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Biology
Higher level
Paper 2

Thursday 9 May 2019 (afternoon)

Candidate session number

2 hours 15 minutes

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Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer two questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[72 marks]**.

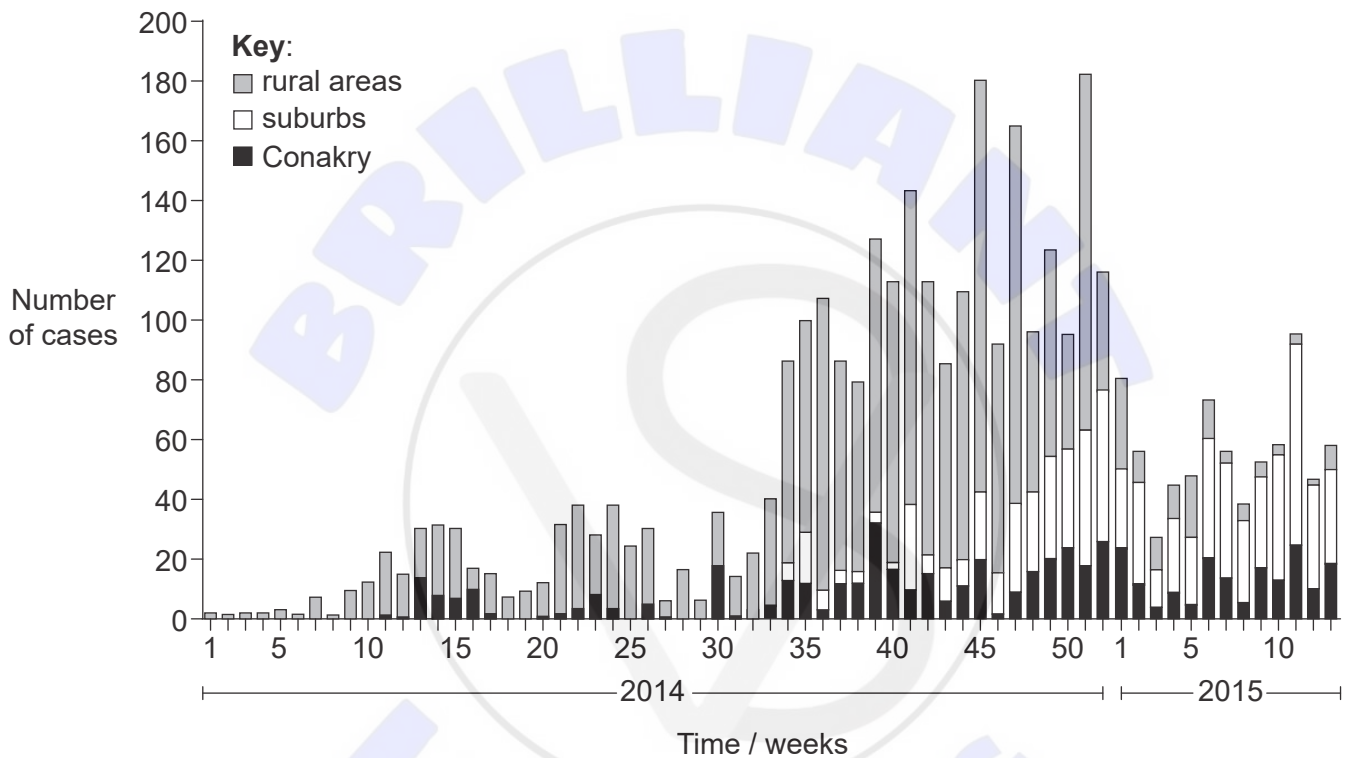


Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

1. Ebola virus disease (EVD) is the disease in humans and other primates that is caused by the Ebola virus. Fruit bats are the reservoir for the virus and are able to spread the disease without being affected. Humans can become infected by contact with fruit bats or with people infected by the virus, their body fluids or equipment used to treat them.

The stacked bar graph shows the epidemiological data for the EVD cases in Conakry, the capital city of Guinea, surrounding suburbs and rural areas in Guinea from the beginning of January 2014 to the end of March 2015.



[Source: Adriana Rico, *et al.* "Epidemiology of Epidemic Ebola Virus Disease in Conakry and Surrounding Prefectures, Guinea, 2014–2015." *Emerging Infectious Diseases* **22.2** (2016): 178–183. PMC. Web. 23 Mar. 2017. https://wwwnc.cdc.gov/eid/article/22/2/15-1304_article]

- (a) Identify the week and year in which the first cases were recorded in the suburbs. [1]

Week:

Year:

(This question continues on the following page)

(Question 1 continued)

- (b) Based on the graph, compare and contrast the progress of the epidemic in the suburbs and rural areas.

[3]

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- (c) Suggest **two** reasons for the overall decline in the epidemic after week 51.

[2]

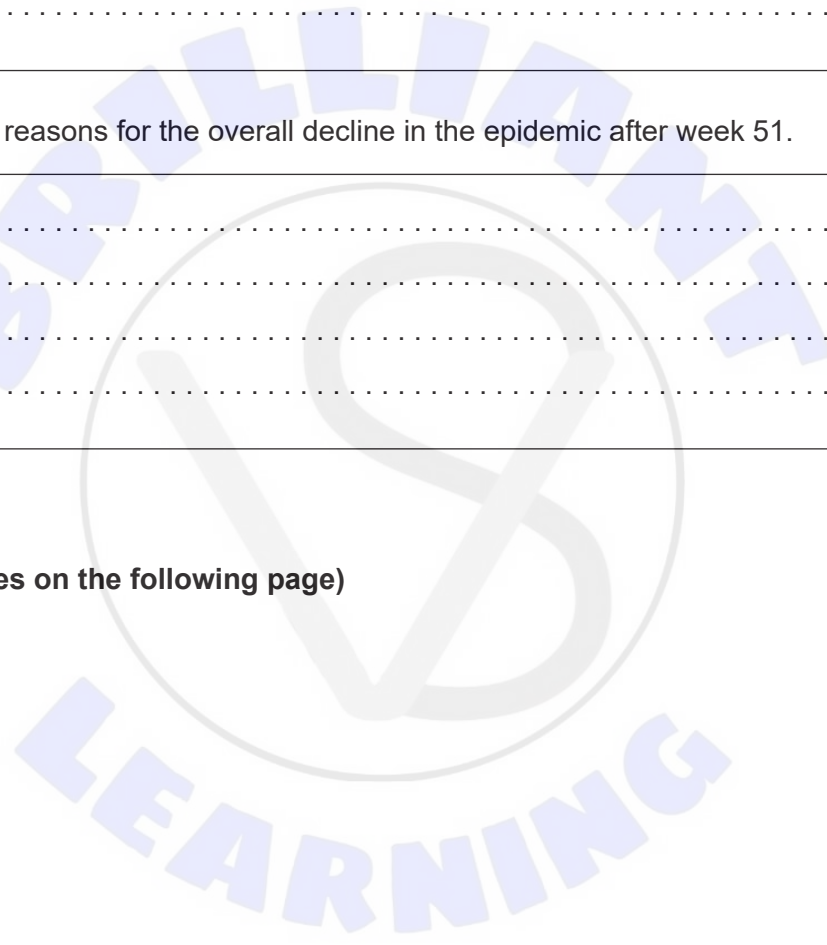
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(Question 1 continued)

The table summarizes epidemiological data from Guinea during the Ebola outbreak in 2014. The data are based on figures supplied by Ebola treatment centres. The last column refers to people who died in places other than Ebola treatment centres.

Location		Number of cases			Fatal cases at the Ebola treatment centres / %	Fatal cases outside Ebola treatment centres / %
		Total	Male	Female		
Capital city	Conakry	553	307	246	40	18
Suburbs	Coyah	236	112	124	47	19
	Forecariah	335	155	180	53	27
	Kindia	108	45	63	60	16

[Source: Adriana Rico, *et al.* "Epidemiology of Epidemic Ebola Virus Disease in Conakry and Surrounding Prefectures, Guinea, 2014–2015." *Emerging Infectious Diseases* **22.2** (2016): 178–183. PMC. Web. 23 Mar. 2017. https://wwwnc.cdc.gov/eid/article/22/2/15-1304_article]

(d) Compare and contrast the data for Conakry with the data for the three suburbs. [2]

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(Question 1 continued)

(e) Suggest reasons for the high percentage of fatal cases at Ebola treatment centres. [3]

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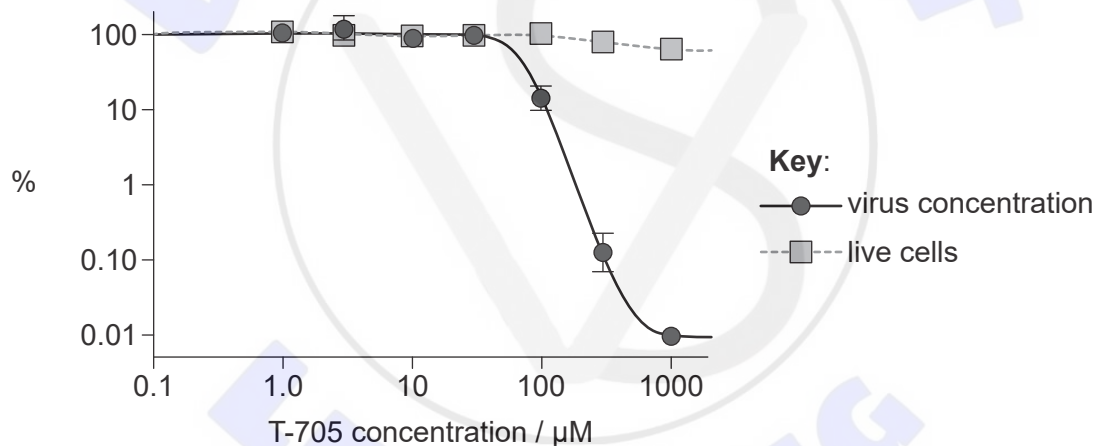
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An antiviral drug, T-705, was tested in order to establish whether it has potential to treat EVD. The graph shows the data from an in vitro trial of T-705 on cells that had been infected with Ebola virus five days previously. Virus concentration and live cells are shown as a percentage of the control.



[Source: Oestereich, Lisa & Rieger, Toni & Neumann, Melanie & Bernreuther, Christian & Lehmann, Maria & Krasemann, Susanne & Wurr, Stephanie & Emmerich, Petra & de Lamballerie, Xavier & Ölschläger, Stephan & Günther, Stephan. (2014). Evaluation of Antiviral Efficacy of Ribavirin, Arbidol, and T-705 (Favipiravir) in a Mouse Model for Crimean-Congo Hemorrhagic Fever. *PLoS neglected tropical diseases*. 8. e2804. 10.1371/journal.pntd.0002804.]

(f) Based on these data, outline the evidence that T-705 has potential to be used as a treatment for EVD. [2]

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(Question 1 continued)

In 2015, an experimental vaccine was trialled in Guinea in an area where new Ebola cases continue to develop. Among the nearly 6000 people who accepted the vaccine, no cases were recorded after vaccination. In comparison, there were 23 cases among those who did not accept the vaccine.

- (g) Explain how vaccination can lead to the production of B cells specific to the Ebola virus. [3]

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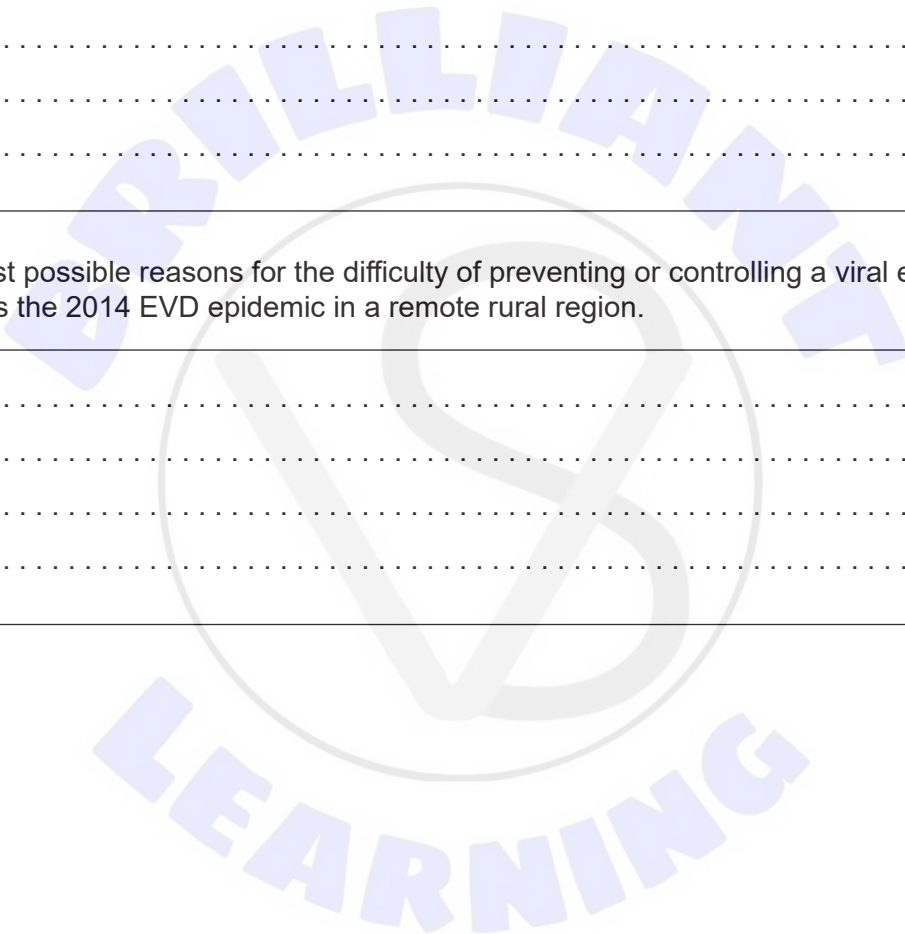
- (h) Suggest possible reasons for the difficulty of preventing or controlling a viral epidemic such as the 2014 EVD epidemic in a remote rural region. [2]

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2. (a) Distinguish between the structure of the chromosomes of prokaryotes and eukaryotes. [2]

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(b) Outline the causes of sickle cell anemia. [2]

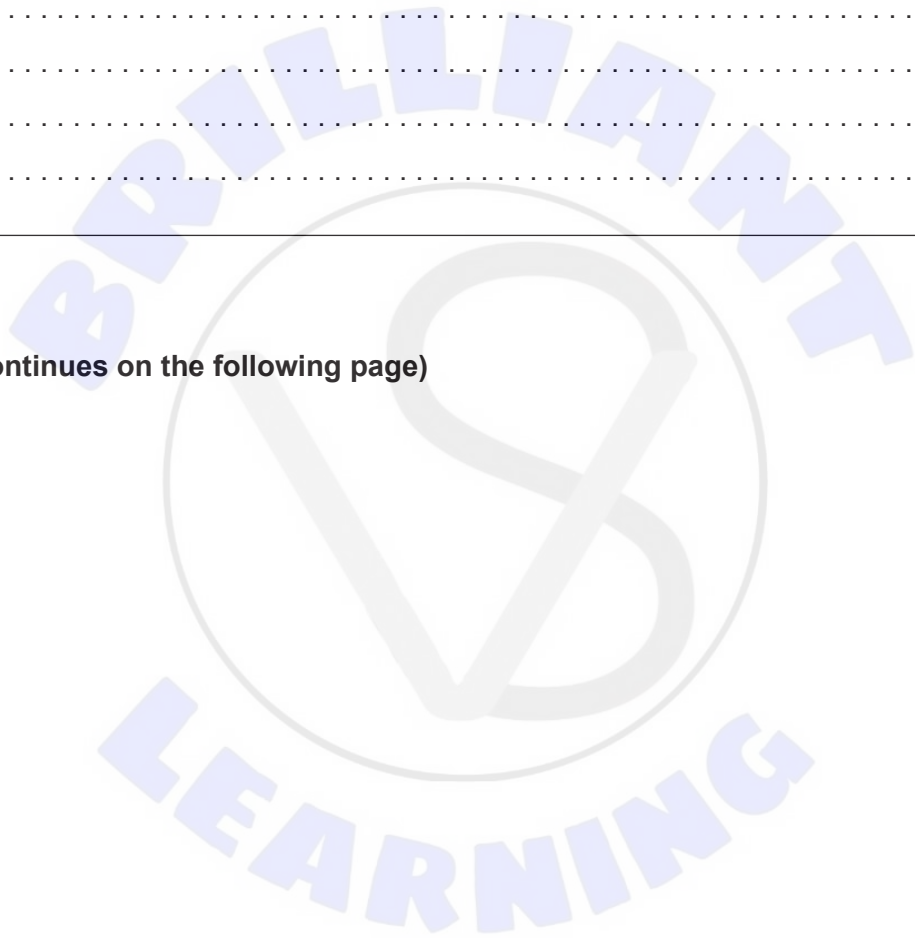
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(Question 2 continued)

- (c) The karyogram shown is for the African marsh rat (*Dasymys incomtus*). In this species, sex is determined by X and Y chromosomes. Females are XX and males are XY.



[Source: © 2011 Hamanaka *et al*, https://embryology.med.unsw.edu.au/embryology/index.php?title=File:Rat_karyotype.jpg]

- (i) Identify, with a reason, the sex of this individual. [1]

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- (ii) State the haploid number for this nucleus. [1]

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(Question 2 continued)

- (d) Thomas Hunt Morgan established that genes for body colour and wing size in *Drosophila* are autosomally linked. The allele for grey body (b^+) is dominant over that for black body (b) and the allele for normal wing size (vg^+) is dominant over that for vestigial wing (vg).
- (i) A fly that is homozygous dominant for both body colour and wing size mates with a fly that is recessive for both characteristics. In the table, draw the arrangement of alleles for the offspring of this mating and for the homozygous recessive parent. [2]

Heterozygous offspring (grey body, normal wings)	Homozygous recessive parent (black body, vestigial wings)

- (ii) The offspring, which were all heterozygous for grey body and normal wings, were crossed with flies that were homozygous recessive for both genes. The table shows the percentages of offspring produced.

grey body, normal wings	48 %
grey body, vestigial wings	3 %
black body, normal wings	2 %
black body, vestigial wings	47 %

Explain these results, based on the knowledge that the genes for body colour and wing size are autosomally linked. [2]

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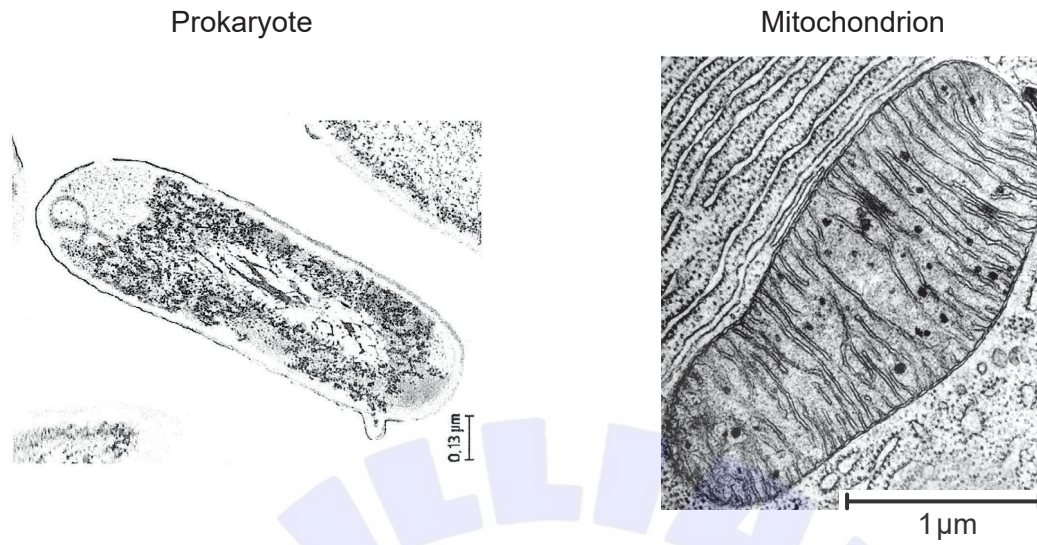
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3. The electron micrographs show a typical prokaryote and a mitochondrion.



[Source: Pradana Aumars, https://commons.wikimedia.org/wiki/Category:Bacteria#/media/File:Bacteria_cell_division.jpg]

[Source: republished with permission of McGraw-Hill Education, from *Harrison's Principles of Internal Medicine*, J L Jameson *et al.*, 16th edition, 2004; permission conveyed through Copyright Clearance Center, Inc]

(a) Compare and contrast the structure of a typical prokaryotic cell with that of a mitochondrion.

[4]

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(b) Explain how mitochondria could have been formed from free living prokaryotes.

[2]

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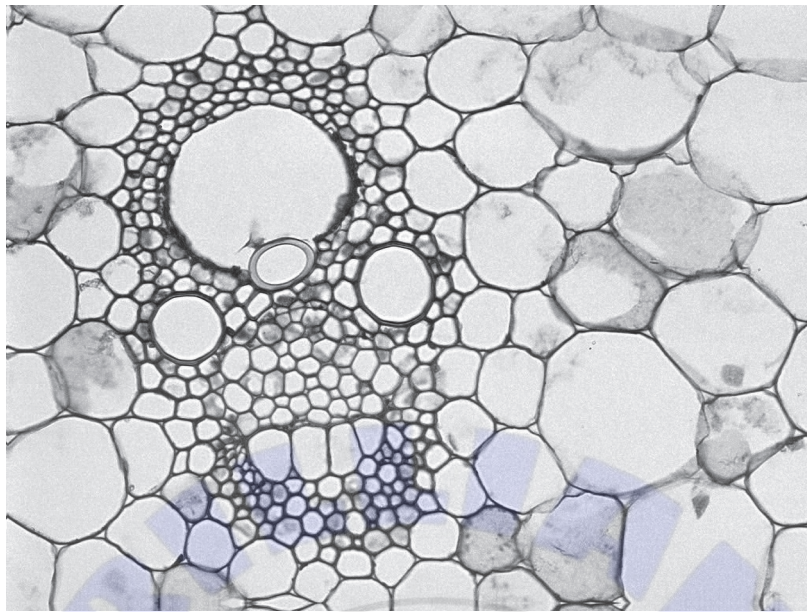
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4. The micrograph shows a vascular bundle from the stem of a barley plant.



[Source: Copyright Carolina Biological Supply Company. Used by permission only.]

(a) Xylem and phloem contain structures that are adapted for transport. Outline the differences between these structures in xylem and phloem. [2]

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(b) Explain how the properties of water allow it to move through xylem vessels. [2]

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(Question 4 continued)

(c) Outline how the structure of cellulose makes it suitable as a component of cell walls. [2]

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Section B

Answer **two** questions. Up to one additional mark is available for the construction of your answers for each question. Answers must be written within the answer boxes provided.

5. (a) Outline the functions of rough endoplasmic reticulum and Golgi apparatus. [3]
- (b) Outline the control of metabolism by end-product inhibition. [5]
- (c) Explain how hydrophobic and hydrophilic properties contribute to the arrangement of molecules in a membrane. [7]
6. (a) Outline the process of inspiration in humans. [4]
- (b) Describe the functions of valves in the mammalian heart. [4]
- (c) Explain how blood solute concentrations are kept within narrow limits in the human body. [7]
7. (a) Outline the roles of helicase and ligase in DNA replication. [4]
- (b) Explain how natural selection can lead to speciation. [7]
- (c) Outline the features of ecosystems that make them sustainable. [4]

