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Biology
Higher level
Paper 2

Wednesday 11 November 2020 (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]**.



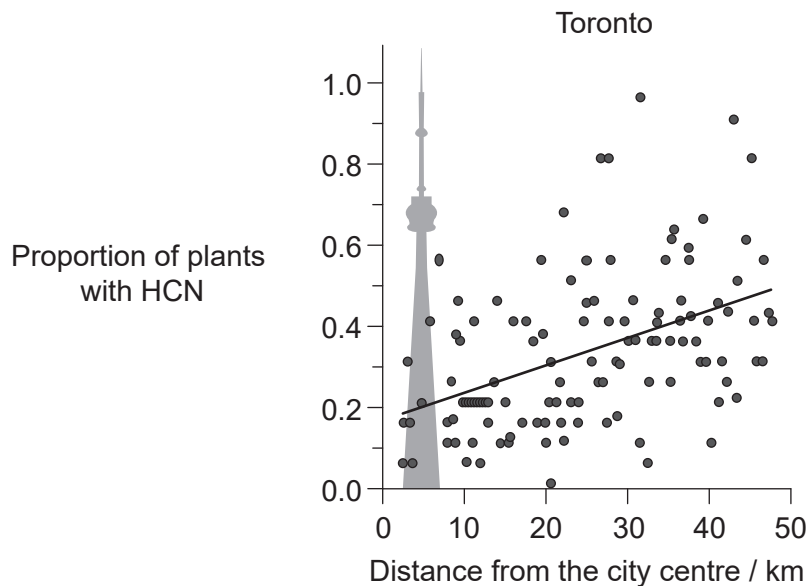
Section A

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

- 1. White clover (*Trifolium repens*) is native to Eurasia but is now a common plant found worldwide in lawns, next to roads, in pastures and similar habitats.



Some *T. repens* plants are able to produce the toxin hydrogen cyanide (HCN) by cyanogenesis. A study at 128 sites (2509 plants) in Toronto (Canada) looked at the proportion of *T. repens* plants producing HCN. The sites were at regular intervals from the city centre towards rural areas.



- (a) (i) State the distance from the city centre at which the highest proportion of plants sampled contained HCN.

[1]

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(Question 1 continued)

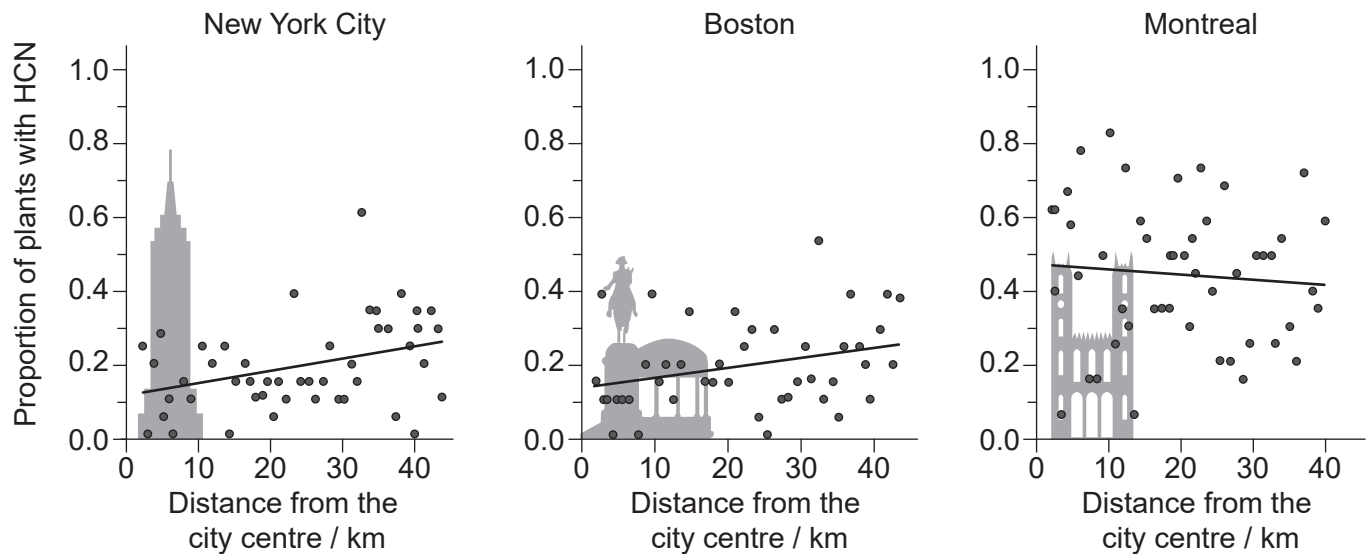
(ii) Outline the relationship shown in the graph.

[1]

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To determine whether similar patterns in cyanogenesis were seen in other cities, studies were also carried out around New York City and Boston (USA) and Montreal (Canada).



(b) Deduce whether the pattern of cyanogenesis was the same in all of the areas around all four cities.

[2]

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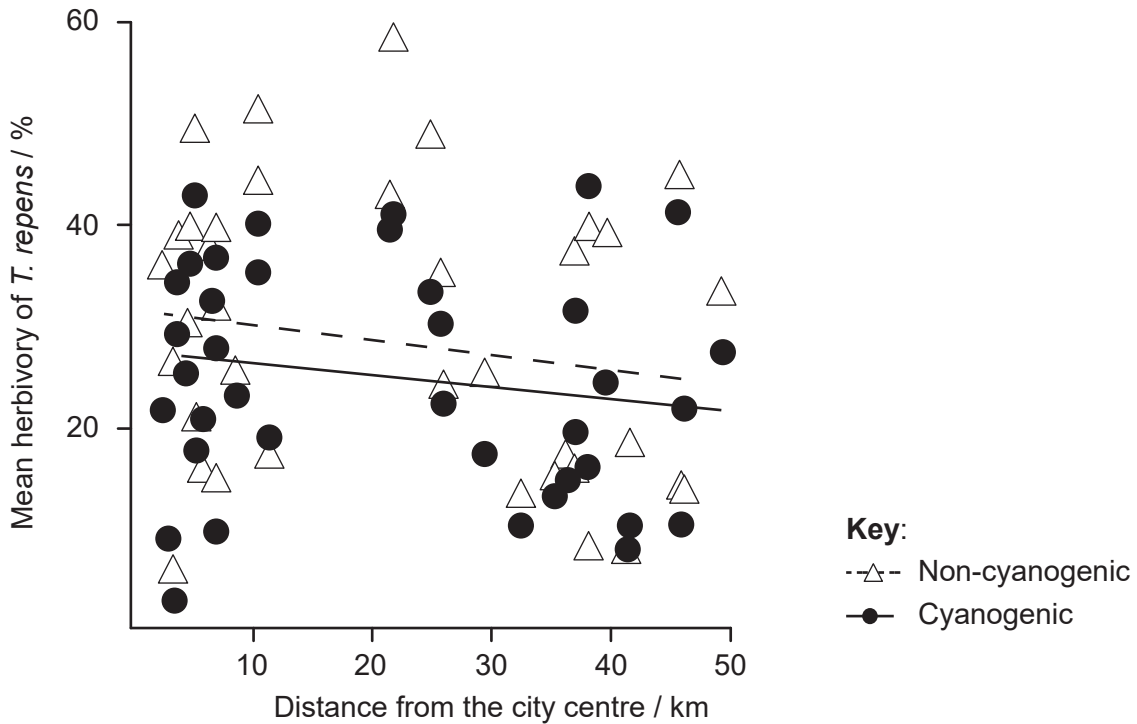
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(Question 1 continued)

The researchers considered two possible ecological causes for the observed gradients in cyanogenesis. First, the researchers assessed the extent of herbivory of *T. repens* plants in Toronto by measuring the percentage of leaf area that was eaten. The graph shows the results for both cyanogenic and non-cyanogenic plants.



(c) Discuss whether the data supports the hypothesis that the gradient in cyanogenesis is due to its benefits against herbivory in rural areas.

[2]

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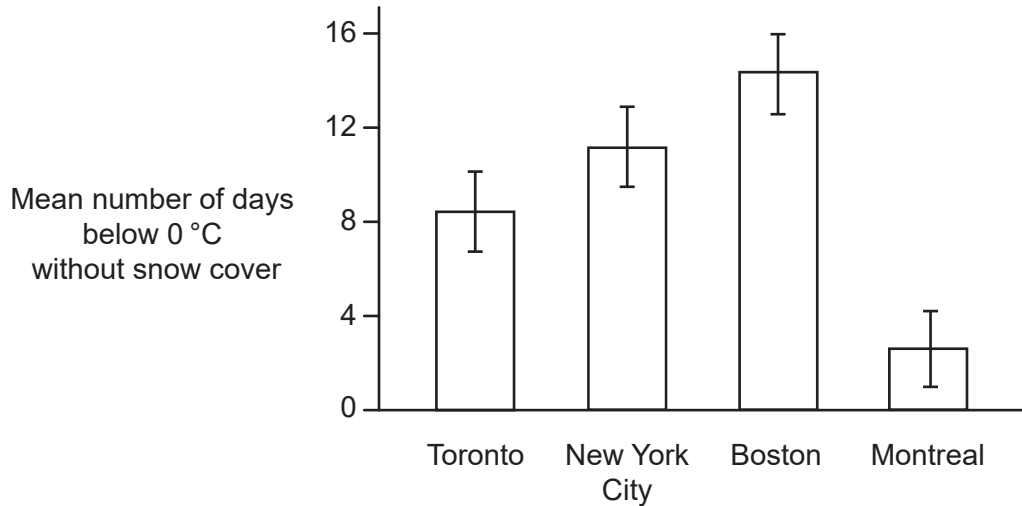
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(Question 1 continued)

The researchers then investigated a possible correlation between cyanogenesis and exposure to freezing conditions. It had been proposed that when a cyanogenic plant freezes, its cells burst, releasing HCN which is toxic to the plant. Snow can insulate the ground and plants from freezing temperatures. However, snow is more likely to melt in cities, which then exposes plants to freezing temperatures.

All four of the cities studied receive below freezing temperatures and winter snowfall. Researchers looked at the number of days below freezing (0°C) that did not have snow cover in these cities.



- (d) (i) Identify with a reason the city where the plants were more insulated from freezing temperatures.

[1]

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(This question continues on the following page)



(Question 1 continued)

- (ii) Using all of the data so far, suggest whether exposure to freezing temperatures in the four cities is supported as a reason for the differences in HCN production in *T. repens*.

[2]

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(Question 1 continued)

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(e) (i)

(This question continues on the following page)



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(Question 1 continued)

(i)

(ii)

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2. (a) (i) Outline how the amphipathic properties of phospholipids play a role in membrane structure.

[2]

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(ii) State the role of cholesterol in animal cell membranes.

[1]

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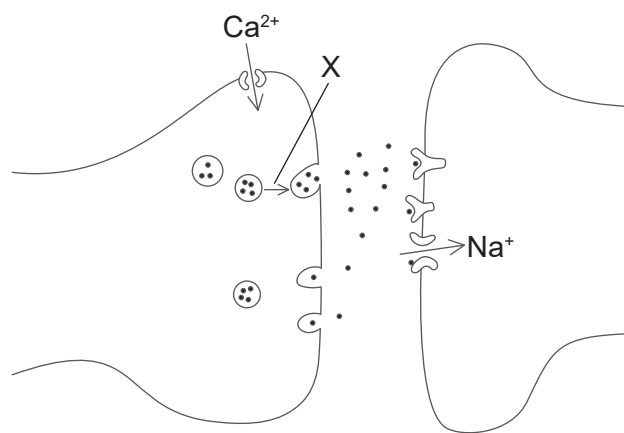


(Question 2 continued)

(b) Describe what happens to the membranes of an animal cell during mitosis. [2]

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(c) The diagram shows part of two neurons.



(i) State the name of the structure shown. [1]

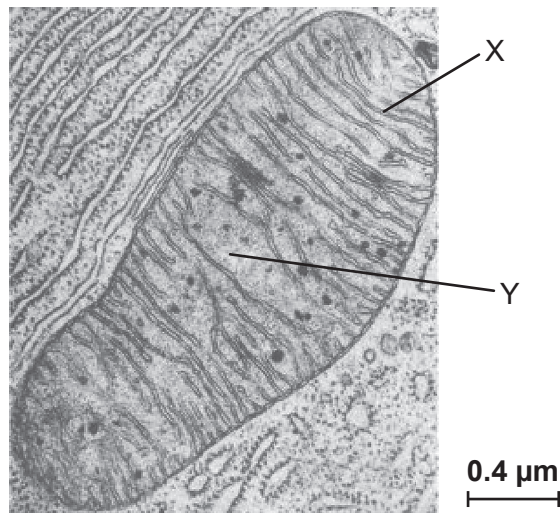
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(ii) X indicates the movement of a structure in the neuron. Explain what events trigger this movement and what happens next. [3]

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3. The electron micrograph shows part of a cell including a mitochondrion.



[Source: Used 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) Outline how the structures labelled X and Y are adapted to carry out the function of the mitochondrion.

[2]

X:
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Y:
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(b) Explain how ATP is generated in mitochondria by chemiosmosis.

[4]

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4. (a) Distinguish between the transfers of energy and inorganic nutrients in ecosystems. [2]

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(b) Outline the role of methanogenic archaeans in the movement of carbon in ecosystems. [2]

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(c) Describe how autotrophs absorb light energy. [3]

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5. Dachshunds have three basic coat types: wire-, smooth- or long-haired. These are affected by two genes, W and K. The presence of W always results in wire hair.



When long-haired dogs are crossed among themselves, they always produce long-haired puppies. When dogs heterozygous for both genes are crossed, they produce offspring in the ratio 12 wire-haired:3 smooth-haired:1 long-haired.

A male wire-haired dog was crossed with several long-haired females and the phenotypic ratio of the puppies was approximately 2 wire-haired:1 smooth-haired:1 long-haired.

- (a) Identify the genotype of the male wire-haired dog. [1]

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- (b) Using a Punnett square, determine how a smooth-haired puppy could be produced in the offspring. [2]

[Empty box for Punnett square]



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.

6. Proteins are an important group of chemicals found in all living organisms.
- (a) Draw a molecular diagram to show the formation of a peptide bond. [3]
 - (b) Outline how proteins are digested and the products of protein digestion absorbed in humans. [4]
 - (c) Explain how polypeptides are produced by the process of translation. [8]
7. Water is the medium of life.
- (a) Outline how hydrogen bonds form in water. [3]
 - (b) Describe the processes that cause water to move from the roots of plants to their leaves. [4]
 - (c) Explain the role of the kidney in osmoregulation. [8]
8. More than 8 million different species are alive today but over the course of evolution, more than 4 billion may have existed.
- (a) Outline the criteria that should be used to assess whether a group of organisms is a species. [3]
 - (b) Describe the changes that occur in gene pools during speciation. [5]
 - (c) Discuss the process, including potential risks and benefits, of using bacteria to genetically modify plant crop species. [7]



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References:

1. [white clover] © International Baccalaureate Organization 2020.

[4 graphs, proportion of plants with HCN in Toronto (p2), proportion of plants with HCN in New York City, Boston and Montreal (p3), extent of herbivory of *T. repens* (p4), mean number of days below freezing without snow cover (p5)] Adapted from Thompson, K.A., Renaudin, M. and Johnson, M.T.J., 2016. Urbanization drives the evolution of parallel clines in plant populations. *Proceedings of the Royal Society B*, [e-journal] 283. <https://doi.org/10.1098/rspb.2016.2180>.
- 2.(c) [diagram, two neurons] © International Baccalaureate Organization 2020.
3. [electron micrograph] Used 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.
5. [three basic coat types] American Kennel Club, 2007. Available at: <https://www.slideshare.net/ghinck/dachshund-power-point>



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