

Biology

Standard level

Paper 3

Tuesday 2 May 2017 (morning)

Candidate session number

1 hour

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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.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[35 marks]**.

Section A	Questions
Answer all questions.	1 – 3

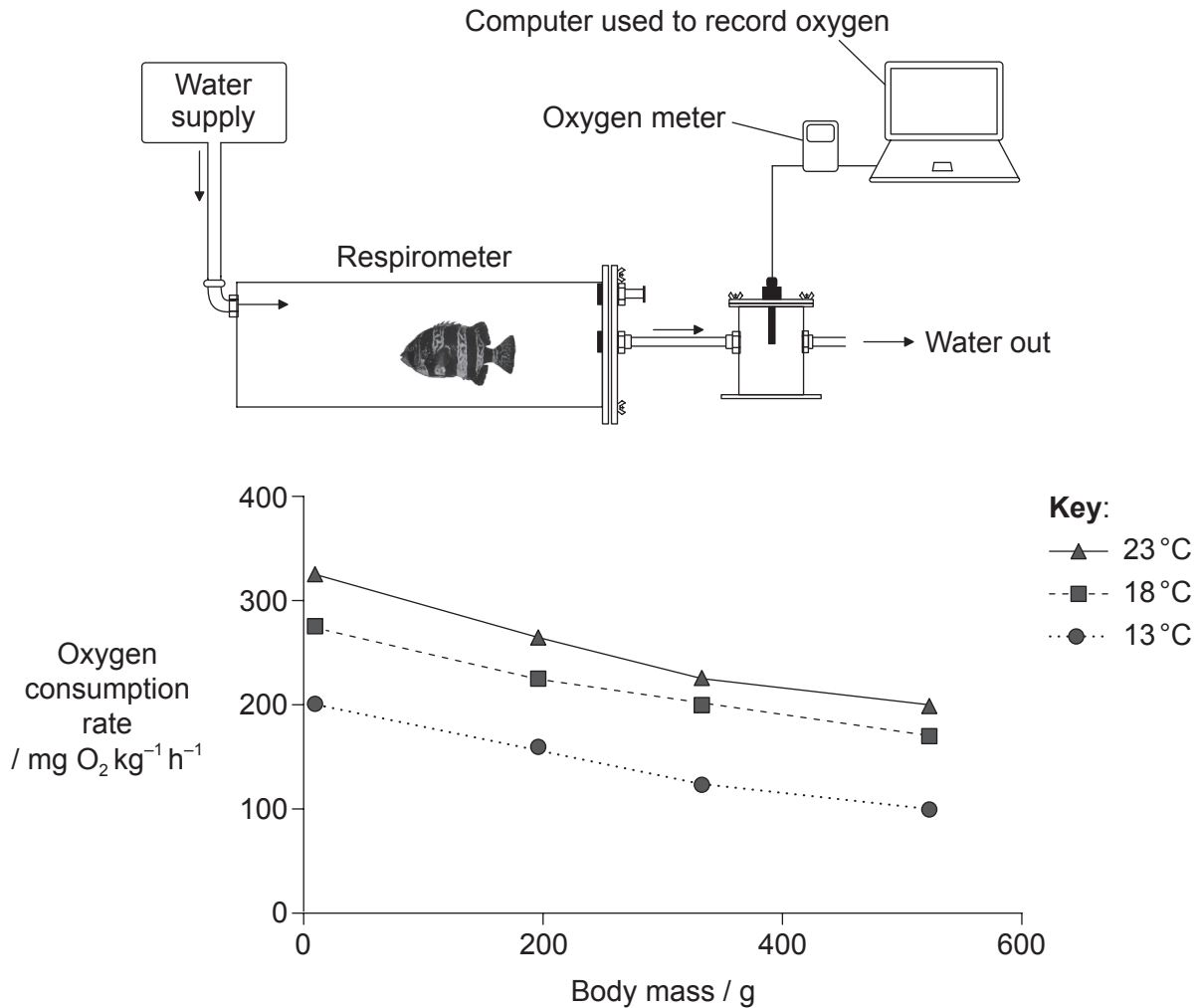
Section B	Questions
Answer all of the questions from one of the options.	
Option A — Neurobiology and behaviour	4 – 8
Option B — Biotechnology and bioinformatics	9 – 13
Option C — Ecology and conservation	14 – 18
Option D — Human physiology	19 – 22



Section A

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

1. The oxygen consumption rate of the fish *Oplegnathus insignis* was examined in a respirometer at three different water temperatures and at four different body masses.



[Source: adapted from E Segovia, *et al.*, (2012), *Latin American Journal of Aquatic Research*, **40** (3), pages 766–773]

- (a) Suggest how the oxygen consumption rate is determined using this apparatus. [2]

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(Question 1 continued)

(b) State the relationship between body mass and the oxygen consumption of fish. [1]

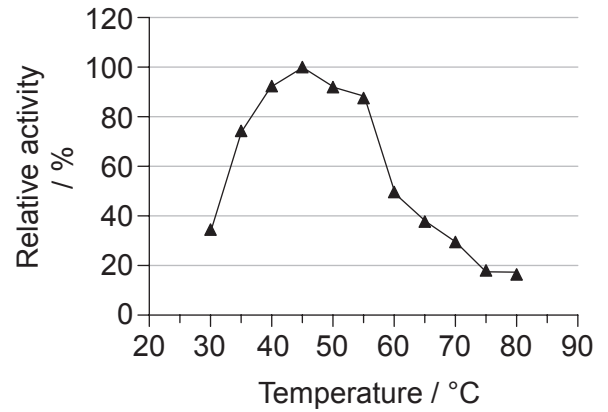
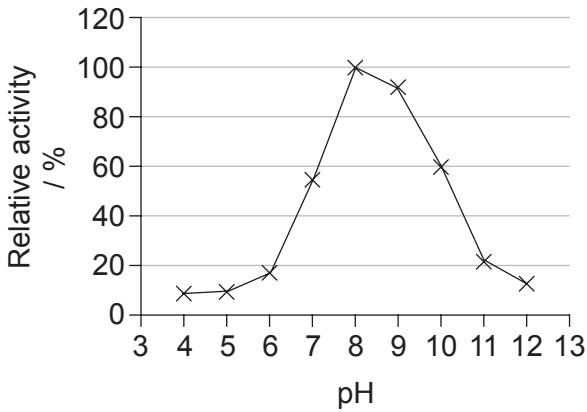
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(c) Predict the effects of global warming on aerobic respiration in fish. [2]

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2. Keratin is a protein found in hair, nails, wool, horns and feathers. The graphs show the relative keratinase activity obtained in experiments into keratin digestion at different pH values and different temperatures.



[Source: Kim Jeong-Dong (2007) 'Purification and Characterization of a Keratinase from a Feather-Degrading Fungus, *Aspergillus flavus* Strain K-03.' *Mycobiology*, 35 (4), pages 219–225]

(a) Determine the optimum pH and temperature of keratinase. [1]

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(b) Suggest **two** changes occurring in the reaction vessel that could be used to indicate keratinase activity. [2]

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(c) State **two** conditions that should be kept constant in both experiments. [2]

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Answers written on this page
will not be marked.



28EP05

Turn over

3. In an experiment to determine the effect of diet on response to leptin, mice were fed a control diet or a high fructose diet for six months and then either injected with a saline (salt) solution or injected with leptin. The food intake of both groups was then monitored over a 24 hour period.

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- (a) Distinguish between the effect of leptin injection on 24 hour food intake in the mice fed the control diet and in the mice fed the high fructose diet.

[1]

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(This question continues on the following page)



(Question 3 continued)

- (b) Discuss the implications of these results for recommending leptin injections as an appetite suppressant for humans. [2]

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- (c) Leptin is a hormone. Hormones are chemicals produced in one part of the body that have an effect in another part of the body. State the

- (i) tissue that produces leptin in humans. [1]

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- (ii) target that leptin normally acts on. [1]

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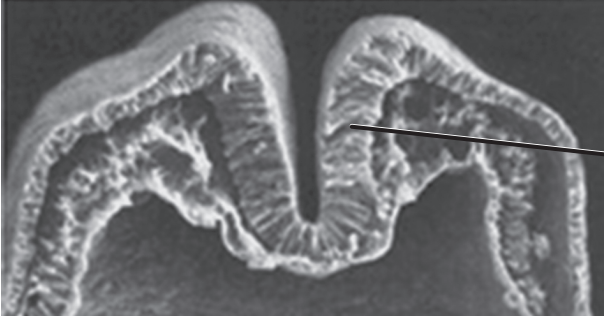
Section B

Answer **all** of the questions from **one** of the options. Answers must be written within the answer boxes provided.

Option A — Neurobiology and behaviour

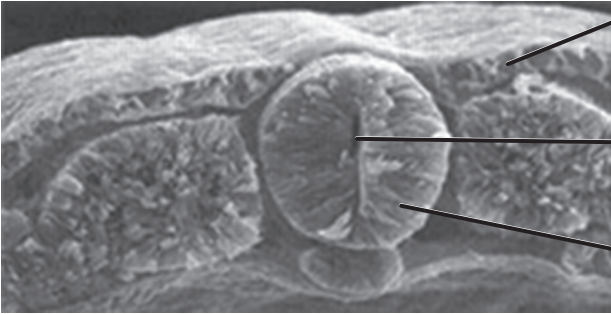
4. The images show the early stages and completed outcome of the process of neurulation.

Early stages



I.

Completed outcome



II.

Structure X

Structure Y

[Source: adapted from www.slideshare.net]

(a) Label the parts I and II on the images. [2]

(b) Structure Y will eventually elongate to form two structures. State the names of these **two** structures. [2]

1.

2.

(Option A continues on the following page)



(Option A, question 4 continued)

- (c) State the condition that arises if the closure of structure X is incomplete during embryonic development. [1]

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- 5. (a) Outline the function of the autonomic nervous system in the human body. [2]

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- (b) Evaluate the use of the pupil reflex to test for brain damage. [3]

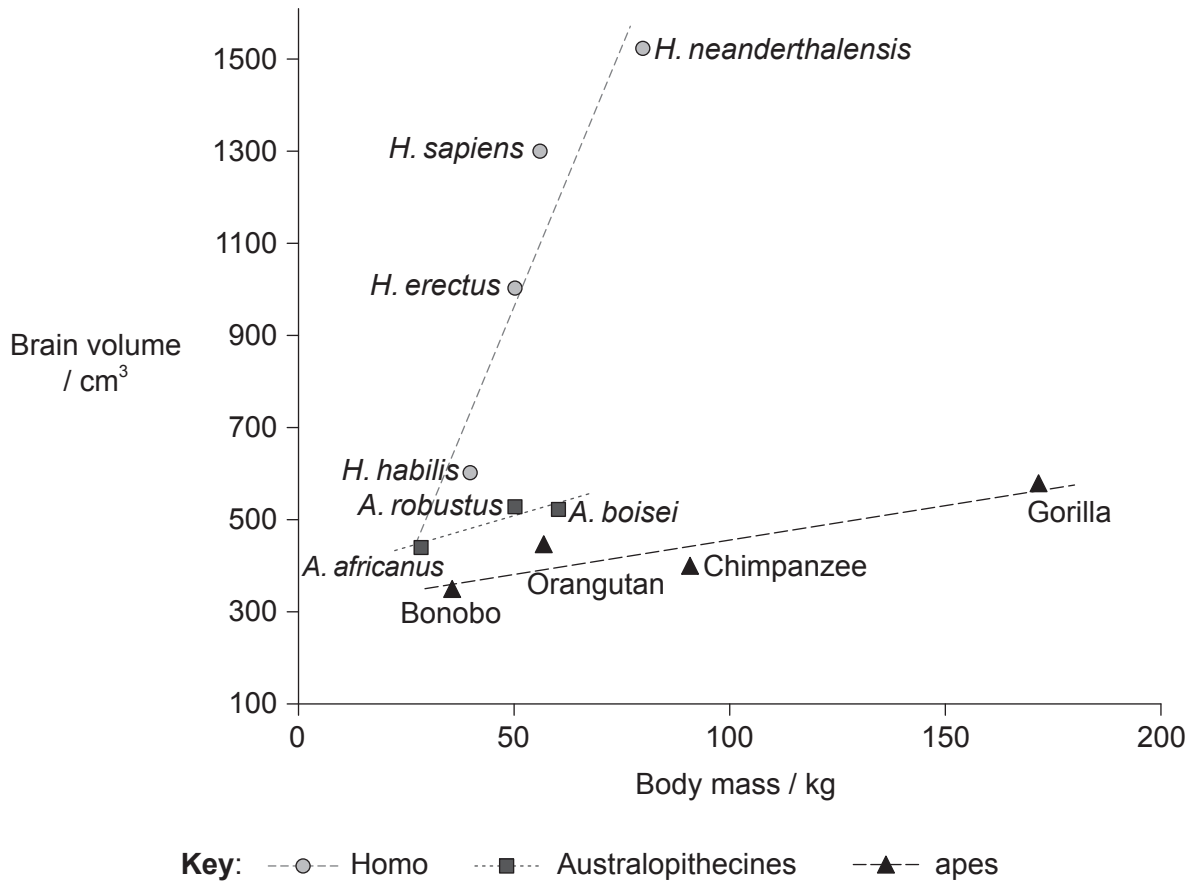
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(Option A continues on the following page)



(Option A continued)

6. The graph shows the relationship between body mass and brain volume in three groups of primates.



[Source: adapted from G Roth and U Dicke (2005) *TRENDS in Cognitive Sciences*, 9 (5), with permission from Elsevier]

Analyse the relationship between body mass and brain volume in these primates.

[3]

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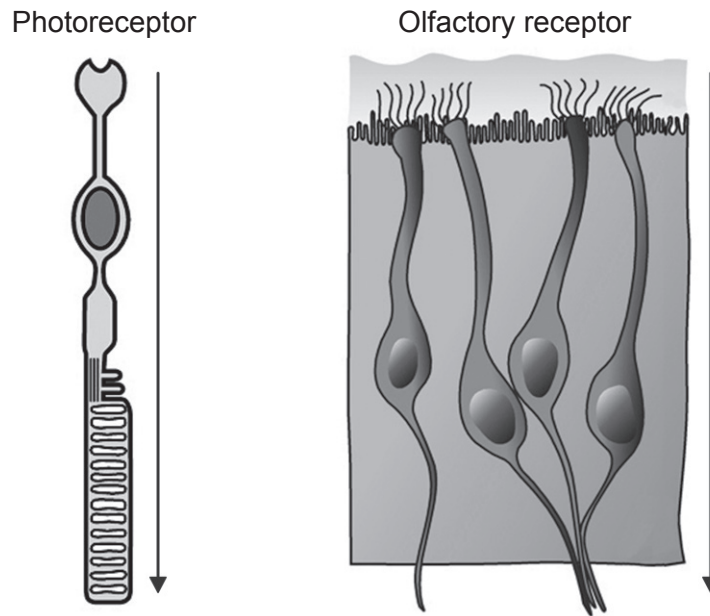
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(Option A continues on the following page)



(Option A continued)

- 7. The diagram shows a photoreceptor and an olfactory receptor. The arrows show the direction of the stimulus.



[Source: adapted from A Louvi and E A Grove (2011) *Neuron*, 69 (6), pages 1046–1060, with permission from Elsevier]

- (a) State the name of the photoreceptor shown. [1]

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- (b) Distinguish between a photoreceptor and an olfactory receptor. [2]

	Photoreceptor	Olfactory receptor
Stimulus perceived		
Tissue where it is found		

(Option A continues on the following page)



(Option A continued)

8. Explain how information from the left and right sides of the visual field is processed. [4]

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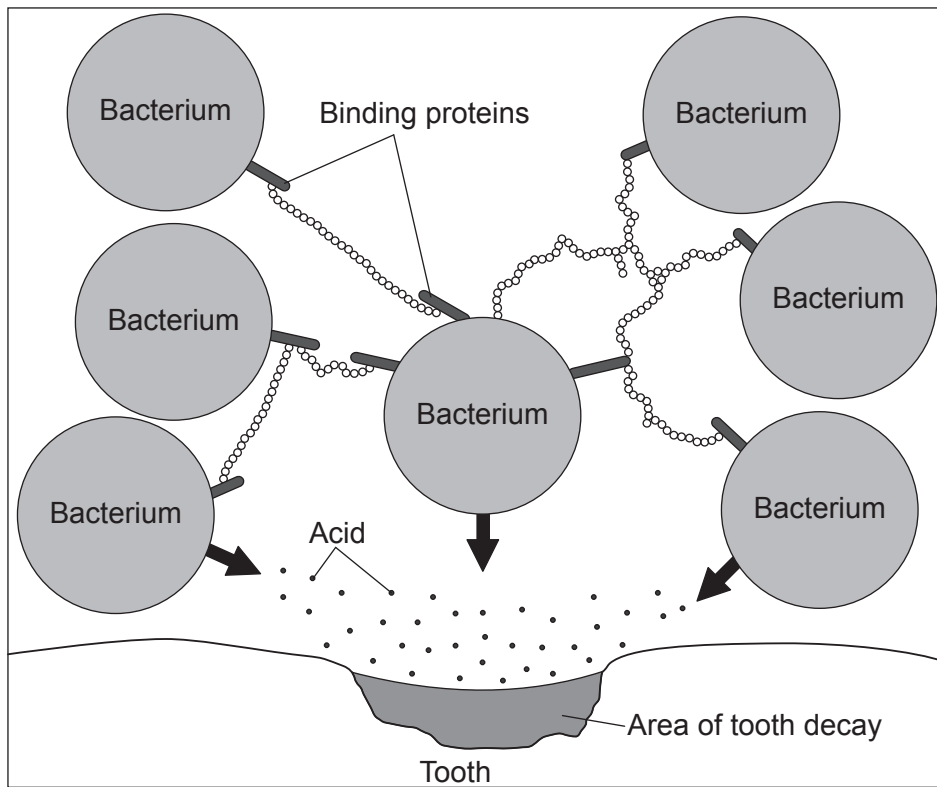
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End of Option A



Option B — Biotechnology and bioinformatics

9. The diagram shows a biofilm that has formed on a tooth.



[Source: © International Baccalaureate Organization 2017]

Using the diagram, explain the concept of emergent properties of biofilms.

[3]

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(Option B continues on the following page)

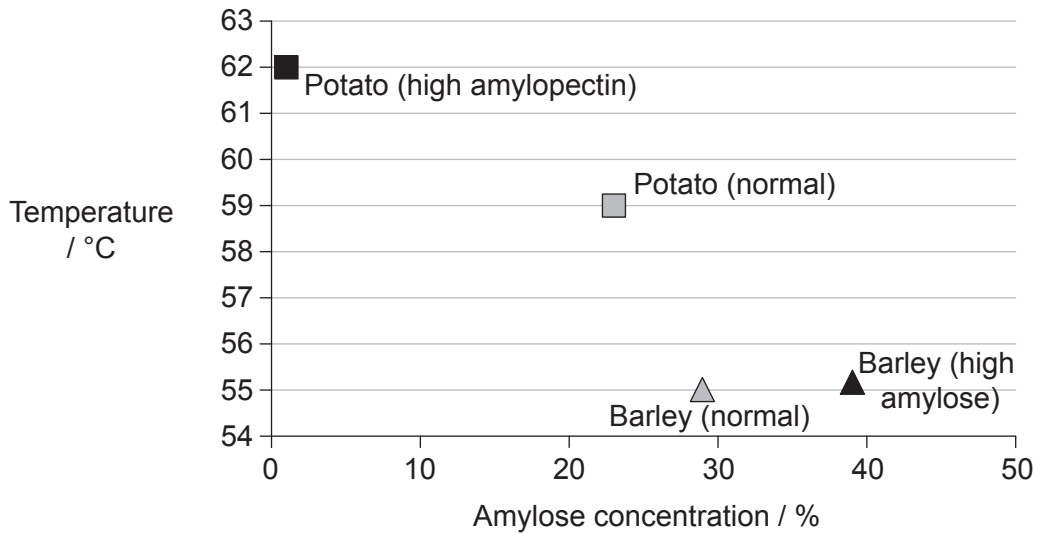


28EP13

Turn over

(Option B continued)

10. Starch from different sources contains differing proportions of amylose and amylopectin. Potatoes (*Solanum tuberosum*) have been genetically modified to produce high-amylopectin starch (Amflora potatoes). Heat induces starch to form a gel in excess water. The graph shows gel formation temperature at different amylose concentrations.



[Source: adapted from H Fredriksson et al. (1998) *Carbohydrate Polymers* 35, pages 119–134, with permission from Elsevier]

(a) Discuss the hypothesis that the temperature at which starches form a gel depends on the degree of cross-linking of amylopectin. [2]

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(b) State **one** advantage of potatoes with a high amylopectin content. [1]

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(Option B continues on the following page)



(Option B, question 10 continued)

- (c) The Amflora potato was approved for industrial applications in the European Union (EU) in 2010 and was withdrawn in January 2012 due to opposition. Discuss reasons for people supporting or opposing the introduction of the Amflora potato in the EU. [3]

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11. Golden rice is a genetically modified variety of rice (*Oryza sativa*). The golden colour comes from beta-carotene, a precursor of vitamin A, in the edible parts of rice. The modification was achieved by the addition of two beta-carotene biosynthesis genes, one from a flower (*Narcissus pseudonarcissus*) and the other from a soil bacterium (*Erwinia uredovora*).

- (a) Using this information, outline the reason for Golden rice being considered a transgenic organism. [1]

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- (b) Outline the bioinformatics method used to identify the target gene in the plant. [1]

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(Option B continues on the following page)



(Option B continued)

12. The diagram shows a batch fermentation system to monitor and control the production of lipase by the fungus *Candida rugosa*.

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- (a) Reservoir jar 1 contains antifoam and reservoir jar 2 contains acid. State **two** other substances required for batch fermentation.

[2]

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- (b) State what probe X could be used to detect, other than pH or foam formation.

[1]

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(Option B continues on the following page)



(Option B, question 12 continued)

(c) Distinguish between batch fermentation and continuous fermentation.

[2]

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13. Explain how microorganisms can be used in response to pollution incidents such as an oil spill.

[4]

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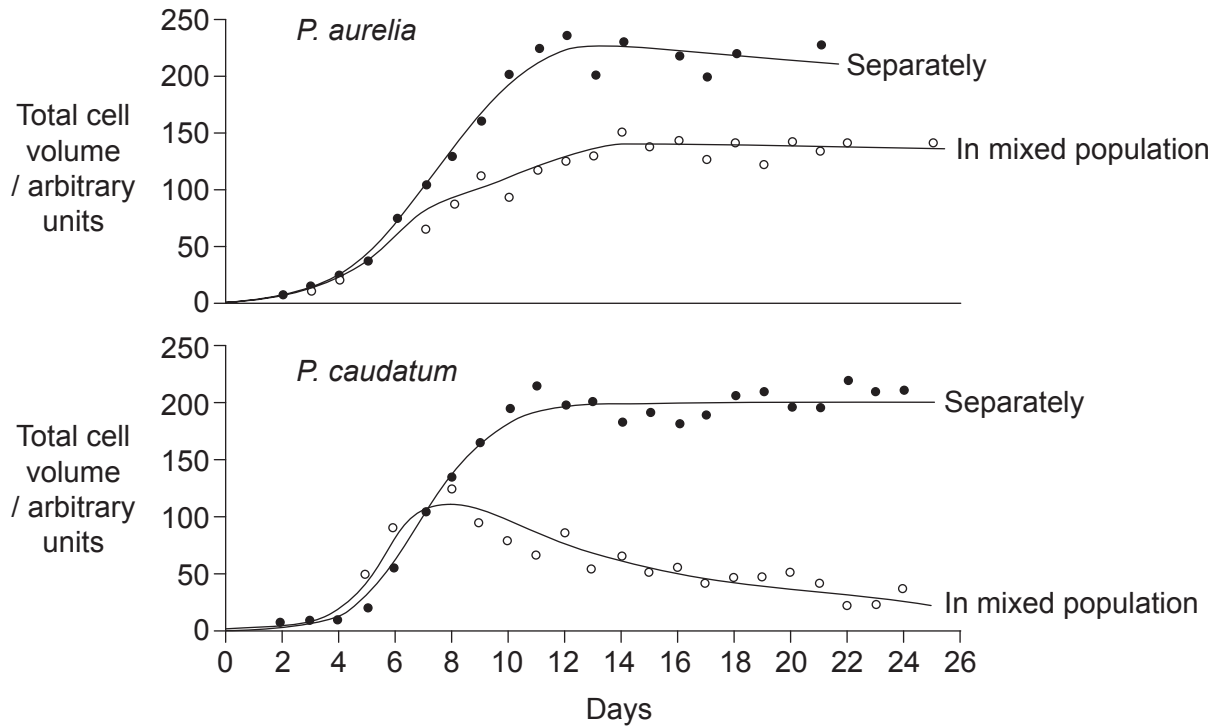
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End of Option B



Option C — Ecology and conservation

14. *Paramecium aurelia* and *Paramecium caudatum* are single cell organisms. They were grown separately and together. The population growth curves are shown.



[Source: G. F. Gause (1934) *The Struggle for Existence*, published by The Williams & Wilkins Company]

Explain the results shown in this experiment.

[3]

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(Option C continues on the following page)



(Option C continued)

15. The net primary productivity is the rate at which all the plants in an ecosystem convert energy to biomass. The graphs show the effect of temperature and precipitation in different environments on the net primary productivity.

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(a) Distinguish between the effects of temperature and precipitation on net primary productivity.

[1]

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(b) Tundra ecosystems have temperatures below 0°C and very dry weather. Identify the approximate net primary productivity in Tundra ecosystems.

[1]

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(c) The points labelled X and Y on the graphs represent the same ecosystem. Deduce the type of ecosystem from the mean annual temperature and precipitation values.

[1]

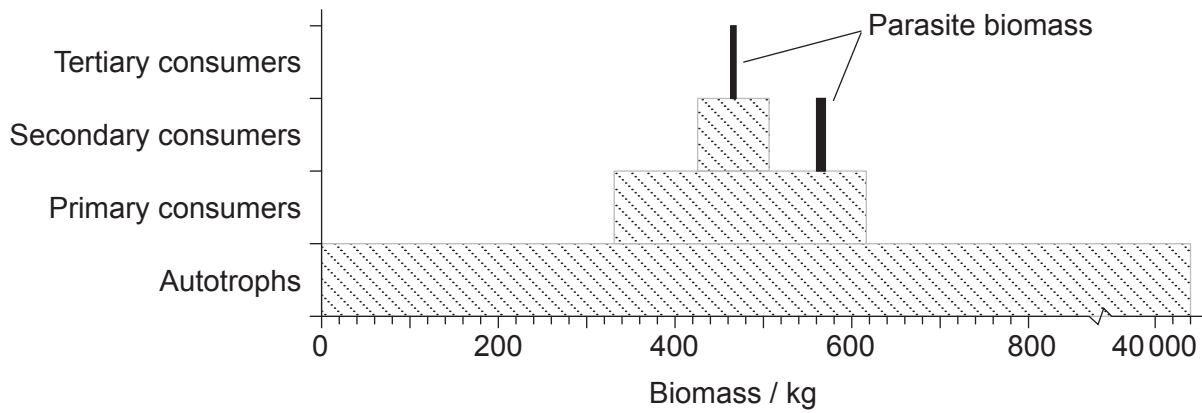
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(Option C continues on the following page)



(Option C continued)

- 16. The pyramid of biomass obtained from a pine forest stream includes the parasite biomass. Parasites are fungi, worms and other organisms that live on a host.



[Source: Michael Sukhdeo (2012) 'Where are the parasites in food webs?'
Parasites & Vectors, 5, page 239. DOI: 10.1186/1756-3305-5-239]

- (a) Estimate the approximate amount of biomass represented by parasites in this ecosystem. [1]

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- (b) Compare and contrast the biomass in the different trophic levels. [2]

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- (c) Outline the reason that parasite biomass occurs in both tertiary consumers and secondary consumers. [1]

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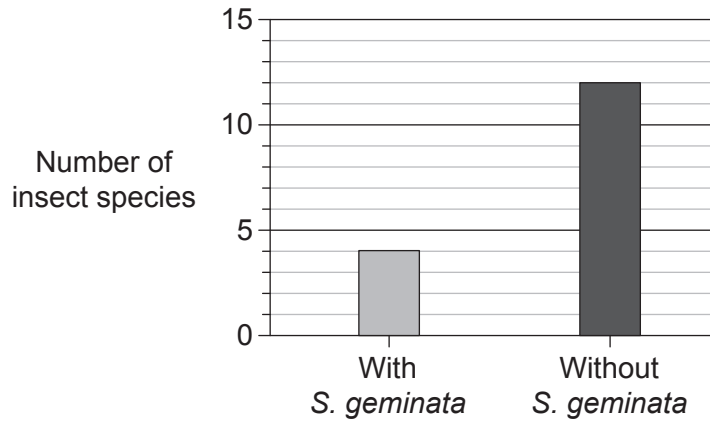
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(Option C continued)

17. The fire ant (*Solenopsis geminata*) is an effective colonizer and has become invasive in a number of ecosystems. Sometimes, efforts to eliminate this species have had an unexpected impact on community structure. It is argued that *S. geminata* can play a beneficial role in corn production. The graph shows how the presence of *S. geminata* can impact insect diversity in areas where crops of corn are grown.



[Source: adapted from Risch and Carroll (1982) *Ecology*, 63, John Wiley & Sons Inc, pages 1979–1983.]

(a) State the impact of *S. geminata* on insect species diversity. [1]

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(b) Discuss whether *S. geminata* might play a positive role in corn production. [3]

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(Option C continues on the following page)



28EP21

Turn over

(Option C, question 17 continued)

- (c) Researchers have argued that *S. geminata* is a keystone species in the corn agricultural system. Outline what is meant by a keystone species.

[2]

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- 18.** Explain the use of indicator species to assess the condition of the environment.

[4]

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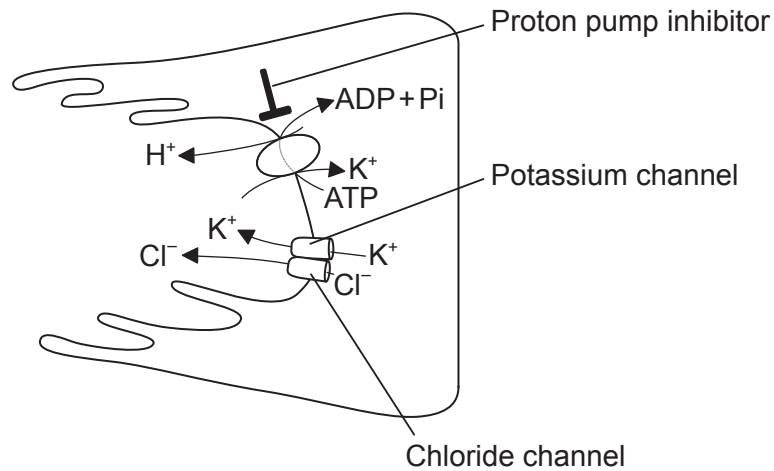
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End of Option C



Option D — Human physiology

19. The diagram shows a cell in the lining of the stomach.



[Source: © International Baccalaureate Organization 2017]

(a) Outline the importance of the proton pumps in the digestion of foods. [2]

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(b) Explain the use of proton pump inhibitors to treat patients complaining of stomach pain. [3]

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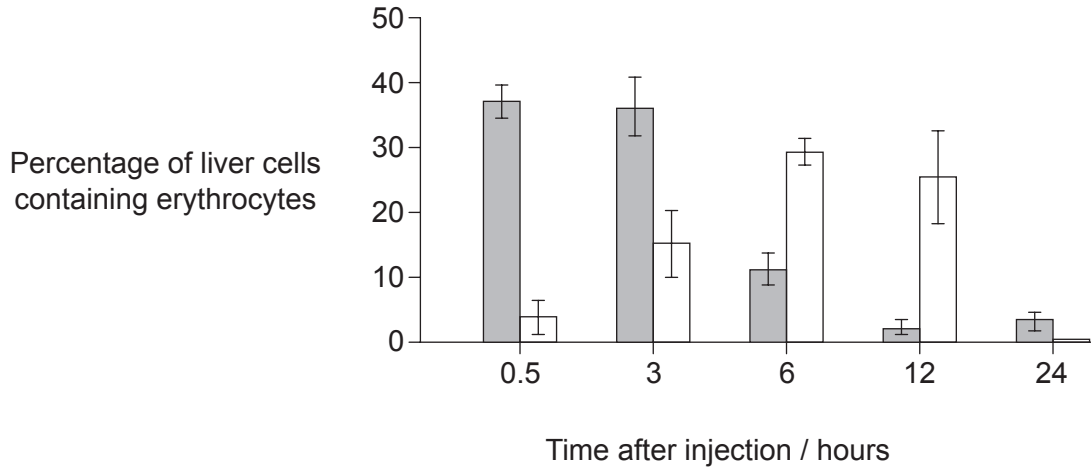
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(Option D continues on the following page)



(Option D continued)

20. Rats were injected with antibodies that induced phagocytosis of red blood cells (erythrocytes) leading to their breakdown. The graph shows the percentage of intact and partially digested erythrocytes in cells of the liver as observed under the microscope.



Key: ■ intact erythrocytes □ partially digested erythrocytes

[Source: adapted from DJ Loegering, *et al.*, (1987), *Infection and immunity*, pages 2074–2080]

(a) State the name of the cells that perform the breakdown of erythrocytes in the liver. [1]

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(b) Describe the breakdown of erythrocytes by liver cells. [3]

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(Option D, question 20 continued)

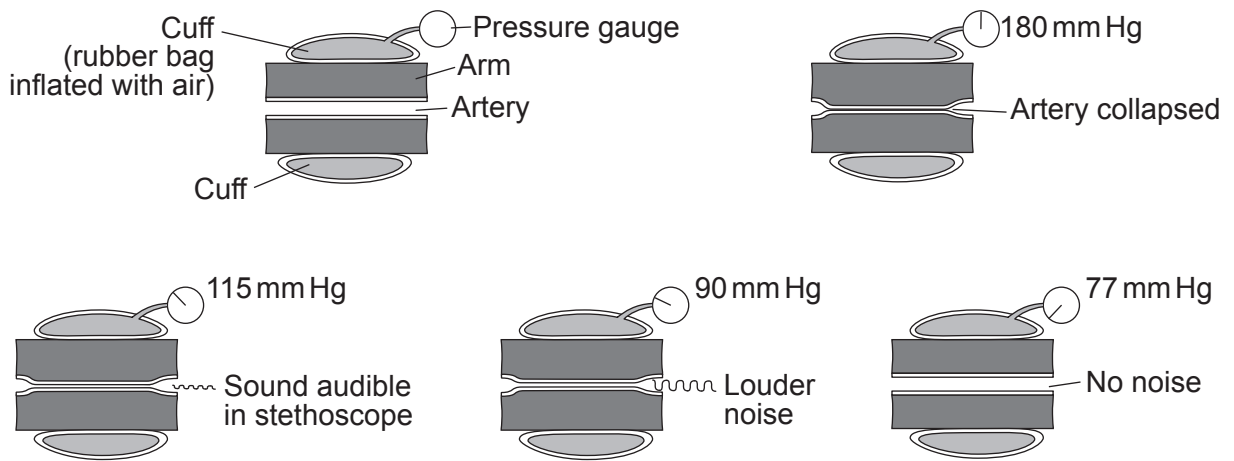
(c) Outline the fate of the iron from the erythrocytes.

[1]

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21. The diagram shows the use of a sphygmomanometer in the measurement of blood pressure.



[Source: adapted from CA Villee, (1972), *Biology*, Sixth Edition, page 357]

(a) Identify the systolic pressure and diastolic pressure for this adult male.

[1]

Systolic pressure (mm Hg):

Diastolic pressure (mm Hg):

(b) Explain the meaning of systolic and diastolic pressure.

[3]

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(Option D continues on the following page)



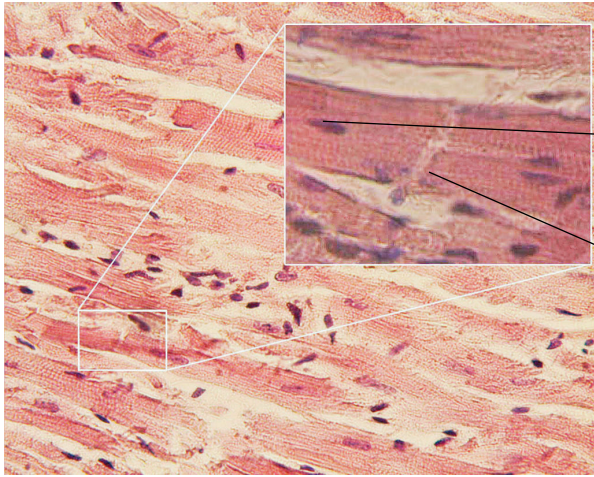
28EP25

Turn over

(Option D, question 21 continued)

(c) The photomicrograph shows cardiac muscle. Label the structures I and II.

[2]



I.
II.

[Source: https://en.wikipedia.org/wiki/Cardiac_muscle#/media/File:Glanzstreifen.jpg]

22. Explain a method to quantify the energy content in food.

[4]

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End of Option D



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28EP28