GCE AS Level Biology

S21-B400U10-1

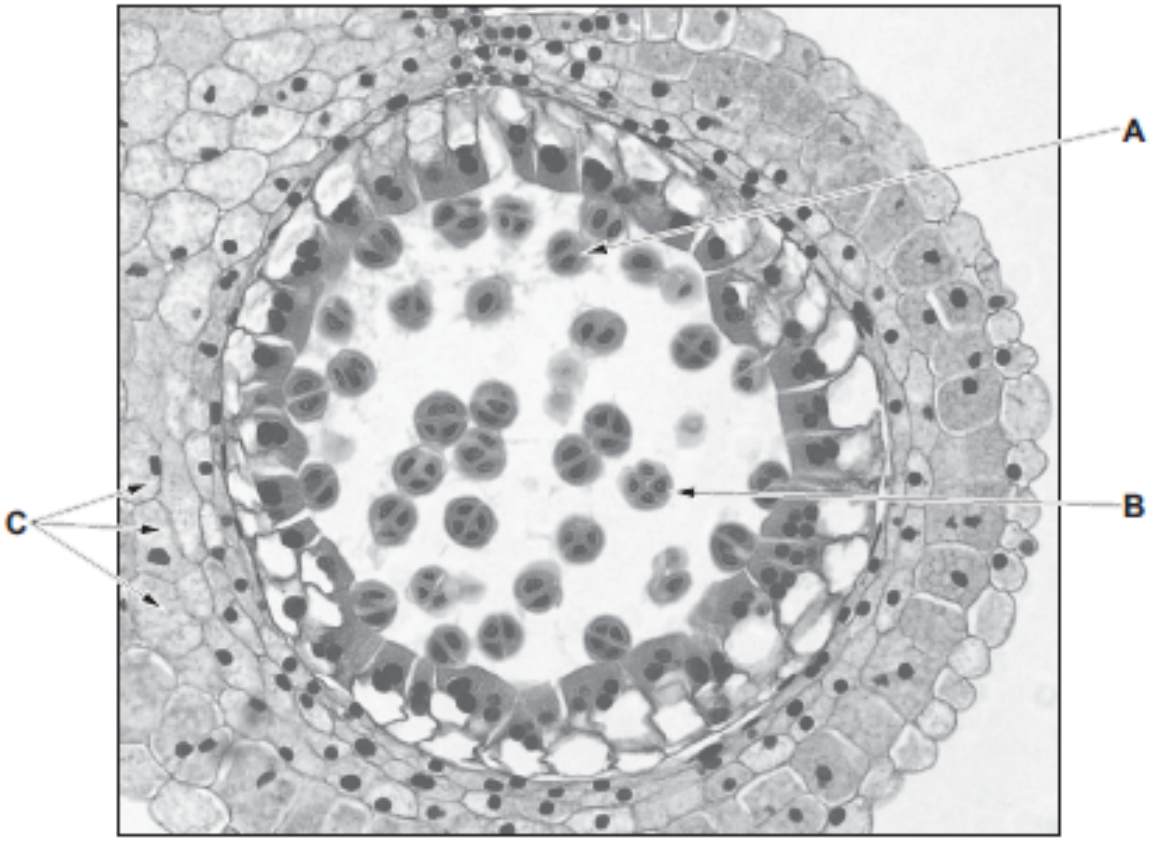
Assessment Resource 1

Basic Biochemistry and Cell Organisation Resource A

1. Mitosis and meiosis are both forms of nuclear division. Both types of nuclear division are involved in the production of gametes.

(a) Image **1** below shows a section through part of an anther of *Lilium sp.* showing stages in the production of pollen grains.

Image 1



(i) It was concluded that structure **A** had just completed meiosis I and structure **B** had just completed meiosis II. Explain how you would draw these conclusions from the photomicrograph. [1]

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(ii) The cells labelled **C** are in interphase. Explain why nuclei are only visible in some cells and, where nuclei are visible, why they appear to be of different sizes. [2]

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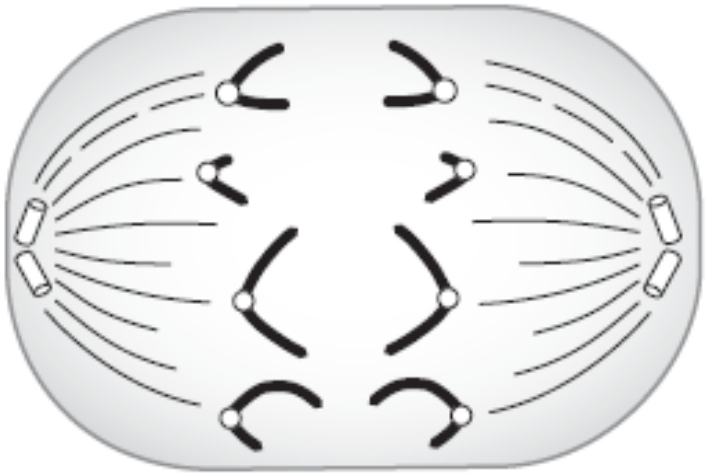
(b) A drawing was made of an animal cell during anaphase. The diploid number in this cell is eight.



Deduce whether this cell is undergoing anaphase of mitosis, anaphase I of meiosis or anaphase II of meiosis. Explain your answer. [3]

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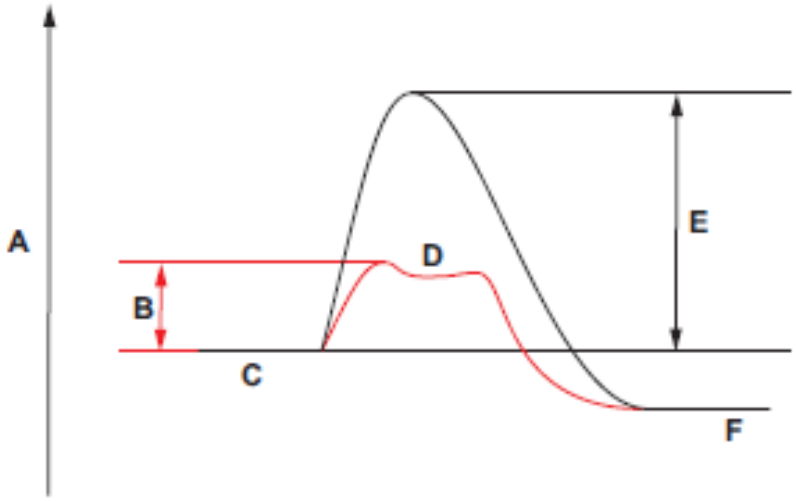
2. Enzymes catalyse reactions by lowering the activation energy of a reaction. This is shown in the graph below.



(a) Using letters from the graph, identify the following: [2]

- the energy level of the products of an enzyme catalysed reaction .....
- the activation energy of an enzyme catalysed reaction .....
- the energy level of an enzyme-substrate complex .....

(b) Adenylate kinase (ADK) is a globular protein that acts as an enzyme involved in the regeneration of ATP in muscle. There are several types of this enzyme. One form catalyses the following reaction:

$$2ADP \longrightarrow AMP + ATP$$

(AMP = adenosine monophosphate)

(i) Suggest why the activity of ADK would be an advantage to muscle. [1]

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(ii) The 'lock and key' model of enzyme action was first proposed in 1894 by Emil Fischer and provides a simple explanation of how enzymes and substrates interact. However, ADK interacts with its substrates by the induced fit mechanism proposed in 1958 by Daniel Koshland.

Explain how the induced fit mechanism differs from the lock and key model. [2]

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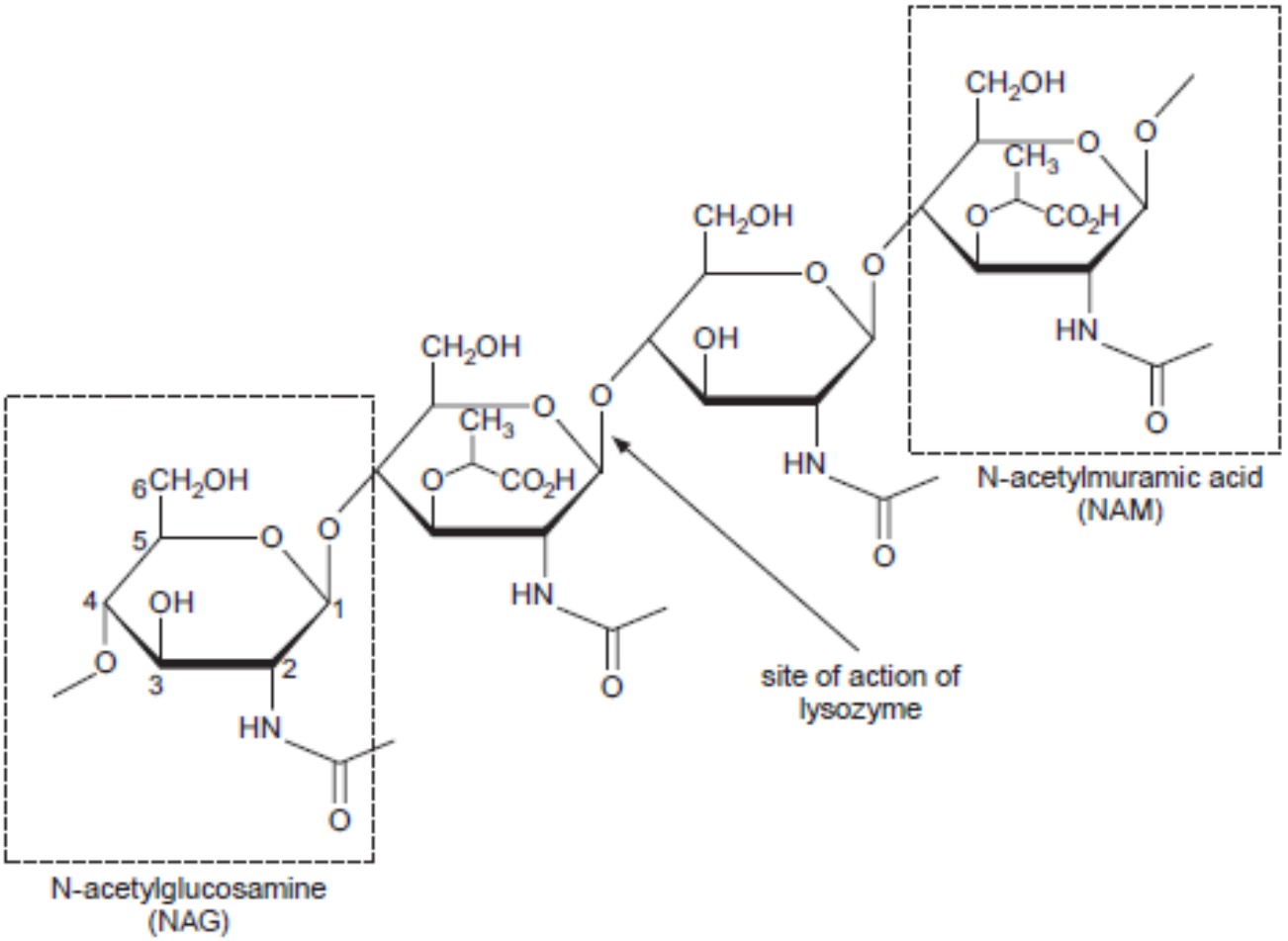
(c) Lysozyme is an enzyme which also forms enzyme-substrate complexes through the induced fit mechanism and can function both intra- and extra-cellularly. It catalyses the hydrolysis of a bond in the peptidoglycan component of the cell walls of some bacteria. This is shown in the diagram below. The carbon atoms have been numbered on one molecule of NAG (N-acetylglucosamine).



(i) State the difference between an intra- and an extra-cellular enzyme. [1]

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(ii) The molecule shown in the diagram is a part of a peptidoglycan molecule. Explain why a peptidoglycan cannot be classified as a true polysaccharide. [1]

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(iii) NAG and NAM can exist as alpha or beta isomers. State what is meant by an isomer. [1]

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(iv) Identify which isomers of NAG and NAM are found in this molecule. Explain your answer. [1]

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(v) In plant cells, cellulose carries out the same function as the peptidoglycan in bacterial cell walls. Peptidoglycan molecules can be cross-linked by the formation of peptide bonds between NAM molecules in adjacent chains.

Describe how the structure of cellulose molecules enables cross-linking and explain why cross-linking of molecules of the polymer shown in the diagram would result in a stronger cell wall. [3]

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3. All organisms need certain elements for healthy growth. Plants obtain most of their essential elements by uptake of mineral ions from the soil. The vascular bundles of plants contain xylem vessels that transport water and minerals from the roots to all other parts of the plant.

The photomicrograph below shows a section through the vascular bundle of a plant.

(a) (i) State if this is a transverse or a longitudinal section. Explain your answer. [2]

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(ii) **Label a xylem vessel on the photomicrograph above** and explain why a group of xylem vessels form a tissue rather than an organ. [2]

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(b) The movement of water through xylem vessels partly relies on the polar nature of water molecules.

(i) Explain why water is a polar molecule. [2]

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(ii) With reference to the polar nature of water molecules, explain how the loss of water from leaves enables water to be transported upwards through xylem vessels. [4]

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(c) The table below shows the concentrations of some ions in the xylem and phloem in a plant grown under laboratory conditions.

Substance	Concentration / mmol dm^{-3}	
	Xylem	Phloem
magnesium	1.1	3.7
nitrate	7.1	0.6
phosphate	0.7	6.6

(i) Describe **one** use made by a plant of the ions listed below: [2]

Magnesium .....

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Nitrate .....

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(ii) Explain how the data supports the following hypotheses regarding **lateral transport** of ions between xylem and phloem.

Hypothesis 1. Nitrate is transported from xylem to phloem by diffusion through plasmodesmata. [2]

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Hypothesis 2. Phosphate is transported from xylem to phloem by active transport and must cross a cell membrane in the process. [3]

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(d) (i) Fick's Law states that the rate of diffusion of a substance is affected by the surface area, the concentration gradient and the distance the substance travels. His law can be used to calculate the time taken for a substance to diffuse using the formula below:

$$\text{time taken to diffuse} = \text{distance}^2 \times \frac{1}{\text{diffusion coefficient}}$$

Use this formula to calculate the distance (in μm) between a xylem vessel and a phloem sieve tube given that: [3]

time taken to diffuse = 5s
diffusion coefficient (at 20°C) = $5 \times 10^4\ \mu m^2\ s^{-1}$

distance = ... μm

(ii) Explain why an increase in temperature will result in a decrease in time taken to diffuse across a cell membrane. [1]

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