**BIOLOGY**

**Insert School Logo**

**UNIT 3 & 4**

**2020**

**Name**:

**Teacher**:

**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: 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  Part A | 2 | 1 | 50 | 40 | 20 |
| Part B | 2 | 1 |
|  |  |  |  | **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*. 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.

**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 a 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. Exposure to UV radiation affects the structure of DNA by

(a) denaturing the histones around which DNA is wrapped.

(b) causing breakages in the bonds between base pairs.

(c) damaging the sugar-phosphate backbone.

(d) converting thymine into cytosine, thereby altering the genetic code.

2. Which of the following statements regarding microevolution is **incorrect**? Microevolution

(a) involves changes at or above the species level.

(b) occurs as a result of natural selection, sexual selection, mutation and genetic drift.

(c) occurs over small time scales.

(d) involves small changes over generations.

3. Genetic drift can reduce the genetic diversity of a species' population because it

(a) decreases the occurrence of spontaneous mutations.

(b) results in the loss of alleles from the gene pool.

(c) changes the frequency of dominant alleles.

(d) can lead to speciation.

4. Geographic isolation of species populations may result in

(a) convergent evolution.

(b) an increase in gene flow.

(c) sympatric speciation.

(d) allopatric speciation.

5. On a phylogenetic tree, the length of a branch represents

(a) the amount of time that has passed since species divergence.

(b) changes in DNA over time.

(c) how long a species has been present on Earth.

(d) the number of common ancestors of a given species.

Questions 6 and 7 relate to the image below.

A picture containing tool, scissors

Description automatically generated

6. The image above represents the process of

(a) meiosis.

(b) independent assortment of alleles.

(c) crossing over.

(d) DNA replication.

7. Which of the following statements regarding the effect of this process is **correct**?

(a) DNA in the resulting cells will be genetical identical.

(b) DNA in the resulting cells will be genetically different.

(c) DNA in the resulting cells will be doubled.

(d) DNA in the resulting cells will be mutated.

8. Animals produce different types of nitrogenous waste, based on the environment in which they live and their metabolic requirements. Energy is expended in the production of these nitrogenous wastes in the form of ammonia, urea and uric acid; requiring the least amount of energy to the most amount of energy, respectively.

Of the animals mentioned below, which list is **correct** based on waste production having high energy to low energy requirements?

(a) Marine fish, eagle, crocodile.

(b) Dolphin, snake, freshwater fish.

(c) Python, frog, shark.

(d) Burrowing frog, possum, turtle.

9. Which of the following is a **process** of macroevolution?

(a) Speciation and adaptive radiation of Galapagos finches.

(b) Development of insecticide-resistance in mosquitoes.

(c) Antibiotic resistance in 'Golden Staph' (*Staphylococcus aureus*) bacteria.

(d) Albino kangaroos occurring in native bushland.

10. Shallow, spreading roots are an adaptation of plants to

(a) saline environments.

(b) arid environments.

(c) seasonal inundation.

(d) fire.

11. Vasoconstriction is a physiological mechanism of thermoregulation in many animal species. Which of the following scenarios involves vasoconstriction to regulate heat transfer?

(a) A lizard sunbaking on a warm rock.

(b) A bilby foraging on a cold night in the desert.

(c) Grey kangaroos licking their forearms on a hot day.

(d) Dolphins swimming in the cold waters of the Southern Ocean.

12. Malaria is a widespread disease found mostly in tropical climes around the globe. Vaccine development for malaria is difficult due to the complicated nature of its lifecycle and transmission. Malarial infection is caused by

(a) the female Anopheles mosquito.

(b) failure to take anti-malarial medication.

(c) travelling in high-risk, tropical countries.

(d) a plasmodium protist.

13. Many palaeontologists have shown great interest in the evolution of horse forefeet over the period of 50 million years. Which type of evidence has been used to compare ancestors of the modern horse to determine the pattern of evolution?

(a) Molecular hybridisation

(b) Mitochondrial DNA

(c) Comparative embryology

(d) Comparative anatomy

The diagram below relates to question 14.

A picture containing game, drawing, table, clock

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**Z**

**Y**

**X**

14. DNA is comprised of molecular units called nucleotides. In the diagram above, the structure labelled 'Z' is a

(a) ribose sugar.

(b) phosphate group.

(c) deoxyribose sugar.

(d) nitrogenous base.

15. Many chemical mutagens alter the genetic code carried in DNA through base substitution. Examples of chemical mutagens known to alter DNA include

(a) alcohol, mustard gas and gamma radiation.

(b) x-rays, cigarette smoke and alcohol.

(c) mustard gas, nitric acid and benzene.

(d) UV radiation, x-rays and pathogens.

16. Phenotypes that display continuous variation are said to be

(a) controlled by multiple alleles.

(b) polygenic.

(c) heterozygous.

(d) homozygous dominant.

17. Which of the following statements regarding herd immunity is **incorrect**?

(a) An infectious disease will become rare in an immune population.

(b) The greater the proportion of immunity, the greater the protection to the community.

(c) Herd immunity protects immuno-suppressed individuals.

(d) Immunity is dependent only on administration of a viable vaccine.

18. SARS-CoV-2, the pathogen that causes Covid-19 (coronavirus), is easily transmitted between hosts and therefore

(a) extremely virulent.

(b) has a high level of infectivity.

(c) is both infectious and highly virulent.

(d) results in a high degree of morbidity.

19. A genetic mutation in which no effect is observed is termed a

(a) silent mutation.

(b) favourable mutation.

(c) missense mutation.

(d) nonsense mutation.

20. Some pathogens, such as viruses and parasites, can be transmitted between different species of vertebrates, including humans. Such pathogens are termed

(a) zoopathogenic.

(b) zoonotic.

(c) zooteric.

(d) zoogenic.

21. In order to conserve water, the kidneys of the desert mouse are structurally different to those of mammals from milder climates. Which of the following is **true** of the desert mouse's kidney compared to a regular field mouse?

(a) The kidneys are much larger in the desert mouse.

(b) There are twice as many nephrons in the kidney of a desert mouse.

(c) The nephron of the desert mouse kidney has a long loop of Henle.

(d) Desert mouse kidneys are less vascularised and filter less blood.

22. Which of the following scenarios would **not** result in the development of antibiotic resistance?

(a) Over prescription of antibiotics for the common cold.

(b) Administering preventative antibiotics to livestock to control possible infection.

(c) Failure to complete the required course of antibiotics.

(d) Prescribing antibiotics specific to the infection undergoing treatment.

23. In the study of heredity, x-linkage refers to the

(a) transmission of disease through deleterious alleles.

(b) absence of a Y chromosome.

(c) inheritance of traits carried on the X chromosome.

(d) inheritance of traits carried on the Y chromosome.

24. Research into *Phytophthora cinnamomi*, the plant pathogen that causes dieback, has shown that native vegetation growing in areas that experience an average annual rainfall of more that 400 mm is susceptible to infection. The most likely reason for this is that

(a) *Phytophthora* cannot survive outside its host in dry conditions.

(b) plants growing in low rainfall areas have deep-rooted and therefore less likely to become infected.

(c) susceptible plant species do not grow in areas with low rainfall.

(d) successful spread of the pathogen requires sufficient movement of water within and on the surface of the soil.

25. *Phytophthora* has a complex lifecycle involving both sexual and asexual reproduction. The asexual production of zoospores takes place in the

(a) roots of infected plants.

(b) soil.

(c) leaf litter.

(d) phloem tissue of the plant.

26. The main role of messenger RNA (mRNA) is to

(a) carry complementary amino acids to the ribosomes for polypeptide synthesis.

(b) transcribe the code from DNA and carry it to the ribosomes for translation.

(c) control the production of amino acids for protein synthesis.

(d) produce identical copies of DNA for mitotic division.

27. A biology student was conducting an investigation to prove Mendel's work on monohybrid crossing of tall and short pea plants. She crossed individuals from the F1 generation, of which the parental genotypes were TT (tall) and tt (short).

What percentage of the F2 generation will exhibit a tall phenotype?

(a) 50%

(b) 25%

(c) 100%

(d) 75%

28. The main purpose of shivering isto

(a) stimulate vasodilation of capillaries.

(b) increase metabolic activity of muscle cells.

(c) increase blood flow to extremities.

(d) trap warm air at the surface of the skin.

29. Tetanus is a disease caused by infection with the bacteria *Clostridium tetani* which is often found in the soil. The bacteria can enter the body through open cuts or wounds. This type of pathogen transmission is

(a) indirect.

(b) direct.

(c) avoidable.

(d) communicable.

30. To maximise gas exchange while reducing water loss, the stomata of arid plants

(a) open during the day.

(b) are more numerous.

(c) are positioned on the underside of the leaf.

(d) covered in a waxy cuticle.

**End of Section One**

**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)**

While the SARS-CoV-2 virus (Covid-19) is believed to have originated in Wuhan, China, the majority of infections transmitted throughout populations around the world have not come directly from this source.

A cruise ship containing passengers from many different countries departs Sydney for a 28-day tour around south-east Asia, down the west coast of South America, around New Zealand's South Island and back to Sydney. Within a week following departure, several passengers and crew become ill with suspected Covid-19. While many passengers are quick to blame the Asian passengers and crew on board, the ship's doctor suspects that the source of infection was a passenger from Sydney.

(a) Explain how DNA profiling could be used to determine whether the individuals infected on the cruise ship had contracted the virus from the Sydney-based passenger.

(5 marks)

(b) Annotate the diagram below with a description of each stage (1 - 5) of a virus infecting a bacterial cell. (5 marks)

A close up of a logo

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**Stage 1**

A close up of a logo

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**Stage 2**



**Stage 3**

A close up of a device

Description automatically generated



A close up of a logo

Description automatically generated **Stage 4**



A close up of a logo

Description automatically generated

**Stage 5**

(c) Bacterial infections are often treated with antibiotics. Outline **four** different ways in which antibiotics can control and/or eliminate a bacterial infection. (4 marks)

1. 2. 3. 4.

(d) Explain why antibiotics are an ineffective treatment for viral infections. (2 marks)

Consider the graph below representing the growth of bacteria in a host organism.

A picture containing different, boat, colorful, group

Description automatically generated

**Bacterial load (108)**



(e) State the growth pattern shown in the graph. (1 mark)

(f) Identify the mode of reproduction of bacteria and explain how it allows for this pattern of growth. (3 marks)

**Question 32 (20 marks)**

Soil salinity is one of the most detrimental abiotic threats to agricultural production worldwide. halophytes have been widely used in salt affected areas as a crop to reduce soil salt content and provide fodder for livestock. Halophytes possess specialised structural and physiological adaptations that enable them to thrive in high salt concentrations which other plants cannot tolerate.

(a) Identify **two** adaptations of halophytes that enable control of their internal salt concentration and osmotic potential. (2 marks)

One

Two

An experiment was conducted to determine the response of three different plant species to increasing concentrations of sodium (Na+) in their growth medium. The scientists conducting the experiment grew 20 plants of each species in six different concentrations of Na+ growth medium. After two months, the leaves were collected from each plant, washed and the Na+ was extracted. The mean data collected from the experiment is summarised in the table below.

**Table 1**: Sodium (Na+) content in leaves of different plant species.

|  |  |  |  |
| --- | --- | --- | --- |
| **Na+ content in growth medium (mM)** | **Mean Na+ content in plant leaves (mM)** | | |
| *Species 1* | *Species 2* | *Species 3* |
| **0** | 1 | 1 | 1 |
| **5** | 8 | 6 | 15 |
| **10** | 22 | 12 | 30 |
| **20** | 60 | 42 | 50 |
| **50** | 200 | 37 | 90 |
| **100** | - \* | 30 | 102 |

*\* no data collected due to plant death.*

(b) Identify the dependent and independent variables in this experiment. (2 marks)

Dependent

Independent

(c) Construct an appropriate graph of the data from Table 1 in the grid provided below. (6 marks)

**A screen shot of a tiled wall

Description automatically generated**

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 clearly that you have redrawn it on the spare page.

The following hypothesis was formulated by the scientists conducting the experiment;

"*Salt tolerant plants will grow better as the sodium content of the growth medium increases."*

(d) Is this a suitable hypothesis? Explain. (2 marks)

(e) Based on the data presented in the graph, identify whether any of the experimental plant species are halophytes. Explain your decision and identify the adaptation for salt tolerance they may possess. (6 marks)

Species 1

Species 2

Species 3

(f) Suggest **one** change to the experimental design and explain how it could improve the validity of the data. (2 marks)

**Question 33 (20 marks)**

An evolutionary biologist was conducting a phylogenetic study of five species of 'legless' lizards. He determined the percentage (%) similarity between DNA sequences of species #1 and the other four lizards. The data is shown in the table below.

**Table 2**: Percentage (%) similarity of DNA between different species of legless lizards.

|  |  |
| --- | --- |
| **Species #** | **% similarity with Sp. #1** |
| 1 | 100 |
| 2 | 88 |
| 3 | 97 |
| 4 | 85 |
| 5 | 90 |

(a) Identify the biotechnological method used by the biologist to compare DNA sequences.

(1 mark)

(b) Use the data in Table 2 to construct a phylogenetic tree showing the evolutionary relationships amongst lizard species. (4 marks)

'Legless' lizards are not completely absent of limbs; they possess small vestigial limbs that varying in size between species. While they are often mistaken for small snakes, their behaviour and morphology are quite different. Legless lizards are known to dive into sand for protection and spend very little time above ground.

(c) Explain how natural selection could have influenced the evolution of legless lizards.

(6 marks)

Like all reptiles, legless lizards are ectothermic.

(d) Define 'ectothermic'. (1 mark)

(e) State **one** advantage and **one** disadvantage of being an ectothermic animal. (2 marks)

Advantage

Disadvantage

(f) Describe **one** structural, **one** physiological and **one** behavioural adaptation that support thermoregulation of lizards living in arid environments. (6 marks)

Structural Physiological

Behavioural

**Question 34 (20 marks)**

Chytridiomycosis is an infectious disease is caused by the amphibian chytrid fungus *Batrachochytrium dendrobatadis.* The fungus only infects those parts of an amphibian's skin containing keratin, a protein that forms a tough and impervious layer. Normally keratin is only found in skin exposed to wear and tear such as the ventral surface of their body and limbs and their feet. Motile zoospores (produced by the fungus) are transmitted through water and invade the keratinised layers of skin in an amphibian, forming cysts called zoosporangia. Within these cysts, the zoospores reproduce asexually and are released into the surrounding water through discharge tubes. The infected keratinised skin builds up and spreads over the amphibian's body, affecting osmoregulation and gas exchange.

(a) Outline the effect of chytridiomycosis disease on the following homeostatic mechanisms. In each response, explain how the disease compromises metabolic functions associated with each mechanism.

(i) Osmoregulation (4 marks)

(ii) Gas exchange (4 marks)

(b) Chytridiomycosis is considered extremely virulent. Define virulent. (1 mark)

In Australia, chytridiomycosis has infected approximately 25% of endemic frog species. Amphibian chytrid fungus has been recorded in four geographic regions within Australia; the east coast (southern QLD to Victoria), Adelaide, southwest Western Australia and Tasmania. As such, infection with chytrid fungus was considered a 'Key Threatening Process' under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* in 2002.

Research regarding epidemiology and lifecycle of chytridiomycosis have revealed that the fungus is sensitive to temperature. Both reproduction and growth rates are affected when it is exposed to unsuitable environmental conditions, as shown in the graph below.

**Figure 1**: Relative growth and reproduction rate of amphibian chytrid fungus under different environmental temperature conditions.

A group of trees in the background

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Relative growth and reproduction rate

Temperature oC

(c) Identify the optimum temperature for growth and reproduction of chytrid fungus.

(1 mark)

(d) Suggest why growth and reproduction rates are negligible at

(i) 30oC (2 marks)

(ii) 5oC (2 marks)

An outbreak of chytridiomycosis reduces the population of a frog species by 75%.

(e) Discuss the effect of this outbreak on the population's gene pool. (4 marks)

(f) Explain **one** factor that could further increase the threat of extinction of one infected frog species over another. (2 marks)

**Question 35 (20 marks)**

One of the most important concepts in biology is homeostasis. In the absence of homeostatic mechanisms, cells and the organisms they comprise could not function effectively in a dynamic environment.

(a) Explain why optimal cellular function is dependent on the maintenance of a constant internal environment. (2 marks)

Most homeostatic mechanisms are controlled via a negative feedback response.

(b) Construct a flow diagram that explains the negative feedback response of homeostasis. (4 marks)

(c) Describe **two** different types of homeostatic receptors present in an organism.

(2 marks)

One

Two

The Patagonian leaf-eared mouse (*Phyllotis xanthopygus*) is no ordinary mouse. In early 2020, research biologists discovered this mouse living at the summit of Llullaillaco, a volcano 6739 metres above sea level in the Andes. The 55-gram mouse was thriving despite the harsh conditions; low air pressure and oxygen, -15oC temperatures and a complete absence of plant life. Its large surface area-to-volume ratio is protected by a thick coat. It shelters in burrows and can hibernate for short periods of time (torpor). However, the most interesting of its adaptations is the ability to thermoregulate with little energy expenditure. The mouse uses brown fat stores for non-shivering thermogenesis - the mitochondria in these lipid-rich fat cells are stimulated to produce heat instead of ATP.

(d) Explain **two** benefits of non-shivering thermogenesis to the survival of the Patagonian leaf-eared mouse. (4 marks)

Most high-altitude rodents have specialised cardiovascular systems to overcome the freezing conditions and low oxygen. Further investigation into these physiological adaptations revealed a relationship between the build-up of metabolites from anaerobic respiration and vasodilation of capillaries. This is shown in the graph below.

A picture containing man, water

Description automatically generated

(e) Summarise the relationship presented in the graph above and suggest how it could influence homeostasis in high-altitude rodents. (3 marks)

A researcher studying brown fat distribution in Patagonian leaf-eared mouse discovered an unusual mutation in several individuals. An enzyme involved in the maintenance of brown fat cells in adult mice was not being produced. As a result, mice with this mutation were not surviving into adulthood. Upon further investigation, the researcher discovered that a messenger RNA (mRNA) molecule responsible for the reproduction of brown fat cells in adult mice were being incorrectly modified prior to leaving the nucleus. This resulted in the synthesis of a non-functional enzyme.

(f) Explain how a faulty mRNA molecule can lead to the synthesis of a non-viable protein.

(5 marks)

**End of Section Two**

**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 26 - 29. When you have answered your first question, turn to page 30 and indicate on that page the second question you will answer.

**Question 36 (20 marks)**

(a) Identify the types of cells and/or structures in which DNA and RNA can be found and describe the differences between these two genetic molecules.

(10 marks)

(b) Explain how sexual selection differs from natural selection as a mechanism for evolution.

(10 marks)

**Question 37 (20 marks)**

In modern agriculture, recombinant DNA technology is often used in favour of artificial selection.

(a) Briefly explain the process of creating a genetically modified crop species using recombinant DNA technology. Outline the advantages and disadvantages of using genetically modified organisms in agriculture and food production. (10 marks)

(b) Discuss how scientists use comparative anatomy to determine ancestral relatedness. Use examples to support your explanation.

(10 marks)

Question number:

Question number:

Question number:

Question number:

**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) Describe the physiological problems posed by living in marine ecosystems and discuss the mechanisms by which bony fish overcome these problems.

(10 marks)

The Covid-19 pandemic has affected almost every person in the world, particularly those living in densely populated areas. Virus particles are transmitted via coughing, sneezing and touching contaminated surfaces and once infected, a host can be asymptomatic for up to two weeks.

(b) Explain how Covid-19 was able to spread so rapidly and how Australia's strict guidelines on quarantine (self-isolation) procedures, border control, hygiene and 'social distancing' kept transmission rates under control.

(10 marks)

**Question 39 (20 marks)**

The body size of an organism influences its ability to effectively control heat transfer. Animals with a large surface area to volume ratio are able to lose heat efficiently, while a small surface area to volume ratio allows for excellent heat retention. However, many animals that possess these morphologies do not appear suited to the habitat in which they live.

(a) Describe **five** adaptations for thermoregulation in endothermic organisms that help them counteract their body size and shape. Use specific examples to support your response.

(10 marks)

(b) Discuss the role of the vector and host in the lifecycle and transmission of malaria. (10 marks)

**End of questions**

Question number:

Question number:

Question number:

Question number:

Supplementary page

Question number:

Supplementary page

Question number:

Spare grid

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**ACKNOWLEDGEMENTS**

**Question 6**

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