Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Standard level
Paper 2

23 October 2024

Zone A morning | **Zone B** morning | **Zone C** morning

Candidate session number

1 hour 15 minutes

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 one question.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.

8824 – 6011

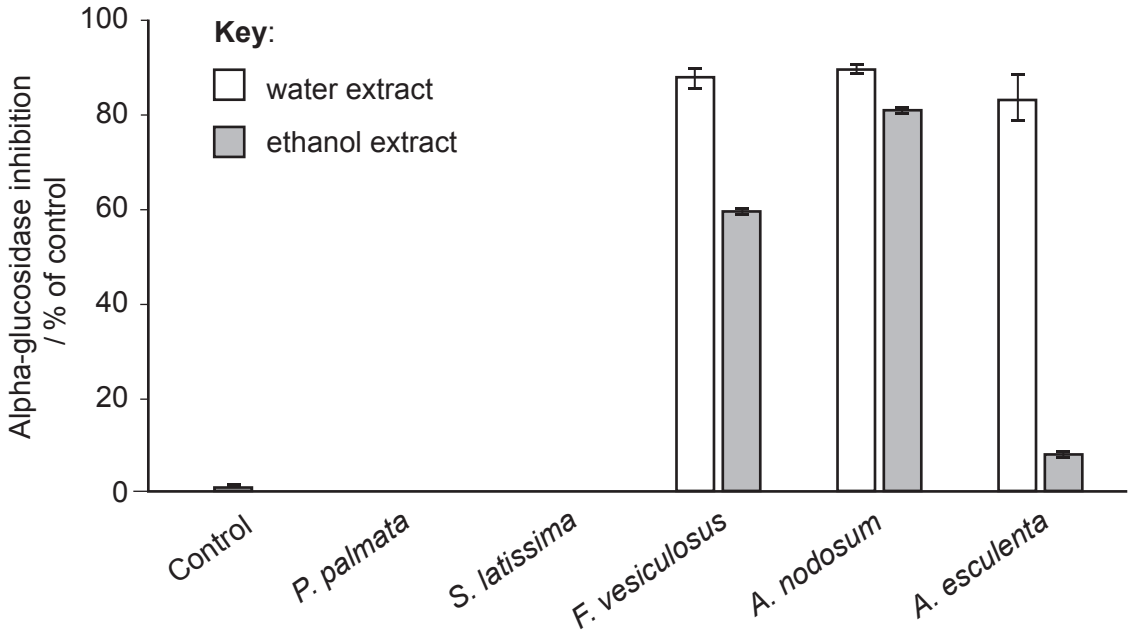
20 pages

Section A

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

1. Type II diabetes, a widespread and challenging health problem, is due to insulin resistance, which results in raised blood glucose. Alpha-glucosidase enzymes catalyse the hydrolysis of carbohydrates. Inhibition of the enzymes slows the absorption of glucose in the intestine and thus slows the rise in blood glucose. A study examined the inhibitory effect of five species of seaweed (*Palmaria palmata*, *Saccharina latissima*, *Fucus vesiculosus*, *Ascophyllum nodosum* and *Alaria esculenta*) on alpha-glucosidase. Dried seaweed extracts made with water or ethanol were added to maltose. The solutions were incubated, then analysed for glucose content.

The graph shows percent inhibition of alpha-glucosidase with different seaweed extracts compared with uninhibited enzyme activity (control).



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(Question 1 continued)

(a) Suggest the control for the experiment. [1]

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(b) Identify which seaweed extracts do not inhibit alpha-glucosidase. [1]

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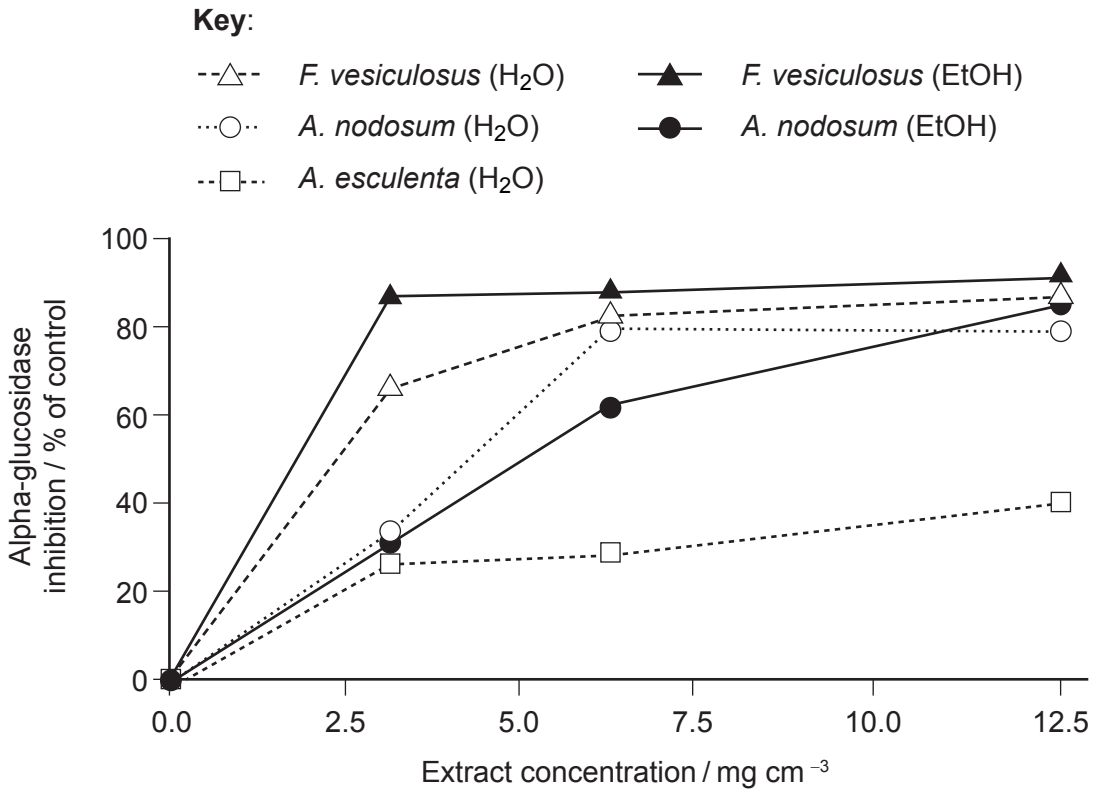
(Question 1 continued)

The effect of different concentrations of extracts was tested using both water (H_2O) and ethanol (EtOH).



(c) Suggest why only the water extract of *A. esculenta* was tested. [1]

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(d) Analyse the effect of increasing concentrations of seaweed extracts. [2]

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(Question 1 continued)

Lifestyle factors and diet can trigger the onset of insulin resistance. A study investigated the preventative effects of adding equal masses of three of the seaweed species to the diet of 50 genetically obese and diabetic mice. A control diet consisted of an equal total mass of food without seaweed. The mice were the same age and of similar body mass at the beginning of the experiment (week 1). The table shows the mean body mass of the groups over the course of the 11-week investigation.

Week	**Mean body mass / g**			
	A. esculenta	*S. latissima*	*P. palmata*	Control
1	33.8	33.6	33.4	33.7
3	36.5	33.6	36.2	37.5
5	38.9	33.6	37.2	39.8
7	39.3	34.3	37.9	40.5
11	39.3	35.8	40.5	41.5

(e) Calculate the greatest increase in mean body mass over 11 weeks. [1]

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(f) Distinguish between the results for *S. latissima and P. palmata*. [2]

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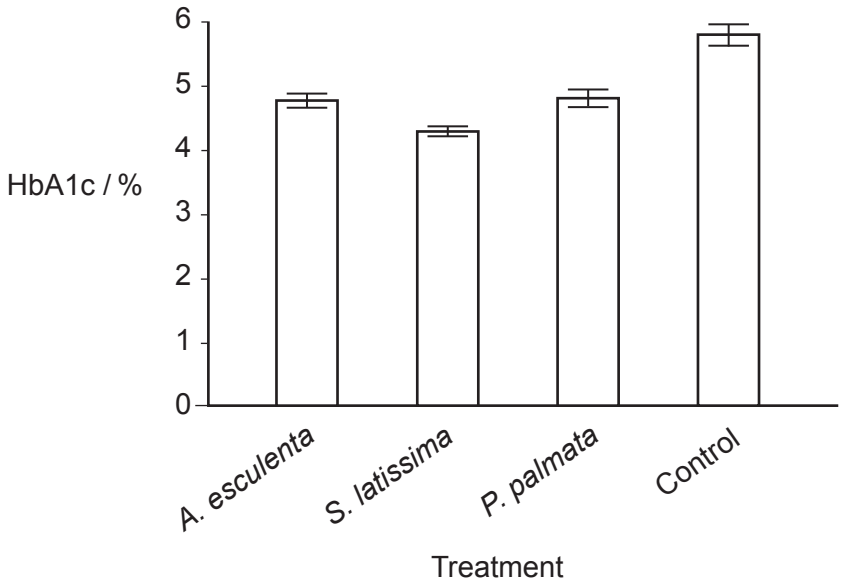
(Question 1 continued)

Glycated hemoglobin (HbA1c) is formed when glucose in blood plasma binds spontaneously to hemoglobin. A high percentage of HbA1c indicates that glucose levels in the blood have been raised for much of the time.

At the beginning of the investigation, after 8 hours without food, blood was taken from all the mice and tested for HbA1c levels. The levels were similar for all mice. The graph shows the levels of HbA1c after 10 weeks of treatment with the seaweed extracts.



(g) Compare and contrast the HbA1c results of all seaweed and control treatments. [2]

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(Question 1 continued)

(h) Using all the data, evaluate the evidence for health benefits of adding dried *S. latissima* to the diet. [3]

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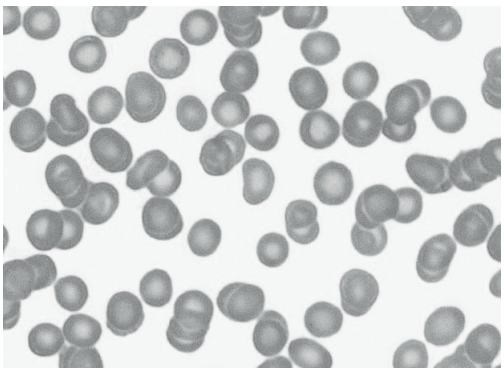
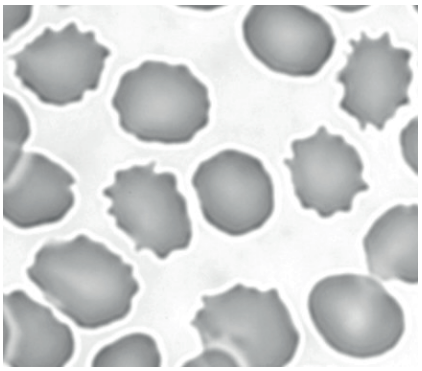
Answers written on this page
will not be marked.

2. The micrographs show red blood cells which were placed in salt solutions of different concentrations.



A



B

(a) Deduce with a reason the change in salt concentration from A to B that would result in the red blood cells shown in the micrographs. [2]

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(b) Suggest a reason that no cells can be seen when blood samples are placed in distilled water. [1]

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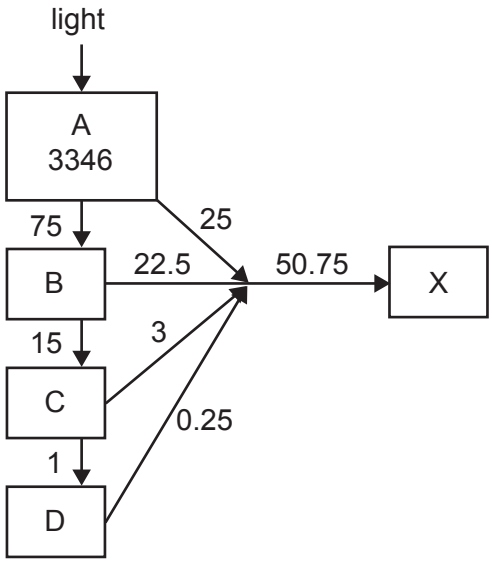
3. An example of energy flow (kJ m^{-2} $year^{-1}$) in the North Sea is shown.



(a) Identify the trophic level represented by C. [1]

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(b) Sketch a pyramid of energy for the trophic levels represented by A, B, C and D. [2]

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(Question 3 continued)

(c) State **two** sources of energy for X. [1]

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(d) Explain the reasons that little energy is transferred between trophic levels, apart from that transferred to X. [2]

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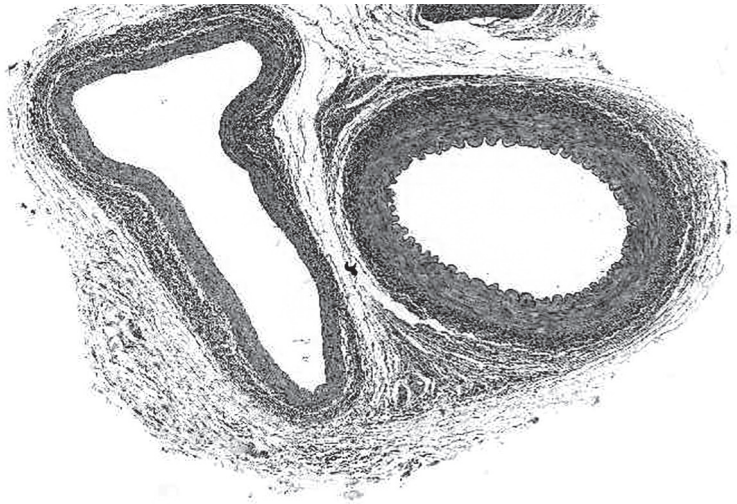
4. The micrograph shows tissue with two major blood vessels.



(a) Label an artery on the diagram. [1]

(b) Distinguish between the structure of arteries and veins. [2]

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(c) Suggest a reason that capillaries are not visible in the micrograph. [1]

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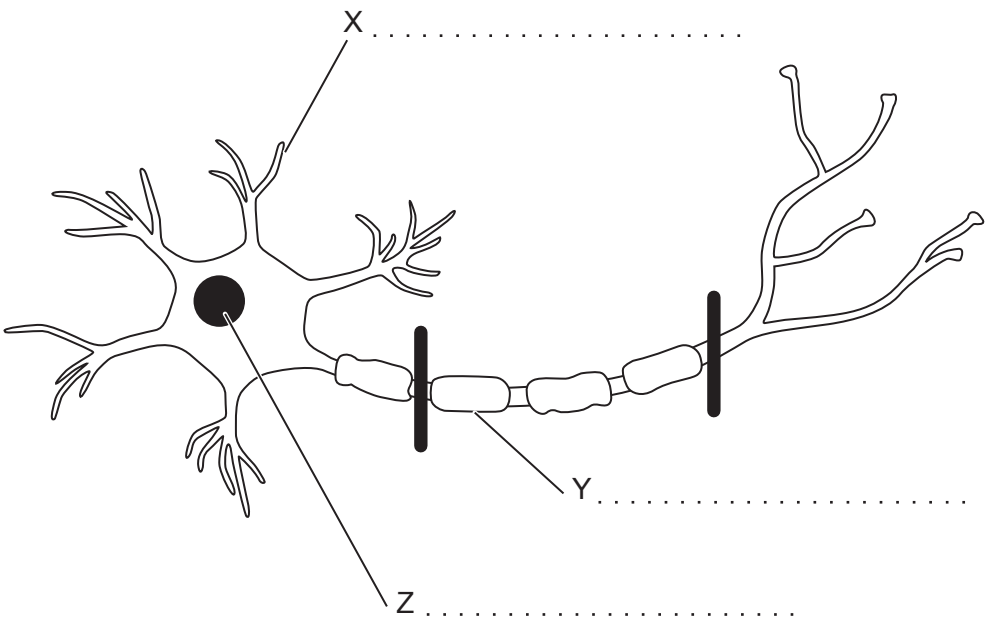
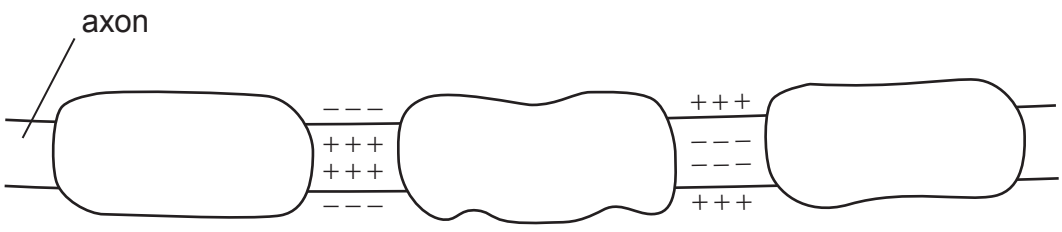
5. (a) Label the structures X, Y and Z on the diagram of a motor neuron. [3]



The section of the axon between the solid black lines in the motor neuron diagram is enlarged and shown.



(b) On the diagram, label the part of the axon representing resting potential with R and the depolarized part with D. [2]

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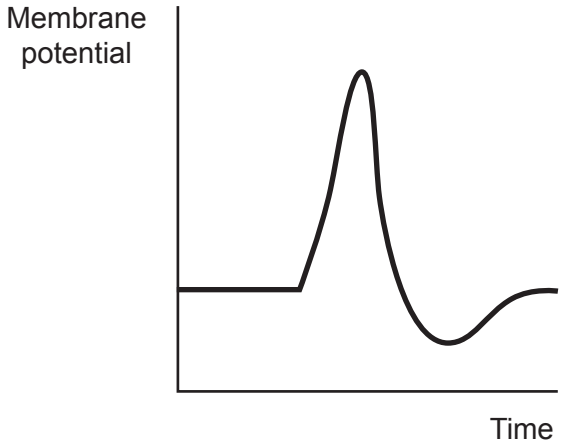
(Question 5 continued)

The oscilloscope trace of a stimulated axon is shown.



(c) Annotate the oscilloscope trace to show depolarization. [1]

(d) Outline the process of saltatory conduction. [2]

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Section B

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

6. Inheritance of one sickle cell allele is known as sickle cell trait, while inheritance of two causes sickle cell anemia.

(a) Outline how a base substitution leads to sickle cell anemia. [4]

(b) Construct a Punnett grid to show how two parents with no symptoms can have a child with sickle cell anemia. [4]

(c) Sickle cell **trait** offers some protection against malaria, which is carried by mosquitoes. Explain how sickle cell trait evolved in countries such as Kenya, where mosquitoes are common, even though sickle cell anemia can be lethal. [7]

7. Water is the most abundant compound on Earth and in organisms.

(a) Outline properties of water that are important in living organisms. [4]

(b) Describe the modes of transport of water-soluble molecules and ions across cell membranes. [4]

(c) Rising levels of carbon dioxide pose threats to marine life. Explain the causes of increased carbon dioxide and its effects in oceans. [7]

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References:

1.a and c Calderwood, D., Rafferty, E., Fitzgerald, C., Stoilova, V., Wylie, A. and Gilmore, B., 2021. *Applied Phycology* 2(1), pp. 10–21. Reference redacted. Source adapted.

1.e and g Sørensen, L.E., Jeppesen, P.B., Christiansen, C.B., Hermansen, K. and Gregersen, S., 2019. *Nutrients* 11(6): 1435. https://www.doi.org/10.3390/nu11061435. Reference redacted. Source adapted.

2. Image A xia yuan, n.d. *Red Blood Cells,40x light micrograph*. [image online] Available at: https://www.gettyimages.ca/detail/photo/red-blood-cells-40x-light-micrograph-royalty-free-image/1168912095?adppopup=true [Accessed 1 October 2023]. Source adapted.

2. Image B Guy Waterval, 2016. https://commons.wikimedia.org/wiki/File:Echinocytes-11.JPG. Licensed under the Apache License, Version 2.0: https://www.apache.org/licenses/LICENSE-2.0. Source adapted.

4. Spitalnik, P., n.d. *Epithelium: Simple Squamous Epithelium*. [image online] Available at: http://www.columbia.edu/itc/hs/medical/sbpm_histology_old/lab/lab02_squamous.html [Accessed 29 November 2019].