Diploma Programme
Programme du diplôme
Programa del Diploma

# Biology
# Standard level
# Paper 3

Tuesday 15 May 2018 (morning)

Candidate session number

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

1 hour

**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 – 7 |
| Option B — Biotechnology and bioinformatics | 8 – 10 |
| Option C — Ecology and conservation | 11 – 14 |
| Option D — Human physiology | 15 – 18 |

2218 – 6018

30 pages

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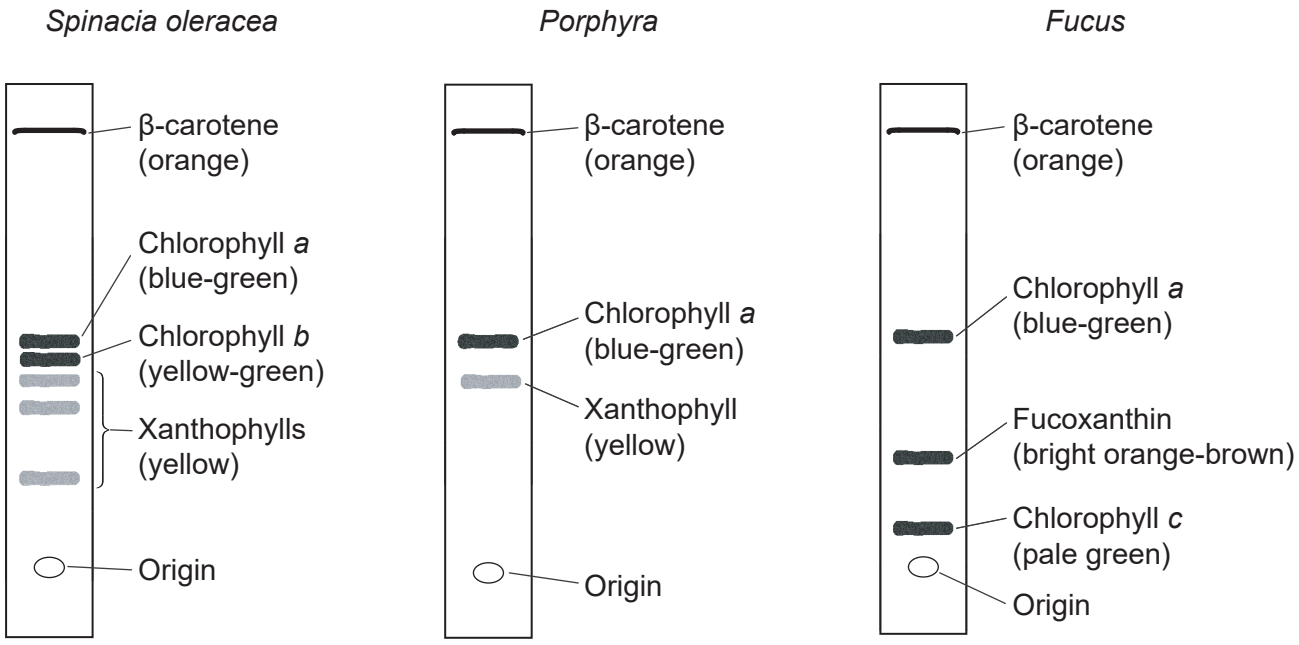
## Section A

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

**1.** Chromatography is a technique used to separate the components of a mixture. The photosynthetic pigments from three organisms were separated by thin layer chromatography: spinach (*Spinacia oleracea*), a red alga (*Porphyra*) and a brown alga (*Fucus*).




[Source: Adapted from "Diversity of Photosynthetic Pigments" by Alexander F. Motten in *Tested Studies for Laboratory Teaching*, Volume 16 of the Association for Biology Laboratory Education and used by permission of the author]

(a) Identify a pigment found in all three organisms. [1]

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(b) Compare and contrast absorption spectra and action spectra. [2]

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**(This question continues on the following page)**

**(Question 1 continued)**

(c) *Porphyra* also contains phycoerythrin, which is a red pigment.

(i) Suggest a reason for phycoerythrin being absent from the *Porphyra* chromatogram. [1]

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(ii) Predict **one** colour of light that will be absorbed efficiently by phycoerythrin. [1]

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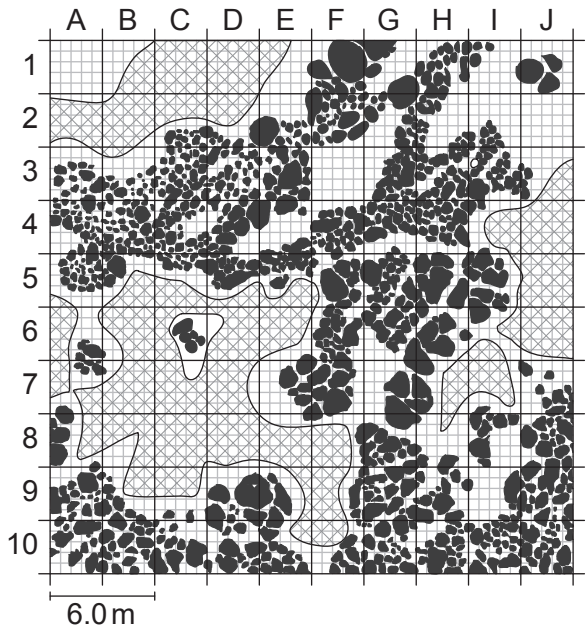
**2.** White sage (*Salvia apiana*) is a native Californian shrub. Slender oat (*Avena barbata*) is a grass, originally from the Mediterranean, which was introduced to California. The map shows the distribution of the two species in relation to one another in an area near Santa Ynez, California.




**Key**:

area covered by *A. barbata*

area covered by *S. apiana*

[Source: Adapted from http://web.csulb.edu. Reproduced with permission from Christine M. Rodrigue, Ph.D.]

(a) Using the scale bar, determine the area of quadrat A1, giving the units. [1]

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(b) Outline how chi-squared can be used to test for an association between the distributions of the two species. [3]

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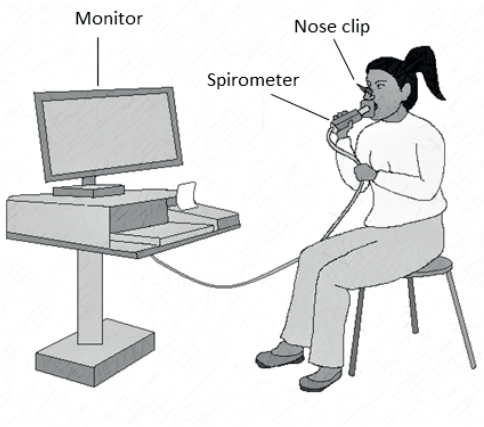
**3.** In an experiment to explore the effect of exercise on ventilation rate, a subject breathed into a data logging sensor that measured air flow.



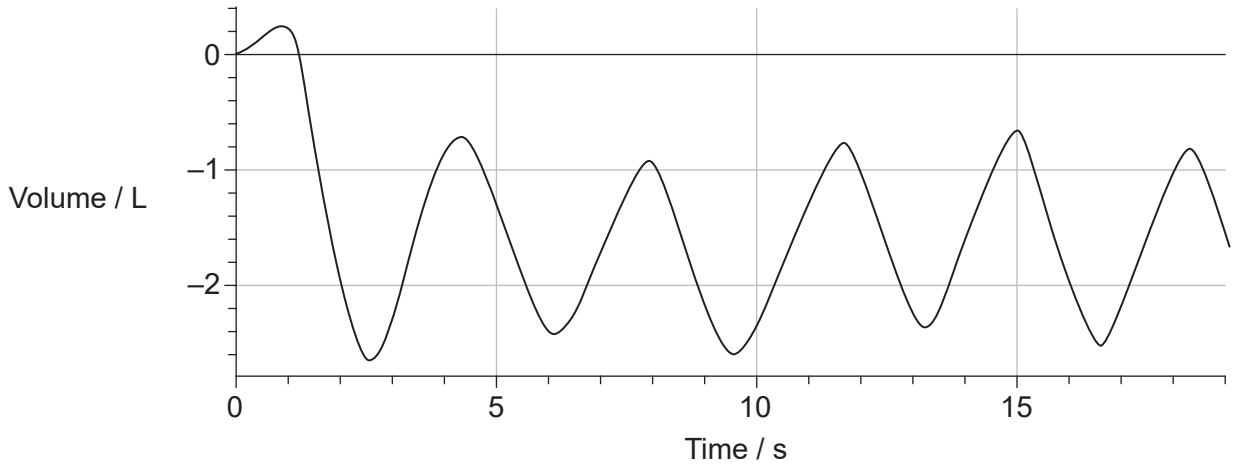

[Source: © International Baccalaureate Organization 2018]

**(This question continues on the following page)**

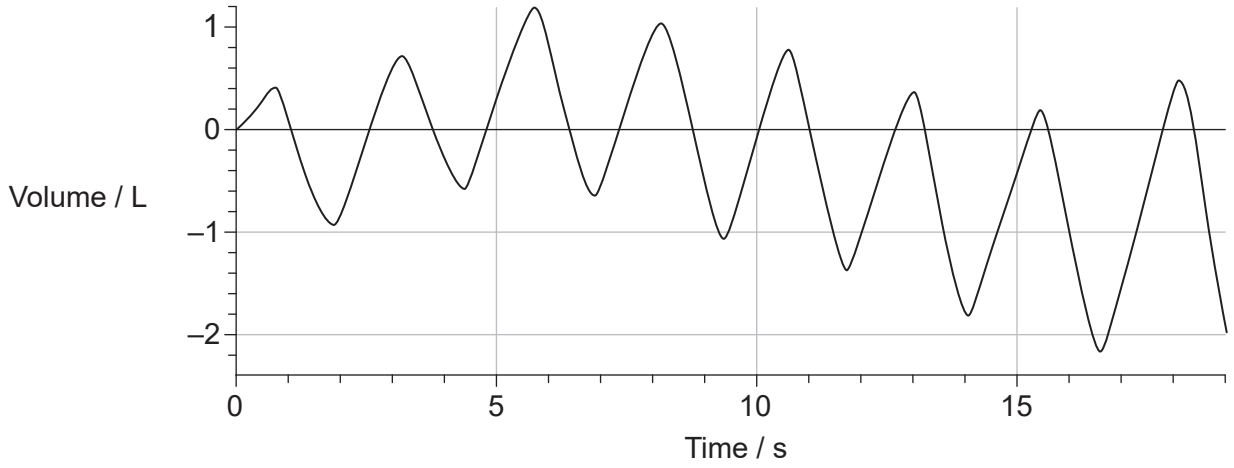
**(Question 3 continued)**

The graphs show the result before the subject exercised and immediately after the exercise had finished.

Before exercise




After exercise




[Source: © International Baccalaureate Organization 2018]

(a) Determine the ventilation rate after exercise. [2]

. . . . . breaths minute$^{-1}$

**(This question continues on the following page)**

**(Question 3 continued)**

(b) Describe how the mean tidal volume after exercise could be determined using the graph. [2]

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(c) Predict, with a reason, the effect of exercise on the rate of cell respiration. [1]

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(d) Identify a muscle responsible for increasing the volume of the chest cavity. [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.** (a) Outline the function of **one named** photoreceptor in the mammalian eye. [2]

Name:

. . . . . .

Function:

. . . . . .

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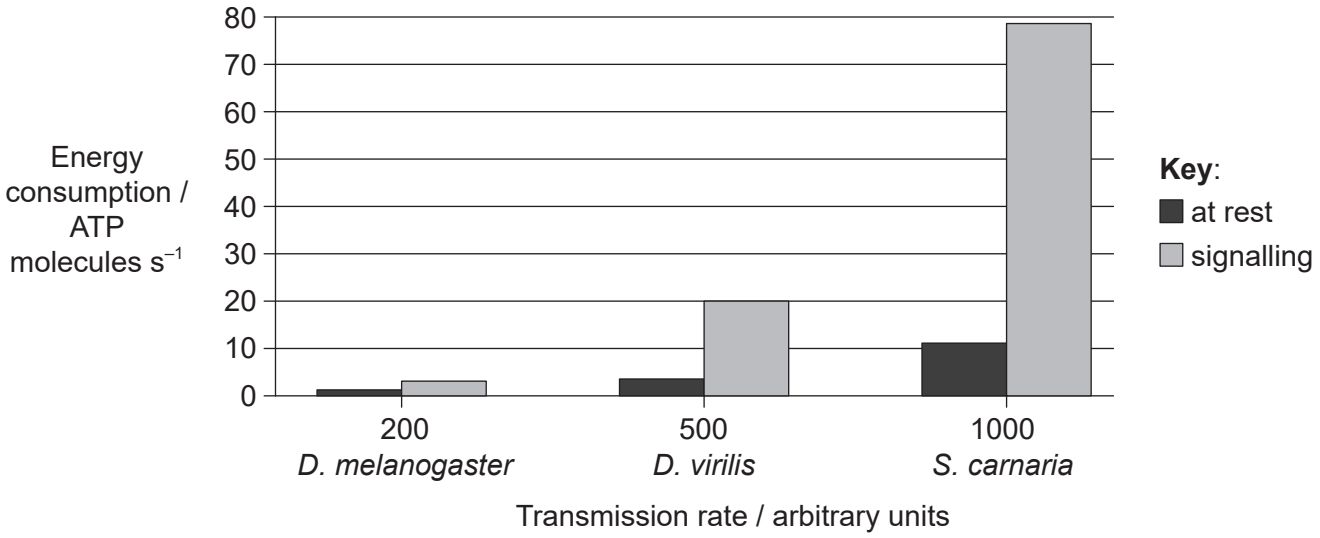
**(Option A continues on the following page)**

**(Option A, question 4 continued)**

(b) The graph shows the energy consumption of photoreceptors in three different species of fly (*Drosophila melanogaster*, *Drosophila virilis* and *Sarcophaga carnaria*) at the mean of the highest transmission rate for each species at rest and while sending a nerve signal (signalling).




[Source: Adapted with permission of J E Niven and S B Laughlin (2008), *Journal of Experimental Biology*, 211, pp 1792–1804]

(i) Explain how neurons at rest still consume energy. [2]

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(ii) Identify the species with photoreceptors that have the fastest signalling transmission rate. [1]

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(iii) Describe the relationship between energy consumption and transmission rate. [2]

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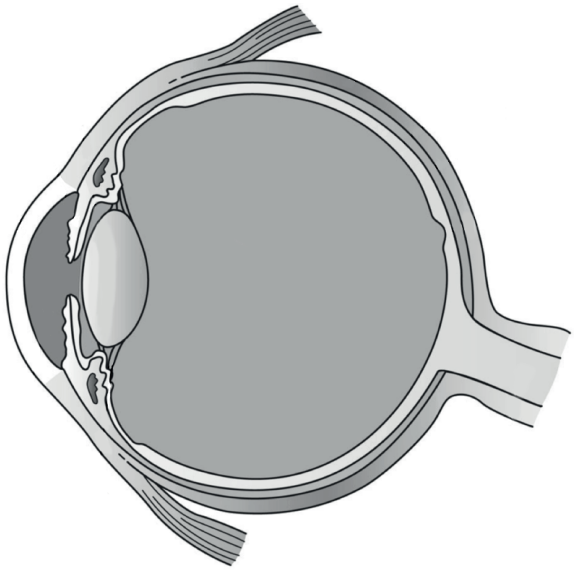
**(Option A continues on the following page)**

**(Option A continued)**

**5.** (a) Label the pupil and the retina on the diagram. [2]



[Source: Holly Fischer https://en.wikipedia.org/wiki/Human_eye#/media/File:Three_Internal_chambers_of_the_Eye.png]

(b) Explain the use of the pupil reflex as a test for brain damage. [3]

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(c) State the property of the nervous system that allows it to change with experience and allows the brain to recover from a stroke. [1]

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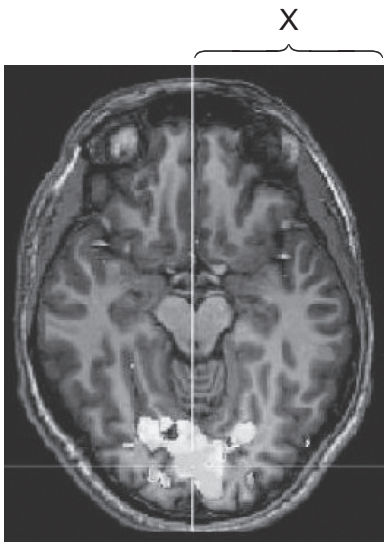
**(Option A continues on the following page)**

**(Option A continued)**

**6.** A person was given a visual stimulus while an image was taken of their brain.




[Source: Activation of visual cortex using crossmodal retinotopic mapping, Lotfi Merabet, Peter Meijer *et al*, 2008, https://www.seeingwithsound.com/hbm2008.html. Used with permission.]

(a) State the name of the technique used to produce the image. [1]

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(b) Identify the area of the brain responsible for processing visual stimuli. [1]

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(c) Identify the area of the brain labelled X in the image. [1]

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**(Option A continues on the following page)**

**(Option A continued)**

**7.** Explain the stages of development and differentiation of neurons. [4]

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## End of Option A

**Option B — Biotechnology and bioinformatics**

**8.** Vinegar is a water-based solution of ethanoic acid. *Acetobacter aceti* is used in the production of vinegar. This bacterium has the ability to convert ethyl alcohol, $C_2H_5OH$, into ethanoic acid, $CH_3COOH$.

$$C_2H_5OH + O_2 \longrightarrow CH_3COOH + H_2O$$

(a) *A. aceti* is a Gram-negative bacterium. If a Gram staining procedure were carried out on a sample of *A. aceti*, predict the result that would be observed after

(i) decolourization. [1]

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(ii) counterstaining. [1]

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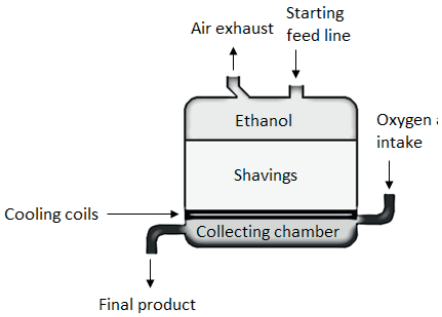
**(Option B continues on the following page)**

**(Option B, question 8 continued)**

(b) In the generator method of ethanoic acid fermentation, *Acetobacter aceti* are grown over wood shavings in a fermenter to the point where they form a biofilm.




[Source: © International Baccalaureate Organization 2018]

At the base of the fermenter oxygen is bubbled in, which then rises through the wood shavings. Ethanol drips through the wood shavings. At a suitable temperature the ethanol is converted to ethanoic acid, which is withdrawn from the bottom of the fermenter, and new ethanol is added at the top.

(i) List **two** abiotic variables that would need to be monitored during this fermentation process. [2]

1. . . . . .

2. . . . . .

(ii) Describe **one** way in which microorganisms in this fermenter could be limited by their own activities. [2]

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**(Option B continues on the following page)**

**(Option B, question 8 continued)**

(iii) Distinguish between batch fermentation and continuous fermentation. [2]

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(c) Outline the concept of an emergent property. [2]

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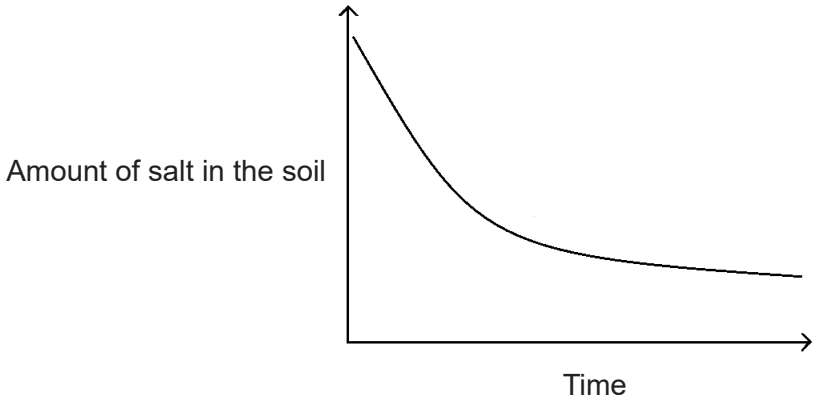
**(Option B continues on the following page)**

**(Option B continued)**

**9.** A build-up of salt (NaCl) in soil is known as salinization. This can make the soil unsuitable for agriculture. One strategy that has been used to address this problem is to add compost mixed with salt-metabolizing bacteria to this soil. The bacteria loosen the association of the $Na^+$ with the soil and allow it to be washed out by rain more effectively. The graph shows the effect of bacteria over time on the amount of salt in the soil.




[Source: © International Baccalaureate Organization 2018]

(a) Outline the trend in amount of salt in the soil over the study period. [1]

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(b) State the name of the strategy that involves the use of organisms to remove toxic substances from a contaminated site. [1]

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**(Option B continues on the following page)**

**(Option B, question 9 continued)**

(c) Another strategy for addressing soil salinization is to use genetically modified plants. A gene from *Arabidopsis thaliana* that codes for a vacuole membrane protein (AtNHX1) known as the $Na^+/H^+$ antiport was inserted into tomato plants. The transgenic plants increased storage of salt in their leaves yet the tomato fruit grew normally compared to unmodified plants.

(i) Suggest how these genetically modified tomato plants could be useful to farmers. [1]

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(ii) Explain how a researcher could determine whether other species contained similar sequences to the AtNHX1 gene. [3]

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**(Option B continues on page 19)**

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will not be marked.

**(Option B continued)**

**10.** Explain how plants can be genetically modified using the Ti plasmid so that they contain the gene for glyphosate resistance. [4]

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## End of Option B

**Option C — Ecology and conservation**

**11.** The data show the numbers and location of four species of arthropods known as barnacles (*Elminius modestus*, *Chthamalus montagui*, *Chthamalus stellatus* and *Semibalanus balanoides*) in a rocky shore habitat in Cuskinny Bay in Ireland. The data was collected by walking along a transect line away from the shore and counting all of the barnacles within 15 cm of either side of the transect line.

Removed for copyright reasons

(a) Determine the height above lowest tide where the density of *S. balanoides* was greatest. [1]

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(b) Identify the **two** species whose realized niches do **not** overlap. [1]

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**(Option C continues on the following page)**

**(Option C, question 11 continued)**

(c) *S. balanoides* is endemic to the area; one of the other three species is an invasive alien. Suggest, with a reason, which species is the invasive alien. [2]

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(d) Within the same bay lives a species of burrowing marine worm, *Lanice conchilega*, commonly known as the sand mason worm. It is a reef-building organism that is considered to be a keystone species. Explain what is meant by the term keystone species. [2]

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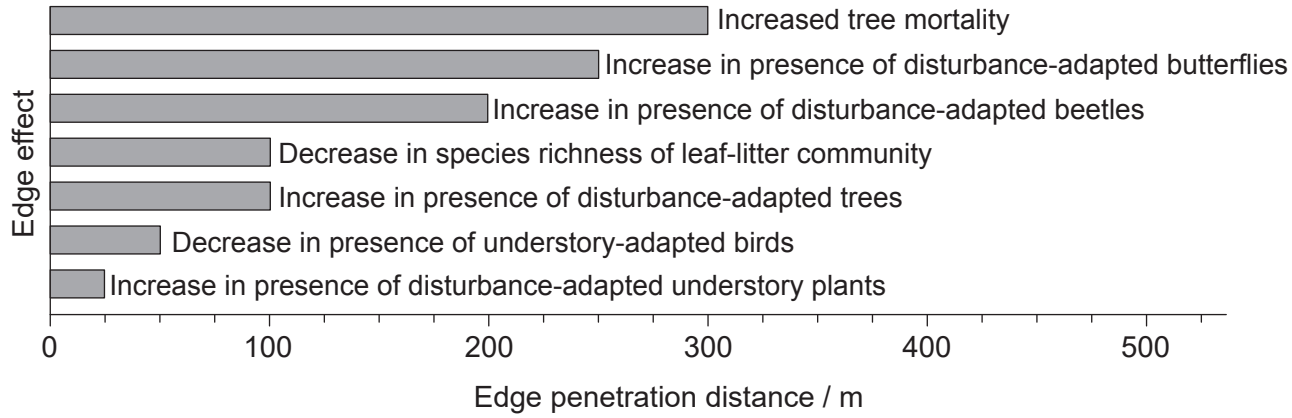
**(Option C continues on the following page)**

**(Option C continued)**

**12.** One challenge associated with establishing nature reserves is concerns about edge effects. The graph shows that some edge effects in the Amazon rainforest are detected quite far in from the edge.




[Source: Reprinted from *Biological Conservation*, 141, William F Laurance, Theory meets reality: How habitat fragmentation research has transcended island biogeographic theory, 1731, Copyright (2008), with permission from Elsevier]

(a) Determine how far from the forest edge an increase in disturbance-adapted beetles would be detected. [1]

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(b) With respect to the example of disturbance-adapted beetles, explain what is meant by an indicator species. [2]

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**(Option C continues on the following page)**

**(Option C, question 12 continued)**

(c) Outline how reserve size and shape can impact edge effects. [3]

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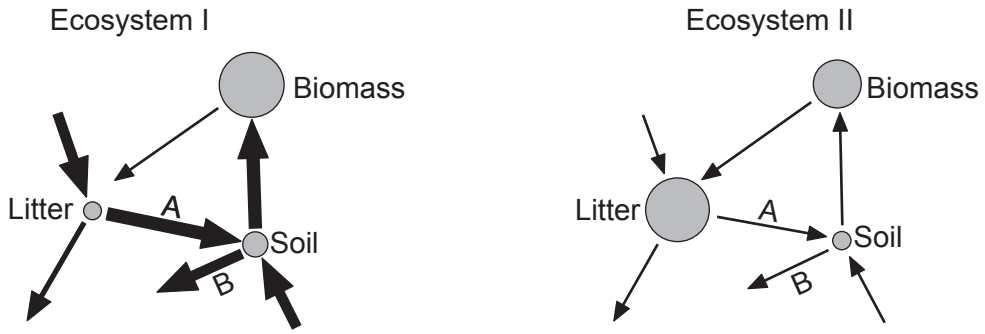
**(Option C continues on the following page)**

**(Option C continued)**

**13.** Gersmehl diagrams for two ecosystems are shown.




[Source: © International Baccalaureate Organization 2018]

(a) Identify the processes represented by the arrows labelled A and B in both diagrams. [2]

Process A: . . . . . .

Process B: . . . . . .

(b) Deduce, with a reason, which ecosystem is representative of a tropical rainforest. [2]

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**(Option C continues on the following page)**

**(Option C continued)**

**14.** Discuss the health consequences and environmental consequences of the use of DDT. [4]

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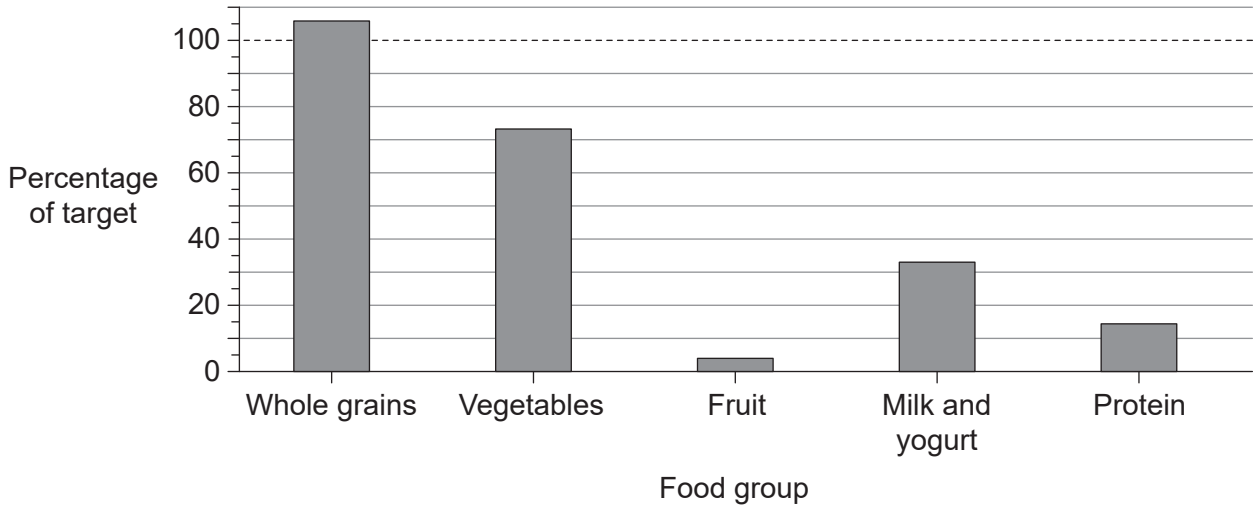
## End of Option C

**Option D — Human physiology**

**15.** A student recorded their dietary consumption over a 24-hour period into diet tracker software. The record of their consumption is shown in the table.

| Breakfast | Cafeteria lunch | Snack | Evening meal | Evening snack |
|---|---|---|---|---|
| Two slices of toast with jam<br><br>and<br><br>Breakfast cereal with milk | French fries with sauce | Granola bar | Spaghetti with tomato sauce | Soft drink and potato chips |

The bar chart shows the degree to which the student's diet met the recommended daily target for five food groups.




[Source: © International Baccalaureate Organization 2018]

(a) Using the bar chart, determine the percentage of the recommended daily target of protein consumed by the student. [1]

. . . . . %

**(Option D continues on the following page)**

**(Option D, question 15 continued)**

(b) Suggest which essential dietary requirement might be missing if insufficient protein is consumed by the student. [1]

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(c) The tracker indicated that the student had exceeded the recommended intake of dietary sodium. Overconsumption of dietary sodium can lead to hypertension. Explain what is meant by hypertension, referring to specific diastolic and systolic values. [3]

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(d) The recommended daily intake of vitamin D is 15 μg. This student consumed just 4 μg. State **two** potential health consequences of vitamin D deficiency. [2]

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**(Option D continues on the following page)**

**(Option D continued)**

**16.** (a) Explain the relationship between infection by the bacterium *Vibrio cholerae* and dehydration. [3]

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(b) Severe dehydration can lead to cardiac arrest. Outline the use of defibrillation to treat life-threatening cardiac conditions. [3]

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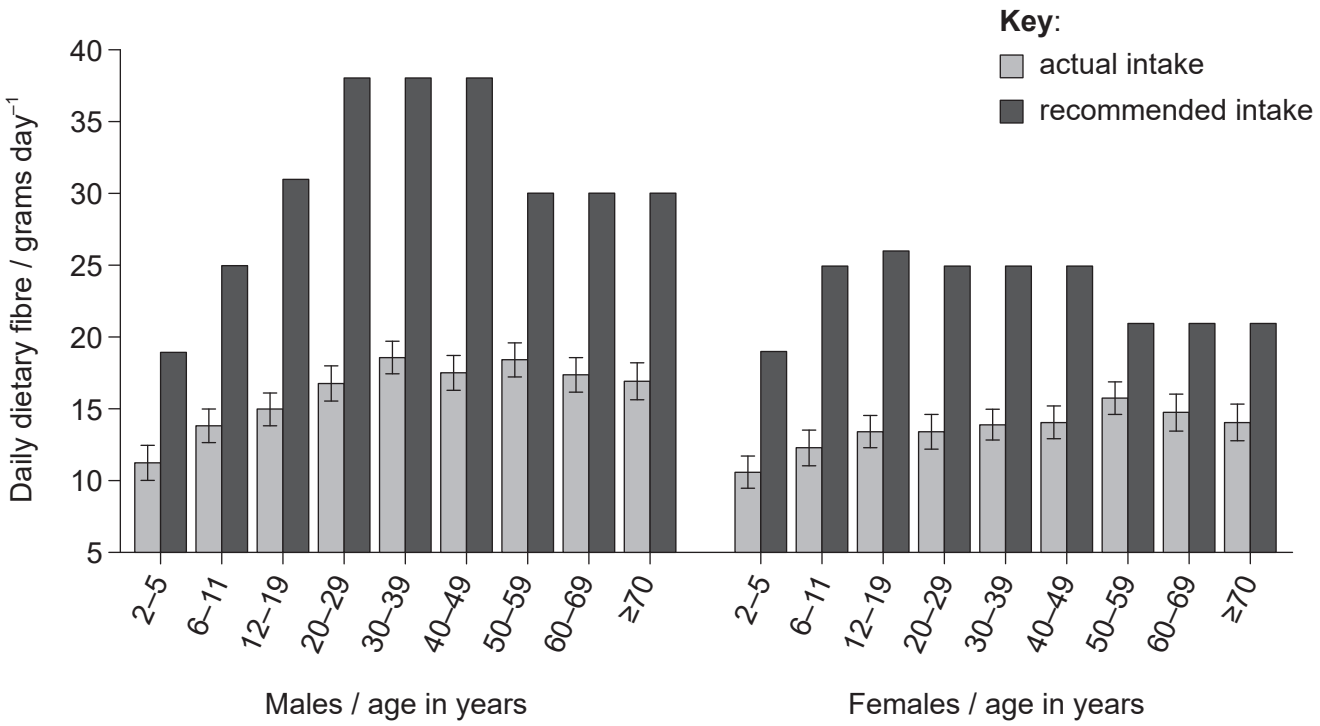
**(Option D continues on the following page)**

**(Option D continued)**

**17.** The bar chart indicates that both males and females in the US eat, on average, less fibre than is recommended.




[Source: Food Surveys Research Group, Agricultural Research Service, US Department of Agriculture]

Explain the importance of dietary fibre. [3]

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**(Option D continues on the following page)**

**(Option D continued)**

**18.** Explain the stages involved in the recycling of erythrocytes by the liver. [4]

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## End of Option D

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