best strategy for managing this disease. (10 marks)

Salmon are able to move between freshwater and seawater, despite the physiological challenges that this presents.

(b) Explain the physiological challenges that fish, such as salmon, face when living in freshwater and in seawater. How have they overcome these challenges? (10 marks)

☐ **Question 39** **(20 marks)**

Most plants are sensitive to salt stress, but a small number of species with special adaptations are able to survive in high salt environments.

(a) Explain how halophytes obtain water and exclude and remove salt. (10 marks)

Malaria is a significant public health problem in many parts of the world.

(b) Assess the biological factors that make malaria a difficult disease to control. (10 marks)

**End of questions**

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Question number: _____

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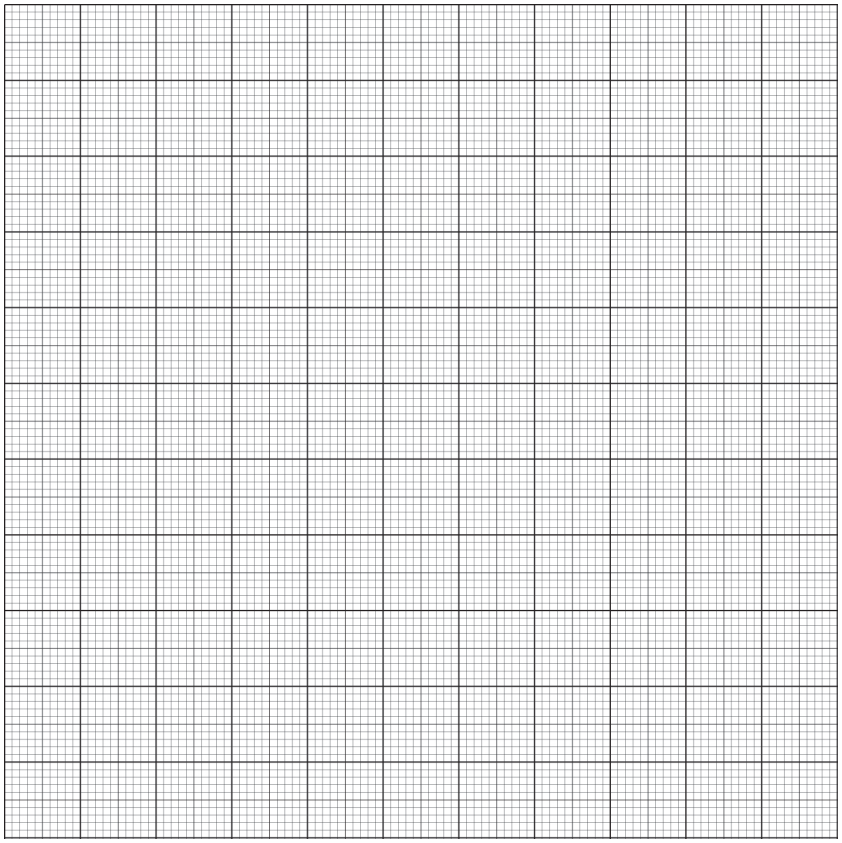

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## ACKNOWLEDGEMENTS

**Questions 12–14** Adapted from: National Human Genome Research Institute. (n.d.). *RNA codon table*. Retrieved May, 2020, from https://www.genome.gov/genetics-glossary/Genetic-Code

**Question 26** Information from: Palmer, J. (2016). *The creatures that can survive without water for years*. Retrieved May, 2020, from http://www.bbc.com/earth/story/20160926-the-creatures-that-can-survive-without-water-for-years

**Question 34** Photograph by courtesy of examining panel.

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