Rewarding Learning

Centre Number

71

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2013

Biology

Assessment Unit AS 1

assessing

Molecules and Cells

[AB111]

TUESDAY 11 JUNE, MORNING

MV18

TIME

1 hour 30 minutes, plus your additional time allowance.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Write your answers in the spaces provided in this question paper.
There is an extra lined page at the end of the paper if required.
Answer **all eight** questions.
You are provided with **Photograph 1.5** for use with Question 5 in this paper.
Do not write your answers on this photograph.

INFORMATION FOR CANDIDATES

The total mark for this paper is 75.
Section A carries 60 marks. Section B carries 15 marks.
Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.
You are reminded of the need for good English and clear presentation in your answers.
Use accurate scientific terminology in all answers.
You should spend approximately **20 minutes** on Section B. This may be longer if you have an additional time allowance.
You are expected to answer Section B in continuous prose.
Quality of written communication will be assessed in **Section B**, and awarded a maximum of 2 marks.

Section A

1 Identify the word or phrase which is described by each of the following statements. [5]

- The paired structures from which spindle fibres originate in animal cells

_____

- The precise part of a chromosome to which the spindle fibres attach

_____

- The stage of mitosis during which chromosomes lie across the equator of the spindle

_____

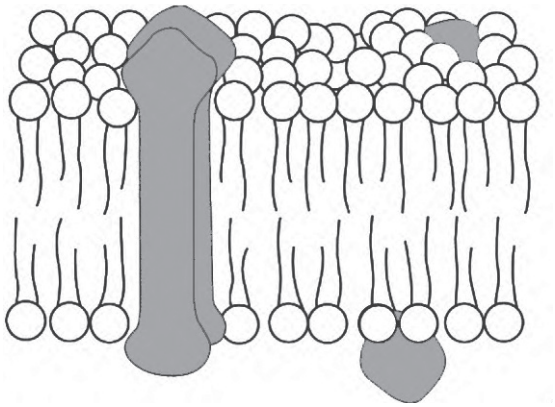
- The stage of mitosis when nuclear membranes form around the two groups of chromosomes

_____

- The precise stage of meiosis in which homologous chromosomes pair up to form bivalents

_____

2 The diagram shows how phospholipids and proteins are arranged in a cell-surface membrane.



(a) Explain why the phospholipids form a bilayer in the cell-surface membrane. [1]

_____

_____

(b) Proteins are scattered throughout the phospholipid bilayer. Some of these proteins act as carriers, enabling the membrane to be selective.

(i) Explain how the structure of proteins allows them to select certain molecules and not others. [1]

_____

_____

(ii) Explain how changes in pH could influence the ability of the proteins to carry certain molecules across the membrane. [2]

(iii) R-groups in amino acids may be hydrophobic or hydrophilic. The positioning of these R-groups helps to anchor the protein carriers in the membrane and also facilitates the passage of ions such as Na^+ or Cl^-. [2]

Suggest how the positioning of these R-groups could

- help to hold the carrier in the phospholipid bilayer

- facilitate the passage of ions such as Na^+ or Cl^-.

3 All organic macromolecules contain the elements carbon, hydrogen and oxygen. Some also contain a variety of other elements.

The following statements give information about the chemical composition and nature of five different macromolecules.

Molecules **A** and **B** contain only the elements carbon, hydrogen and oxygen.

- When hydrolysed, molecule **A** produces monomers that reduce Benedict's reagent.

- When hydrolysed, molecule **B** produces some sub-units that lower the pH of the solution.

Molecules **C**, **D** and **E** all contain other elements in addition to carbon, hydrogen and oxygen.

- When hydrolysed, molecule **C** produces sub-units, all of which contain nitrogen and some also contain sulfur.

Molecules **D** and **E** both contain phosphate.

- When hydrolysed, molecule **D** creates two other types of sub-unit in addition to the phosphate. One type of sub-unit lowers the pH of the solution.

- When hydrolysed, molecule **E** creates four types of sub-unit. Each sub-unit has a nitrogen-containing molecule and a pentose, in addition to the phosphate.

Identify the macromolecules from the information that is given on page 6. [5]

Molecule **A** _____

Molecule **B** _____

Molecule **C** _____

Molecule **D** _____

Molecule **E** _____

4 Pumpkins, melons and cucumbers all belong to a family of plants (the Cucurbitaceae) commonly known as gourds. As they are related species they would be expected to have many sections of their DNA in common. However, as they are different species, they would also be expected to have some unique sections of DNA.

Modern DNA technology allows scientists to extract DNA and to amplify specific relevant sections, such as Microsatellite Repeat Sequences (MRSs), that might show similarities or differences between the species. Following amplification, the relevant sections of DNA of each species can be separated and analysed.

(a) Outline how a scientist might amplify a specific section of DNA (e.g. containing a particular MRS). [3]

(b) Twelve different sections containing MRSs were selected for amplification. Outline how the scientists could separate the selected amplified sections and then mark them to create a DNA fingerprint (profile) for analysis. [3]

(c) Describe how the scientists could now use the fingerprints (profiles) obtained from pumpkins, melons and cucumbers to show that these are related species and also to show that they are actually different species. [2]

Related species: _____

Different species: _____

5 **Photograph 1.5** is an electronmicrograph of a mitochondrion that has just divided, along with some surrounding cell structures.

(a) Identify the structures labelled **A** and **B**. [2]

A _____

B _____

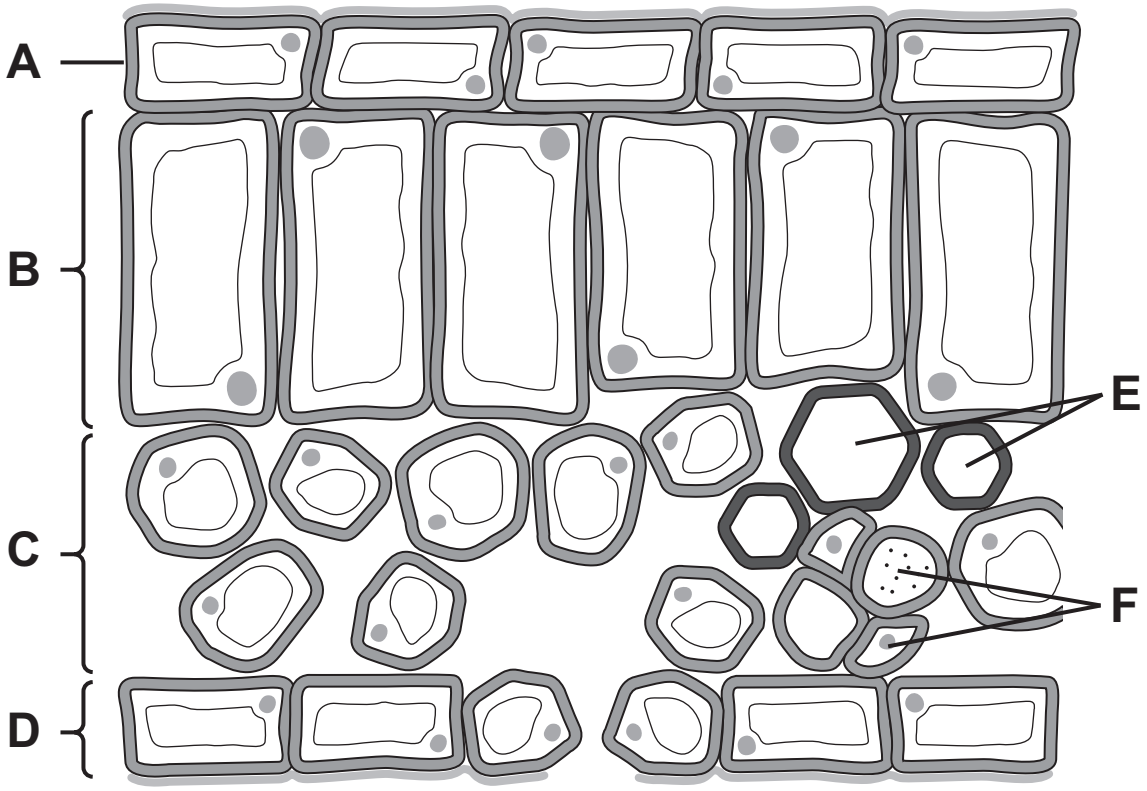
(b) Using the scale bar (on **photograph 1.5**), calculate the magnification of this electronmicrograph. (Show your working.) [3]

Answer _____

(c) Identify the precise stage of the cell cycle during which mitochondria would be most likely to divide. Explain why mitochondria divide at this stage. [2]

(d) State the precise function of mitochondria in the cell. [1]

6 **(a)** The diagram below shows a transverse section through part of a mesophytic leaf. Six tissues are labelled **A–F**.



(i) Using the appropriate letter from the diagram, identify the tissue in which each of the following processes happen. [3]

- maximum absorption of light _____
- diffusion of gases _____
- transport of water _____

(ii) State the role of the cuticle. [1]

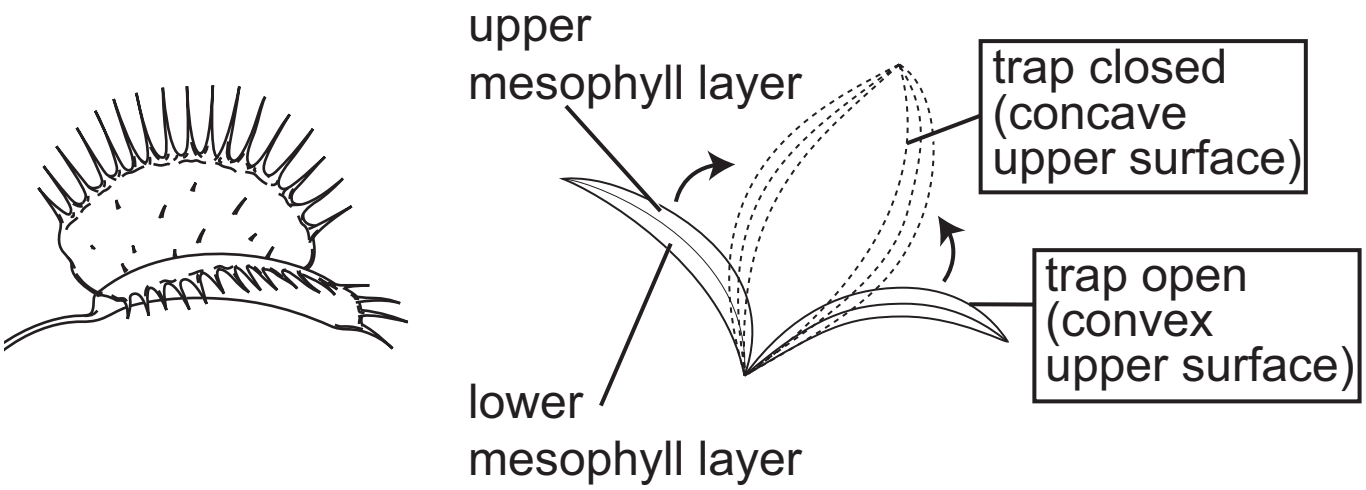
_____

_____

(b) The Venus Flytrap plant (Dionaea muscipula) possesses modified leaves which form two plates of a trap. When triggered, small invertebrates are caught and digested. The mechanism of trap closure is believed to involve osmotic changes and the flow of water between the mesophyll layers within the plates.

A whole view of the plates is shown below, together with a cross-sectional view showing the mesophyll layers.

whole view **cross-sectional view**



The plate consists of two mesophyll layers, the upper and lower mesophyll. The water potentials of the cells of these layers is different and information regarding this is shown in the table below.

Potential/kPa	Cells of upper mesophyll	Cells of lower mesophyll
ψ_{cell}	0	
ψ_s	–250	–250
ψ_p		100

(i) Calculate the missing values and present these in the empty spaces in the table above. [2]

When the trap is open, water movement between the mesophyll layers is not possible. However, when triggered to close, water will move from one layer to the other.

(ii) Determine the direction in which water will flow when the trap is triggered to close. Explain your answer. [2]

(iii) Explain what causes the change in the shape of the plates during closure of the trap. [2]

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7 **(a)** Enzymes are biological catalysts which work by lowering the activation energy of a reaction. Two models of enzyme action have been proposed: the lock and key hypothesis and the induced fit model.

(i) Explain the term 'activation energy'. [1]

_____

_____

_____

(ii) Describe **one** similarity and **one** difference between the lock and key hypothesis and the induced fit model of enzyme action. [2]

Similarity _____

_____

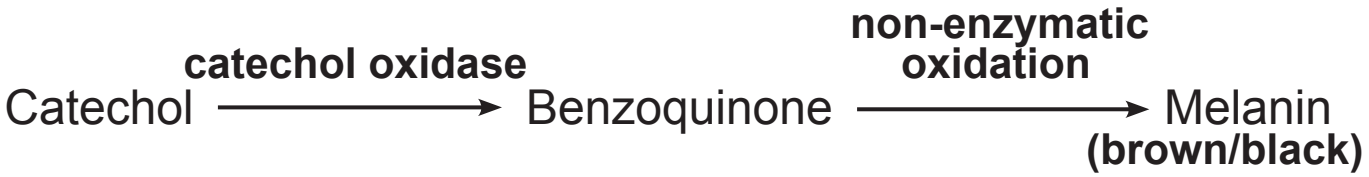
_____

Difference _____

_____

_____

(b) The cells of many fruits and vegetables including apples, bananas and lettuce contain the enzyme catechol oxidase. The enzyme is found in the cytoplasm, whereas its substrate catechol is usually confined to the vacuole. The reaction is a major cause of browning in fruits and vegetables. The enzyme's action is summarised below.



(i) Explain how dropping a banana or apple leads to the development of brown/black 'bruised' areas on the fruit. [2]

(ii) Suggest an explanation for the fact that lettuce leaves will brown faster if they are cut with a knife, rather than torn by hand. [2]

(c) The catechol oxidase molecule consists of four polypeptide chains, each of which is attached to a copper atom. The enzyme is not functional without the copper atoms. State the term used to describe the role of copper in the action of the enzyme. [1]

_____

(d) The following are methods for decreasing the activity of catechol oxidase and thus preventing browning in fruits and vegetables:

1. Cut fruit is coated with an antioxidant such as ascorbic acid, which prevents oxygen from reaching the cells of the fruit.

2. Vegetables are blanched (immersed in boiling water for one minute) prior to preservation.

3. Compounds such as cinnamic acid are added to fruit juice. Cinnamic acid is structurally similar to catechol.

Select the treatment **1**, **2** or **3** which

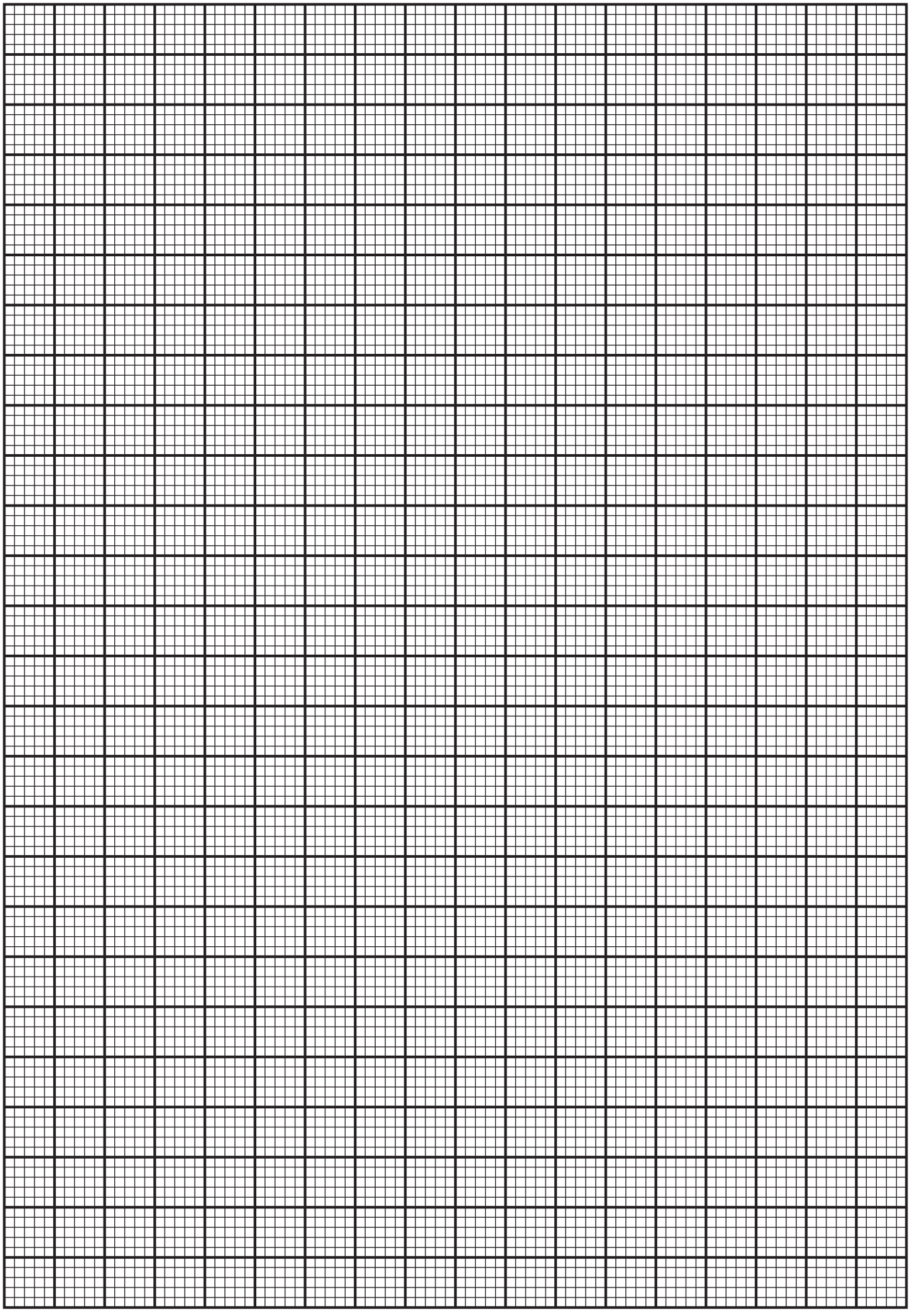
- represents an example of competitive inhibition _____
- permanently changes the shape of the enzyme _____ [2]

(e) Spoilage of fruit juice can also be prevented by removing the catechol oxidase enzyme. One way of doing this is to pour the juice through a column containing a protease enzyme immobilised on glass beads.

An experiment was carried out to determine the optimum flow rate for the juice through the column. A tap was used to adjust the flow rate. Once the juice had been passed through the column, it was tested to determine the concentration of catechol oxidase remaining. The results of the investigation are shown in the table below.

Flow rate/ $mm^3\ min^{-1}$	**Concentration of catechol oxidase remaining in treated juice/arbitrary units**
10	0
20	0
30	5
40	45
50	85
60	125
70	140

(i) Plot the results using a suitable graphical technique. Use the graph paper opposite. [4]



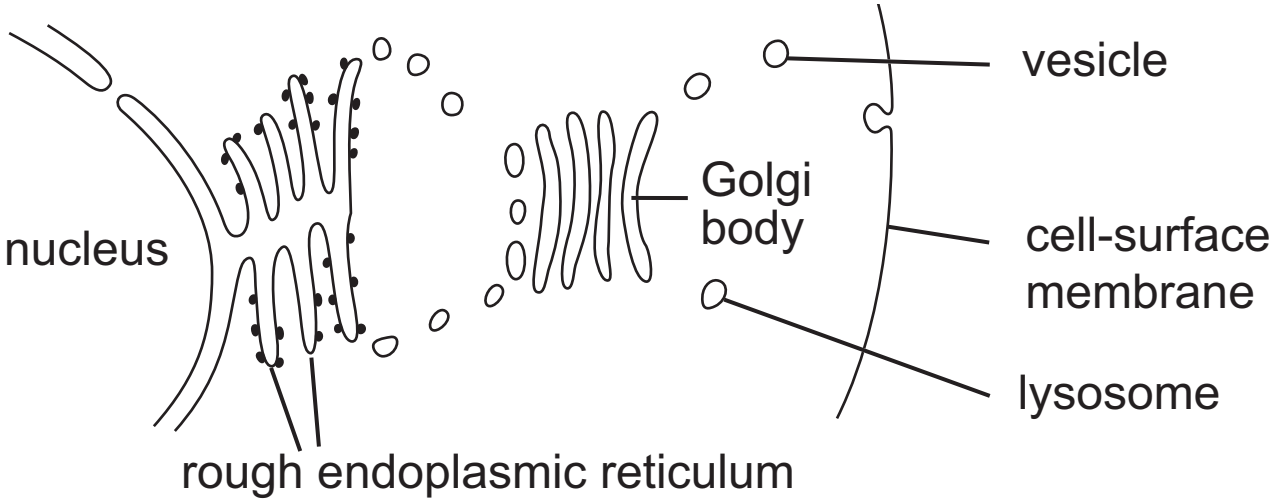
(ii) It was concluded that the optimum flow rate for the juice through the column was 20 mm^3 min^{-1}. Explain how this conclusion was reached. [2]

(iii) Describe and explain the trend shown by the results for flow rates of 40–70 mm^3 min^{-1}. [2]

Section B

Quality of written communication is awarded a maximum of 2 marks in this section.

8 Proteins have many roles in cells. For example, enzymes are involved in both extracellular and intracellular digestion, while conjugated proteins provide essential receptors and recognition sites on cell-surface membranes. Within the cell many organelles work together to make and transport these enzymes and conjugated proteins. The following diagram shows the relative positioning of these organelles.



Describe the involvement of each of the following:

- the nucleus and rough endoplasmic reticulum in the production of polypeptides (details of the process of polypeptide synthesis are **not** required)
- the Golgi body in the production of the functional enzymes and conjugated proteins
- vesicles and lysosomes in the transportation of products for secretion or for use within the cell. [13]

Quality of written communication [2]

Extra lined page

THIS IS THE END OF THE QUESTION PAPER

SOURCES

Pg12, Q6(a), Diagram showing a transverse section through part of a mesophitic leaf: © Biology for CCEA AS level by Dr J Napier, page 120 published by Colourpoint Books, 2012. ISBN 978 1780730103
Insert, Photograph 1.5 (for use with Question 5) Electronmicrograph of a mitochondrion that has just divided
© Don W. Fawcett / Science Photo Library

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
8	
Total Marks	

GCE Biology Advanced Subsidiary (AS)

Assessment Unit AS 1
Molecules and Cells

Summer 2013

Photograph 1.5 (for use with question 5)