Biology

Standard level

Paper 1B

1 hour 30 minutes [Paper 1A and 1B]

Instructions to candidates

- Write your session number in the boxes above.
- Do not open the examination paper until instructed to do so.
- Answer all questions.
- Answers must be written in the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for paper 1B is **[25 marks]**.
- The maximum mark for paper 1A and paper 1B is **[55 marks]**.

1. A hypothetical study was conducted on two plant species growing in the same habitat. Scientists measured their growth rates and seed production when grown separately and when grown together. The results are presented in the table below.

Condition	Species A Growth (cm/week)	Species B Growth (cm/week)	Species A Seed Production	Species B Seed Production
Grown separately	2.5	3.0	200	250
Grown together	1.2	1.8	80	120

a) Compare the growth rates and seed production of Species A and Species B when grown separately versus together. [2]

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b) Identify and explain the ecological principle demonstrated by the data in the table. [2]

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(c) i) Explain how an abiotic factor, such as soil pH or water availability, could influence the outcome of competition between Species A and Species B. [1]

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ii) How does interspecific competition affect the realized niche of Species A. [2]

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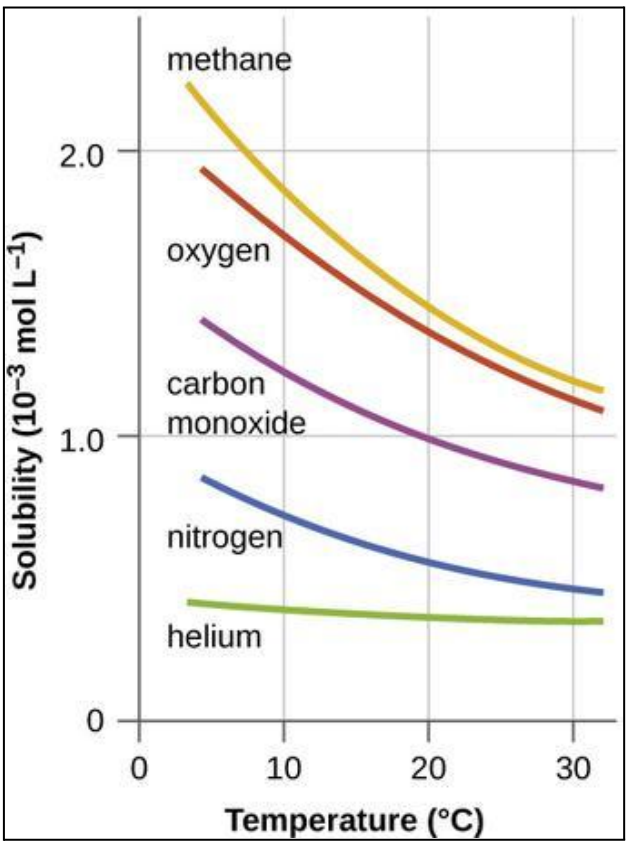
2. The graph below shows the relationship between water temperature and the solubility of oxygen (O_2) and other molecules in water.



a) i) Describe the relationship between water temperature and oxygen solubility shown in the graph. [1]

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ii) Explain why this relationship may pose a challenge to aquatic organisms as global temperatures rise. [2]

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b) The polar nature of water contributes to the solubility of gases like oxygen. Explain how polarity and hydrogen bonding influence this process. [2]

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c) Oxygen solubility differs from that of carbon dioxide (CO_2) in water. Compare the solubility of these two gases and explain the biological significance of this difference for aquatic ecosystems. [2]

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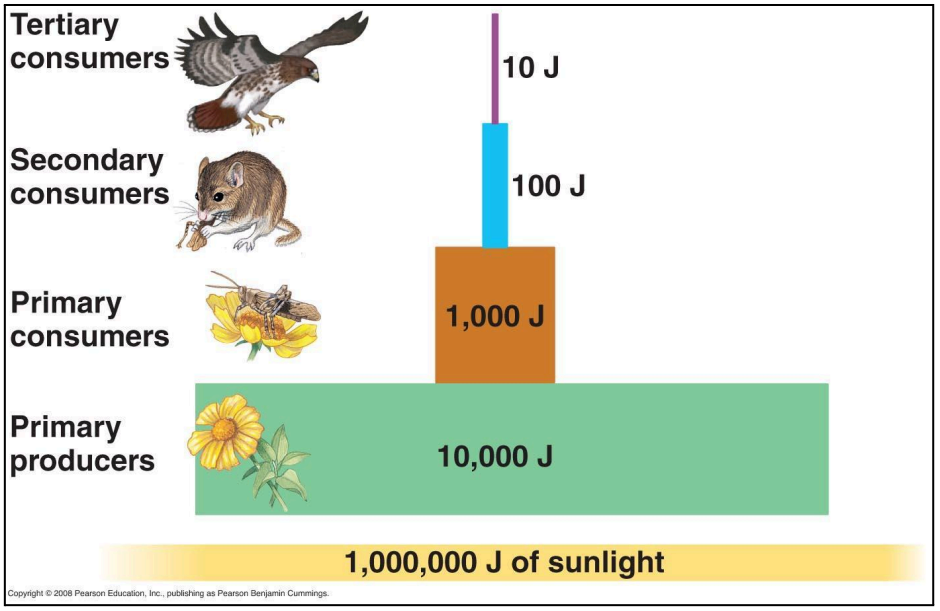
3. Ecosystems function as open systems where both energy and matter enter and exit. While energy flows in one direction and is eventually lost as heat, matter is continuously recycled. The interactions between autotrophs, heterotrophs, and decomposers govern these processes.



(a) Explain two reasons why energy cannot be recycled in ecosystems, whereas matter can. [2]

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(b) Using the energy pyramid provided, calculate the percentage of energy transferred from:

i) Producers to primary consumers. [1]

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ii) Secondary consumers to tertiary consumers. [1]

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c) Explain two roles of decomposers in the cycling of carbon in ecosystems. [2]

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d) Describe how an increase in atmospheric carbon dioxide affects energy transfer in an ecosystem. [2]

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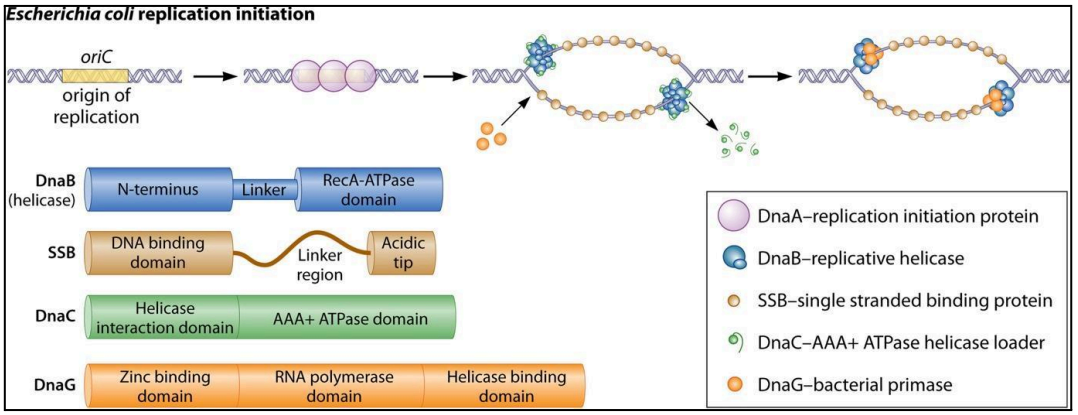
4. DNA replication in *Escherichia coli* begins at the origin of replication (*oriC*), where the initiator protein DnaA binds to initiate unwinding. The process involves key proteins, including DnaB helicase, which separates DNA strands, and DnaG primase, which synthesizes RNA primers.

   The helicase loader DnaC helps load the helicase onto single-stranded DNA, and single-stranded binding proteins (SSB) stabilize the unwound strands. Recent studies show that while the replisome is dynamic, DnaB helicase remains a stable component. The helicase translocates in the 5′-to-3′ direction using ATP hydrolysis and plays a critical role in replication accuracy.

   The image below illustrates the key steps in the initiation of DNA replication in E. coli.



a) Explain how complementary base pairing contributes to the accuracy of DNA replication. [1]

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b) Given the role of DnaB helicase described in the passage, explain how the unwinding of the DNA double helix supports semi-conservative replication. [2]

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