Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Standard level
Paper 2

14 May 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]**.

2224 – 6011

23 pages

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Answers written on this page
will not be marked.

Section A

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

1. Fish play a key role in the functioning of temperate shallow lakes. They affect nutrient cycles and interactions between trophic levels. Studies were done to compare fish community structure and dynamics between shallow lakes in Denmark (temperate) and in Uruguay (subtropical).

The following organisms were found in one of these lakes:

- macrophytes – large aquatic plants
- zooplankton – microscopic animals
- piscivorous fish (eat other fish)
- algae – aquatic plants
- omnivorous fish (eat plants and animals)
- planktivorous fish (eat plankton)
- phytoplankton – microscopic plants
- herbivorous fish (eat plants)

(a) (i) Draw a food chain of four trophic levels for the lake. [2]

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(ii) Suggest **one** way that fish can increase the nutrient content in shallow lakes. [1]

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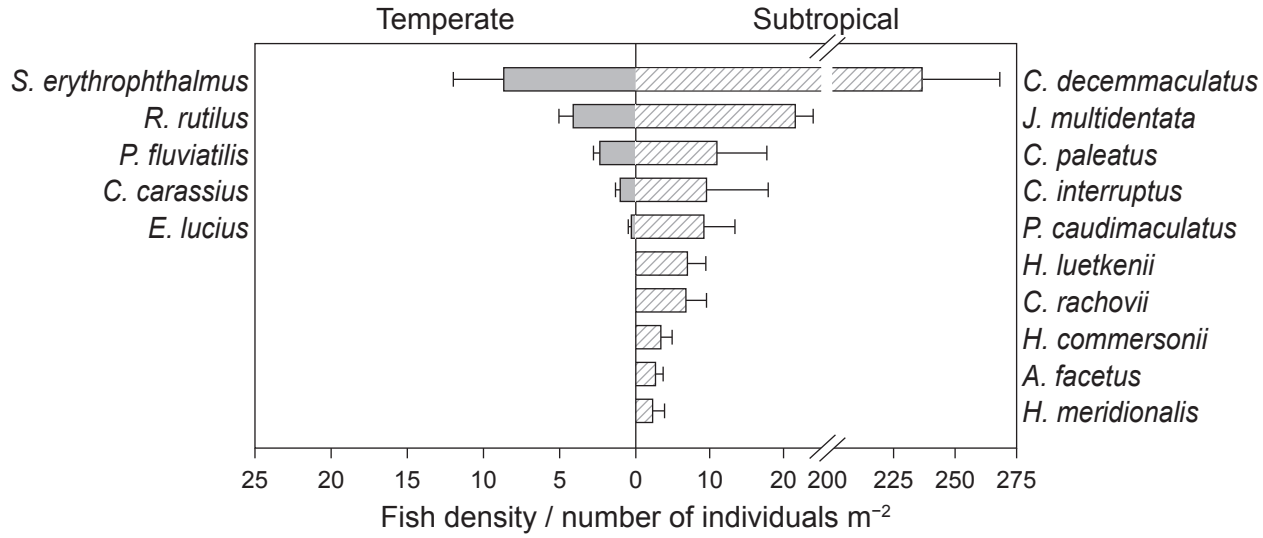
(Question 1 continued)

Investigators counted the number of individuals of different fish species in the temperate and subtropical lakes.



(b) Distinguish between the fish communities in the temperate and subtropical lakes. [2]

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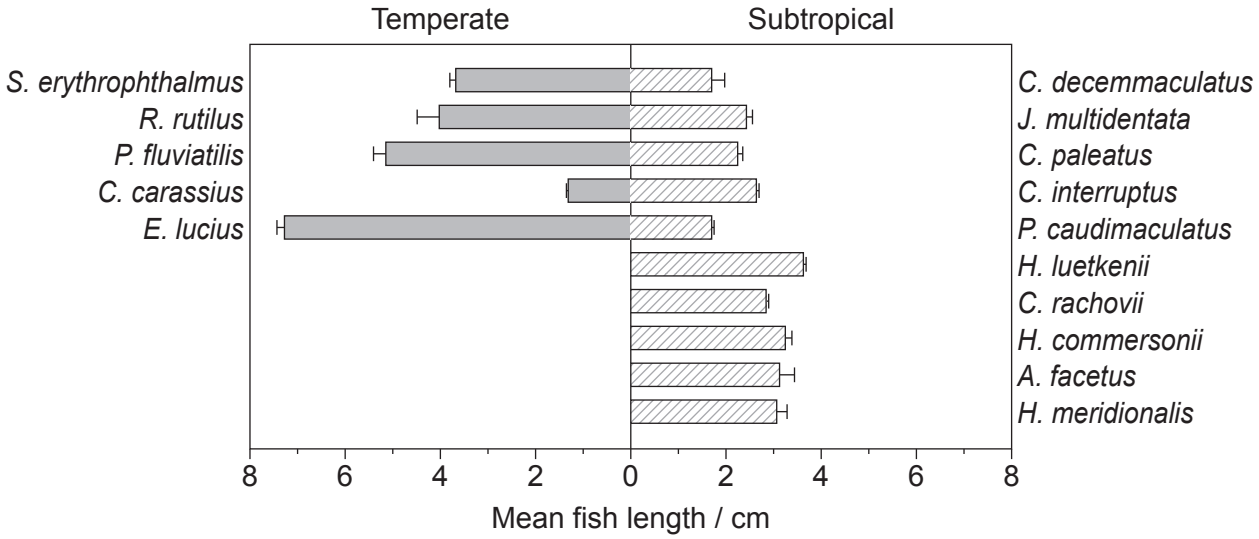
(Question 1 continued)

The scientists measured the length of the fish found in the temperate and subtropical lakes.



(c) (i) Compare and contrast the mean length of the fish found in the two types of lakes. [2]

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(ii) Using the data from both graphs, estimate the mean length of the fish with the greatest density in the subtropical lake. [1]

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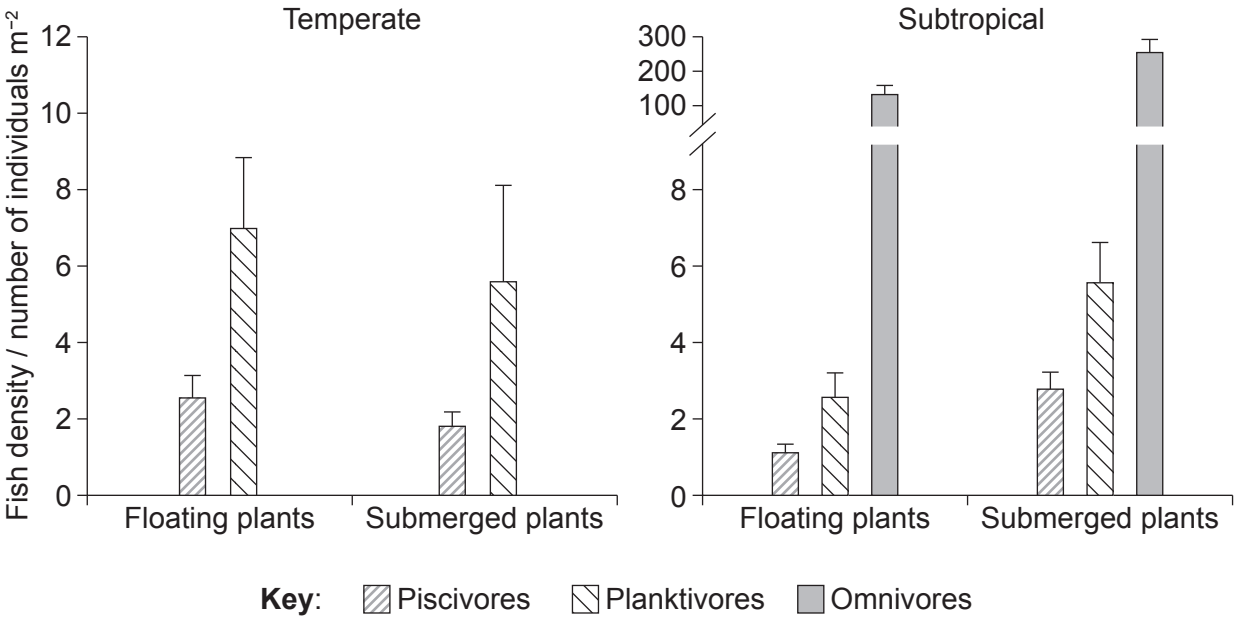
(Question 1 continued)

Daily samples were taken of the numbers of fish found among floating plants and submerged plants in both types of lakes in order to study their preferred habitats.



(d) (i) Identify the habitat in which the greatest density of omnivores was found. [1]

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Based on the information presented, suggest a reason for each of the following observations:

(ii) Planktivores are found in larger densities than piscivores in both habitats in both types of lakes. [1]

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(iii) Smaller fish are more abundant among submerged plants than among floating plants. [1]

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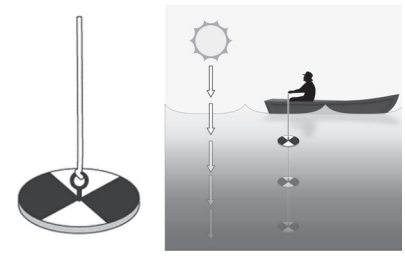
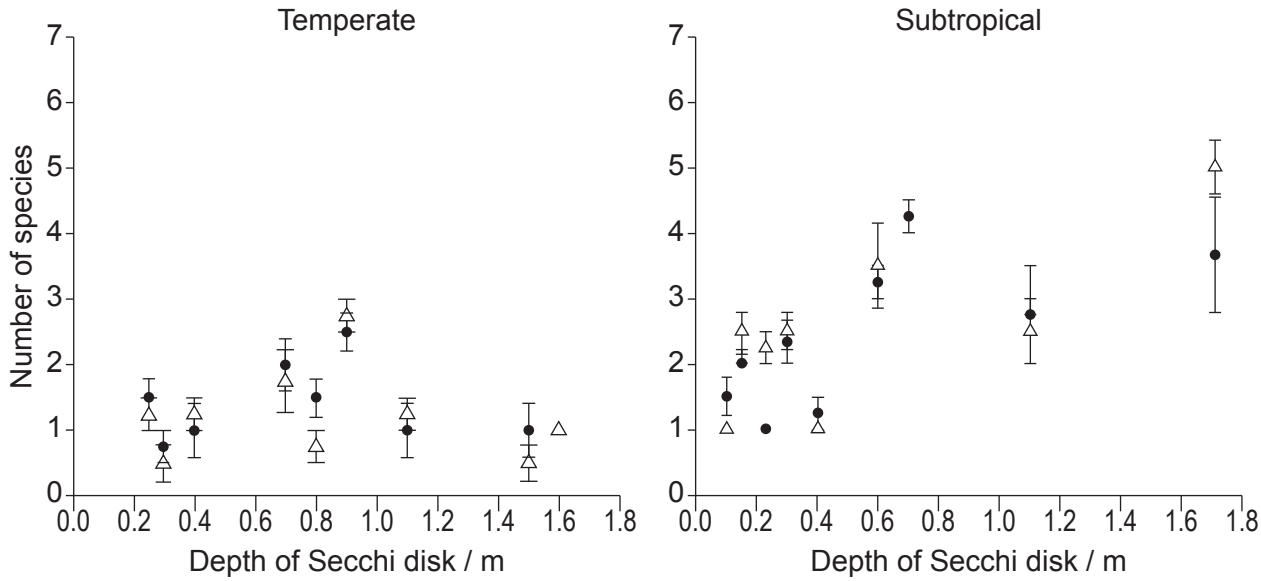
(Question 1 continued)

Water transparency was measured with a Secchi disk by lowering it in water and measuring the depth at which it is no longer seen. A greater depth recorded in meters indicates greater transparency of water.



The data on the depth of the Secchi disk was then correlated with the number of fish species found among plants in the two types of lakes.



Key: ● Floating plants △ Submerged plants

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(Question 1 continued)

(e) Discuss the relationship between the number of fish species found among plants and water transparency in each type of lake. [2]

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(f) Based on all the information presented, predict **one** effect that warming due to climate change could have on fish community structure in temperate lake ecosystems. [1]

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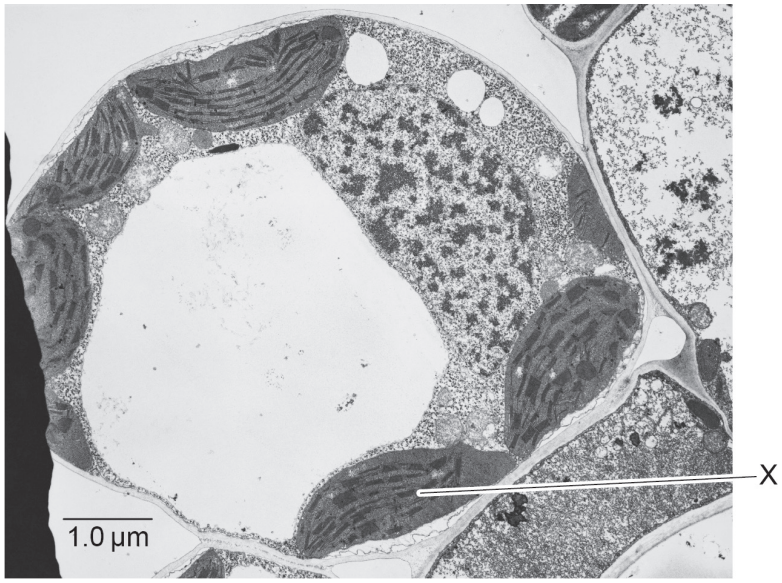
2. The electron micrograph shows structures in a plant cell.



(a) (i) List **two** structures seen in the electron micrograph that identify this as a plant cell. [2]

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(ii) Calculate the actual length of the organelle labelled X. [1]

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(iii) The plant cell in the micrograph performs all functions of life. Explain the reason that this cell needs to carry out excretion. [2]

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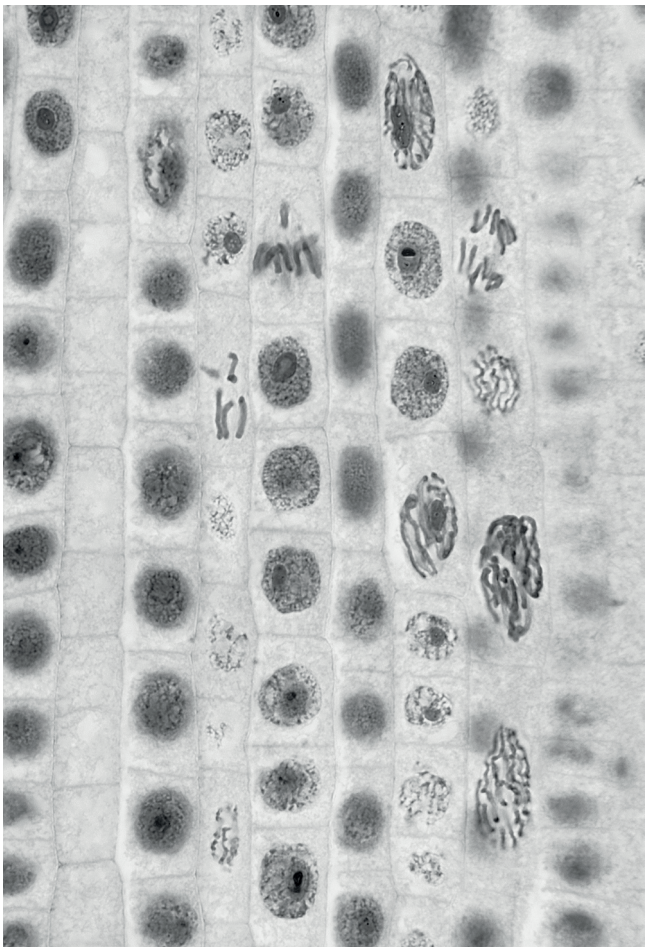
(Question 2 continued)

(b) The micrograph shows onion (*Allium cepa*) root tip cells.



Explain what a high mitotic index could indicate. [2]

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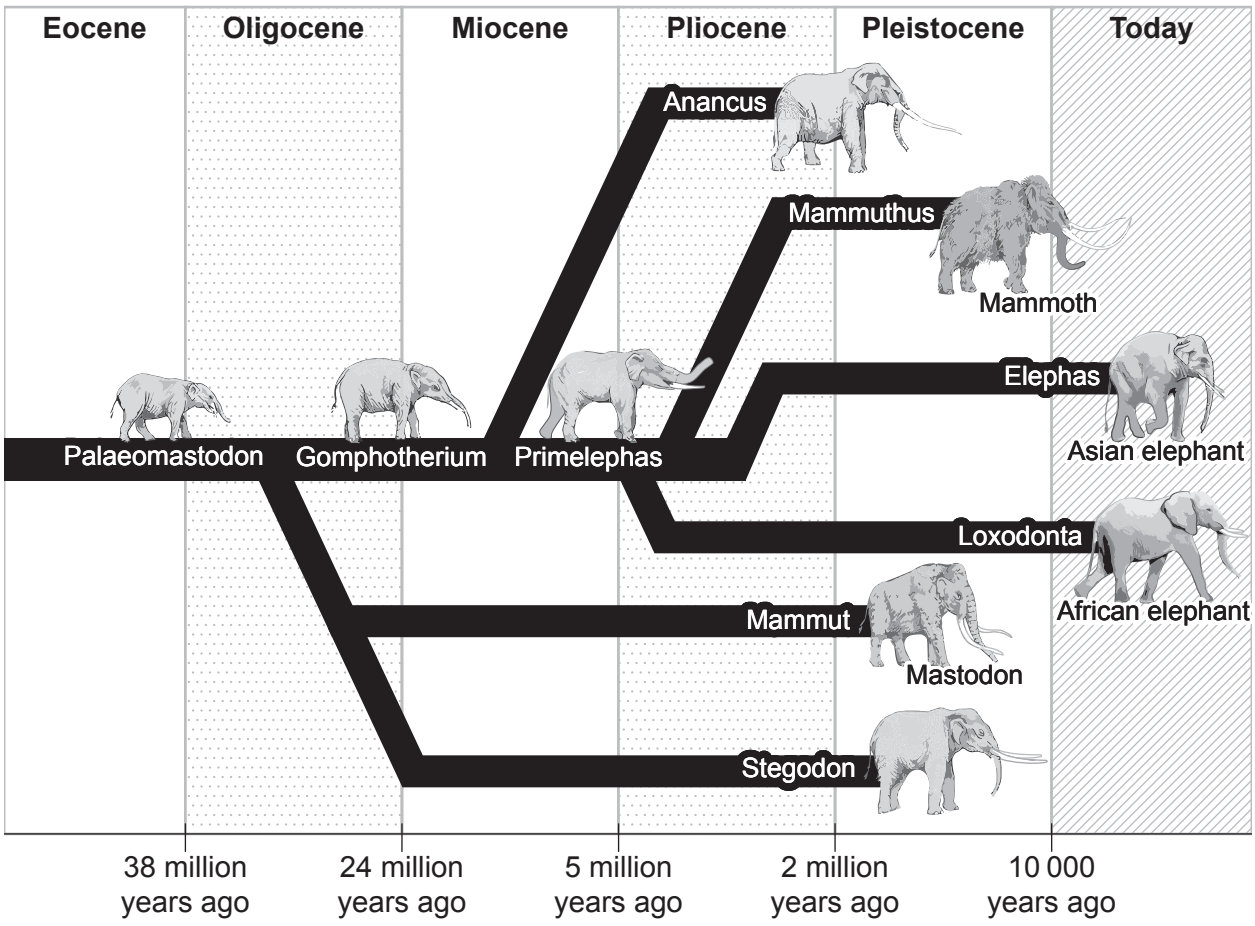
3. Evolution occurs when heritable characteristics of a species change.

(a) Below is an evolutionary chart of elephants.



(i) Identify which species is most closely related to the Asian elephant. [1]

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(ii) State the type of evolution that occurred with the elephants and their ancestors. [1]

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(Question 3 continued)

(b) (i) List **two** features that are present in prokaryote cells that distinguish them from eukaryotes. [2]

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(ii) Explain the evolution of antibiotic resistance in bacteria. [3]

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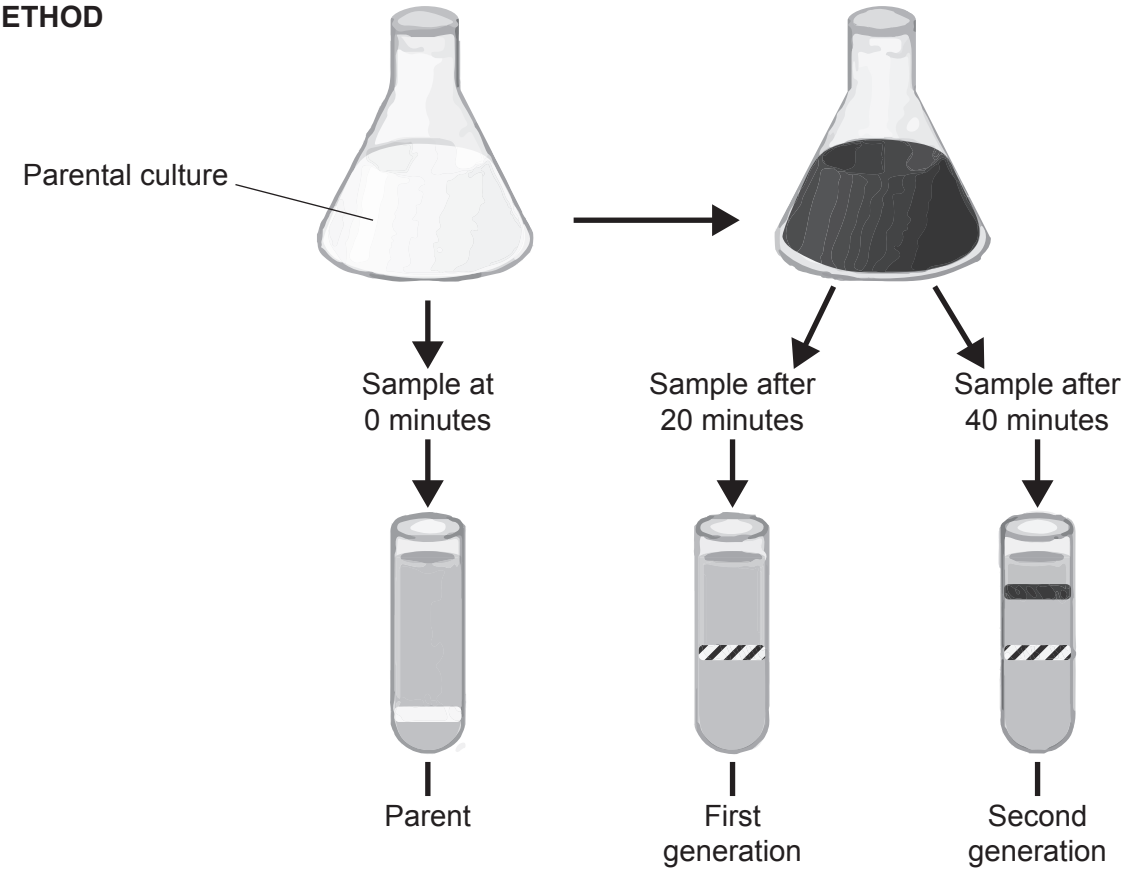
4. (a) Draw a labelled diagram showing the structure of a DNA nucleotide. [3]

(b) Meselson and Stahl grew bacteria in a medium with ^{15}N (heavy nitrogen) so that all bacteria in the parental culture contain heavy DNA. They then transferred some of the bacteria to a medium with ^{14}N (light nitrogen).

Samples were taken at 0, 20 and 40 minutes and centrifuged with the results as shown.

METHOD



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(Question 4 continued)

(i) Explain the results of the first and second generation. [2]

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(ii) State the conclusion Meselson and Stahl drew from their experiment. [1]

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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.

5. Living organisms depend on energy in order to carry out their essential functions.

(a) Triglycerides are used as energy stores by living organisms. Describe their structure and properties. [4]

(b) Outline the flow of energy through an ecosystem. [4]

(c) In order for humans to obtain energy from their food, they must digest and absorb molecules that can release energy. Explain the processes that occur in the digestive system from the time triglycerides are ingested until they are absorbed. [7]

6. Genetic information controls the production of all proteins needed by the body to carry out its functions, including proteins acting as enzymes and hormones as well as proteins for structures and transport.

(a) Outline protein structure. [4]

(b) Describe the role of **two named** hormones in the regulation of blood sugar levels. [4]

(c) Explain the stages and processes of meiosis leading to genetic variation. [7]

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References:

1. (a)–(d) Teixeira-de Mello, F., Meerhoff, M., Pekcan-Hekim, Z. and Jeppesen, E., 2009. *Freshwater Biology* 54, 1202–1215 [e-journal]. https://doi.org/10.1111/j.1365-2427.2009.02167.x. Source adapted.

1. (e) Left diagram: [*Secchi disk*], 2015. [image online] Available at: https://link.springer.com/referenceworkentry/10.1007/978-94-017-8801-4_123 [Accessed 5 June 2024]. Source adapted.

1. (e) Graph: Teixeira-de Mello, F., Meerhoff, M., Pekcan-Hekim, Z. and Jeppesen, E., 2009. *Freshwater Biology* 54, 1202–1215 [e-journal]. https://doi.org/10.1111/j.1365-2427.2009.02167.x. Source adapted.

2. (a) Biophoto Associates/Science Photo Library. Timothy grass mesophyll cell, TEM, n.d. Available at: https://www.sciencephoto.com/media/1238215/view [Accessed 24 June 2024]. Source adapted.

2. (b) Wim Van Egmond/Science Photo Library. Onion (*Allium*) root tip mitosis Series, n.d. Available at: https://www.sciencephoto.com/media/453843/view [Accessed 24 June 2024]. Source adapted.

3. African elephant: michaklootwijk, n.d. *Female African elephant in golden light*. [image online] Available at: https://www.gettyimages.co.uk/detail/photo/female-african-elephant-in-golden-light-royalty-free-image/1034192370 [Accessed 18 May 2023]. Source adapted.

Asian elephant: Wayne Marinovich, n.d. *Asiatic Elephant walks through the long grass in Kaziranga National Park, India*. [image online] Available at: https://www.gettyimages.co.uk/detail/photo/asiatic-elephant-walks-through-the-long-grass-in-royalty-free-image/1322823772 [Accessed 18 May 2023]. Source adapted.