Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS

B400U10-1

S23-B400U10-1

MONDAY, 15 MAY 2023 – MORNING

BIOLOGY – AS component 1
Basic Biochemistry and Cell Organisation

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**18**	
2.	**17**	
3.	**23**	
4.	**8**	
5.	**9**	
Total	**75**	

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ADDITIONAL MATERIALS

In addition to this paper you may require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of quality of extended response (QER) will take place in question **5**.

The quality of written communication will affect the awarding of marks.

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Answer **all** questions.

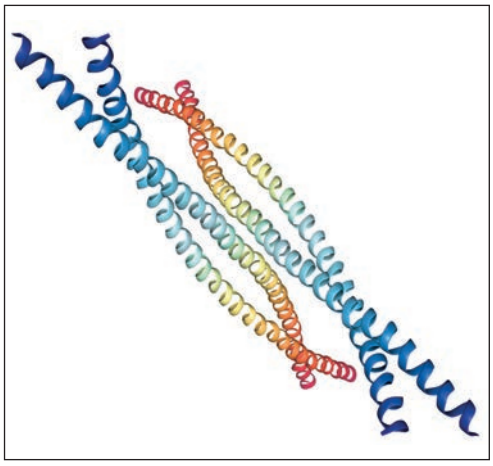
1. (a) Inorganic ions are found in many of the main biological molecules in living organisms. **Complete Table 1.1** to state **one** role of each of the inorganic ions shown. [2]

Table 1.1

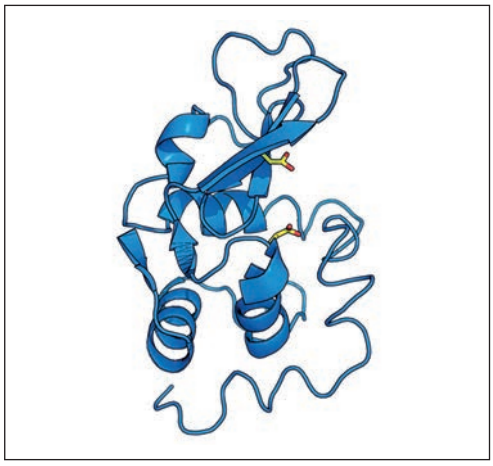
Inorganic ion	Role in living organisms
Mg^{2+}	.....
Fe^{2+}	.....
Ca^{2+}	.....
PO_4^{3-}	.....

(b) Proteins are major biological molecules. The structures of keratin and lysozyme are shown in **Image 1.2**.

Image 1.2



Keratin



Lysozyme

(i) State **two** structural differences between the two types of proteins shown in **Image 1.2**. [2]

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(ii) Polypeptides are polymers of amino acids joined by peptide bonds. Name the type of reaction which takes place to form these bonds. [1]

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(iii) Lysozyme is an enzyme which functions in a way that supports the theory of the induced fit hypothesis. Describe the induced fit hypothesis. [4]

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(iv) Describe how the lock and key hypothesis is different from the induced fit hypothesis. [2]

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(c) Acid phosphatase (ACP) is an enzyme that catalyses the removal of an inorganic phosphate ion from a substrate by the induced fit model of enzyme action.

(i) The enzyme acid phosphatase is a protein. Name the reagent that would be used to test for protein **and** the colour produced by a positive result. [2]

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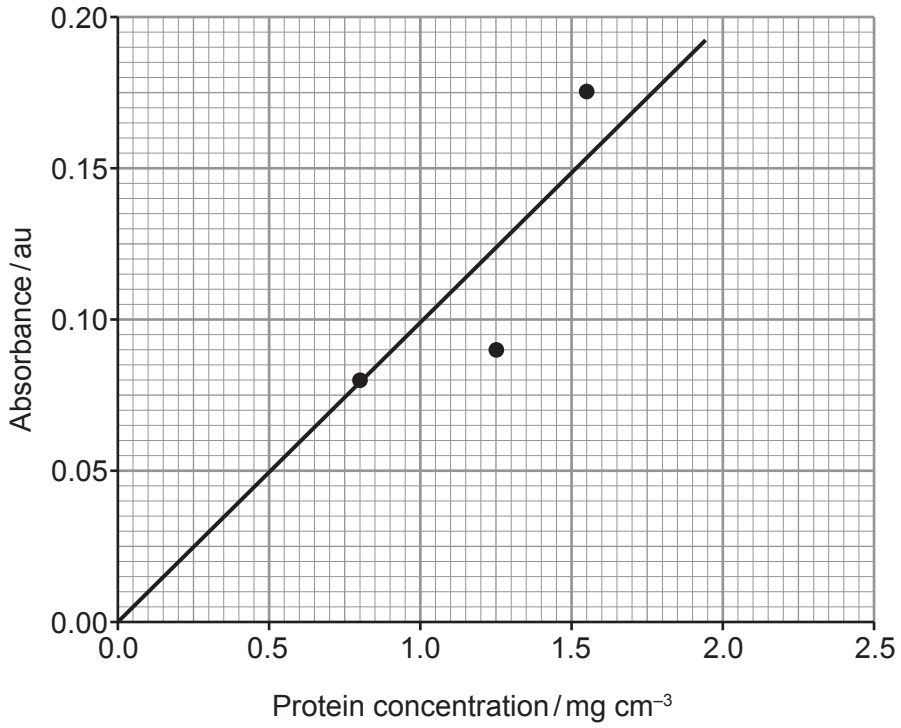
The concentration of ACP in mung bean leaves of different ages was investigated. A standard curve was produced using three known concentrations of protein. The samples of protein were mixed with a reagent and the absorbance of light of the protein and reagent measured using a colorimeter. The standard curve is shown in **Graph 1.3**.

Graph 1.3



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Leaves of different ages were collected. Protein was extracted from the leaves and the sample placed with the reagent in a colorimeter. **Table 1.4** shows the concentration of protein found in the different leaf extracts.

Table 1.4

Age of leaf / days	Protein concentration / mg cm^{-3}
1	2.1
2	1.9
3	1.7
4	1.0
5	.....
6	0.2

(ii) The extract from the day 5 leaf was tested and the absorbance was found to be 0.04 au. **Use the standard curve in Graph 1.3** to determine the protein concentration of the extract. **Write your answer in Table 1.4**. [1]

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(iii) Explain why chlorophyll would need to be removed from the extract before the absorbance is measured. [1]

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(iv) Explain why this method would not allow the determination of the actual **acid phosphatase (ACP)** concentration. [1]

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(v) Use evidence from **Graph 1.3** to explain **one** possible source of error with the method used to produce the standard curve. [2]

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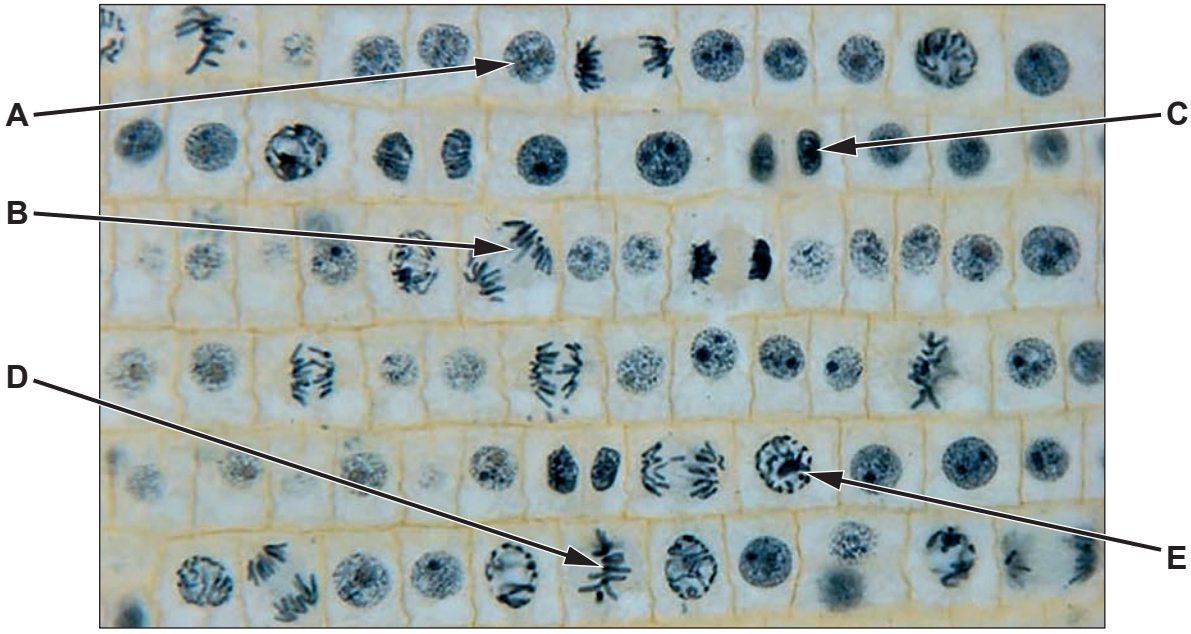
2. Cell division was observed in the root tips of onions. The root tips were removed and prepared for viewing with the light microscope. The photomicrograph in **Image 2.1** shows cells in the root tip at ×400 magnification.

Image 2.1



(a) (i) State what was added to the tissue during preparation and explain why this was necessary. [2]

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(ii) Give **three** reasons why chromosomes cannot be seen in all cells in **Image 2.1**. [3]

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(iii) Using letters **(A–E)** from **Image 2.1**, identify cells that match the descriptions of the stages in **Table 2.2**. [3]

Table 2.2

Description of the stage	Letter
The chromosomes condense	.....
Pairs of chromatids are on the equator	.....
The nuclear envelopes are being reformed	.....
Replication of DNA is taking place	.....
Chromatids being pulled to the poles	.....

(iv) Identify the longest stage of the cell cycle. Use evidence from **Image 2.1** and your own knowledge to explain your answer. [2]

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(b) The mitotic index can be calculated to show the number of cells undergoing mitosis. This can give an estimate of the growth rate at the root tip. The number of cells undergoing mitosis were counted at different distances from the root tip. The results are shown in **Table 2.3**.

Table 2.3

Distance from the root tip / μm	Total number of cells in field of view	Total number of cells in mitosis	Mitotic index / %
200	57	7	12.3
500	49	4	.....
1500	53	1	1.9
2000	54	0	0

(i) Calculate the mitotic index for 500 μm from the root tip. **Write your answer in Table 2.3**. [2]

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(ii) Suggest how you could increase the reliability of the method for calculating the mitotic index of this root tip. [2]

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(iii) Explain the significance of mitotic cell division to living organisms. [3]

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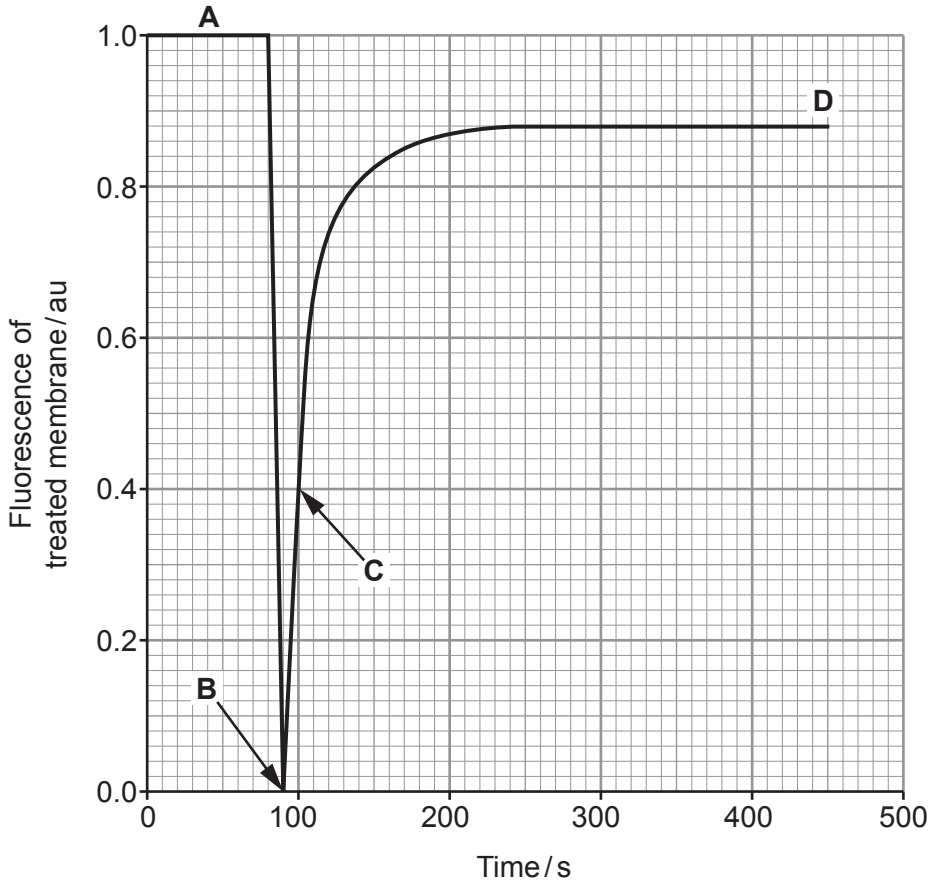
3. (a) Cell membranes are composed of a double layer of phospholipids.
An experiment was carried out to investigate the positioning of phospholipids in the membrane of a living cell. All phospholipids in the membrane were labelled with a fluorescent marker dye. When the marker dye absorbed light, it stopped fluorescing. The membrane in the area exposed to light then appeared as a dark spot. The level of fluorescence of the membrane over a period of time is shown in **Graph 3.1**.

Graph 3.1



(i) Use **one** of the letters **(A–D)** shown on **Graph 3.1** to suggest when the cell membrane was exposed to the light and explain your answer. [1]

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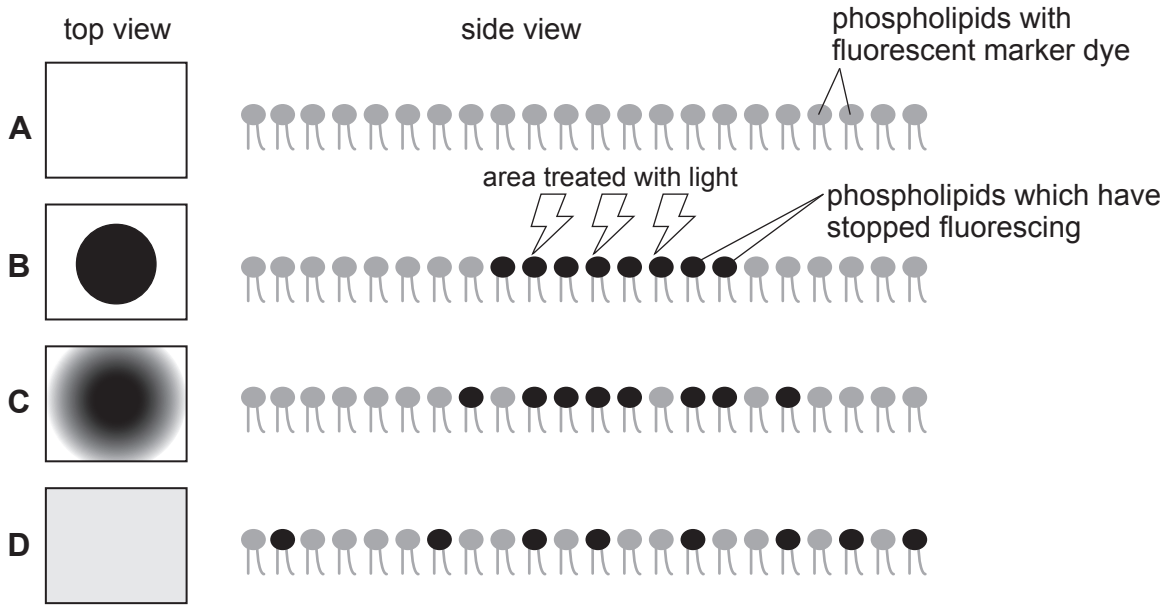
Image 3.2 shows the top and side view of an area of the membrane before, during and after exposure to a light source.

Image 3.2



(ii) Use the results shown in **Graph 3.1 and Image 3.2** and your knowledge of membrane structure to explain the recovery of the fluorescence. [3]

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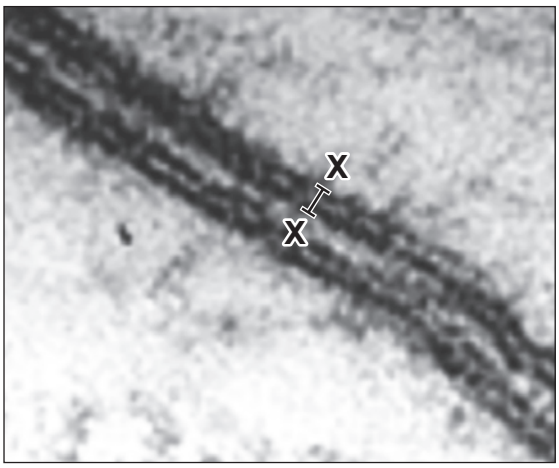
(b) **Image 3.3** shows an electron micrograph of the plasma membranes of two adjacent cells.

Image 3.3



(i) Use only the **scale bar** to calculate the magnification of **Image 3.3**. [2]

Magnification = × .....

(ii) Use your answer from (i) to calculate the actual width of the plasma membrane shown by **X–X**. **Express your answer to two significant figures**. [2]

Actual width = ... nm

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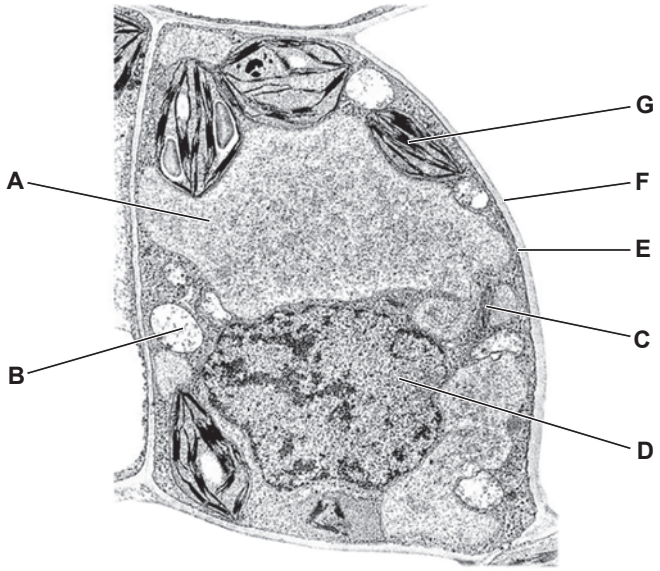
(c) **Image 3.4** is an electron micrograph of a plant cell showing some organelles.

Image 3.4



Using letters **(A–G)** from **Image 3.4**, identify the organelles in **Table 3.5**. [2]

Table 3.5

Organelle	Letter
Chloroplast	.....
Nucleus	.....
Vacuole	.....

(d) The effect of sodium chloride concentration on membrane structure was studied using beetroot cells. Beetroot cells contain a red pigment called betalain which is released when the membrane structure is disrupted. A temperature of 30 °C disrupts the membrane structure and allows the pigment to escape from the cell.

The method used to study the membrane structure is shown below:

Method

- Samples of beetroot were added to test tubes containing a range of sodium chloride solutions.
- They were left for five minutes at 30 °C.
- A sample of the liquid was then placed in a cuvette.
- The absorbance of light was recorded using a colorimeter.

(i) Suggest why the temperature would need to be controlled in this experiment. [2]

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The results of the investigation are shown in **Table 3.6**.

Table 3.6

NaCl concentration / %	Absorbance of betalain solution / au			
	Trial 1	Trial 2	Trial 3	Mean
0.1	0.49	0.52	0.48	0.50
0.2	0.26	0.26	0.27	0.26
0.3	0.14	0.20	0.15	.....
0.4	0.09	0.10	0.08	0.09
0.5	0.03	0.01	0.03	0.02

(ii) Calculate the mean absorbance for 0.3% NaCl solution. **Write your answer in Table 3.6**. [1]

(iii) Use the data in **Table 3.6** to describe and explain the effect of increasing the concentration of the NaCl solution on the permeability of the beetroot membrane. [4]

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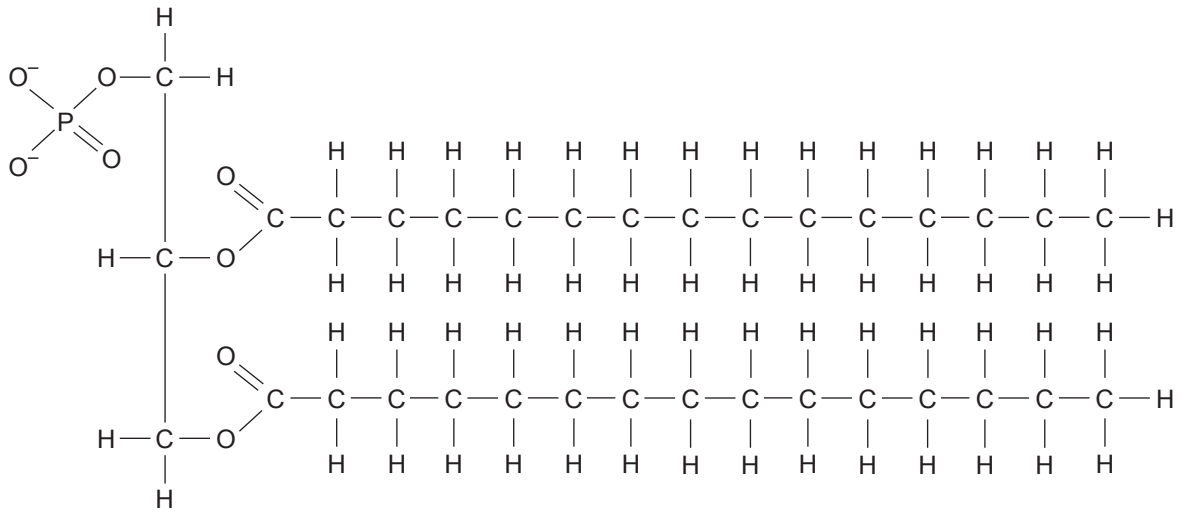
Image 3.7 shows the structure of a phospholipid.

Image 3.7



(iv) When dissolved in water, NaCl dissociates to form Na^+ and Cl^- ions. Use the structure shown in **Image 3.7** and the data in **Table 3.6** to suggest how the interaction between the Na^+ ions and the phospholipid affects the fluidity of the membrane. [4]

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(v) Suggest how the method could be modified to investigate the effect of temperature on membrane stability. [2]

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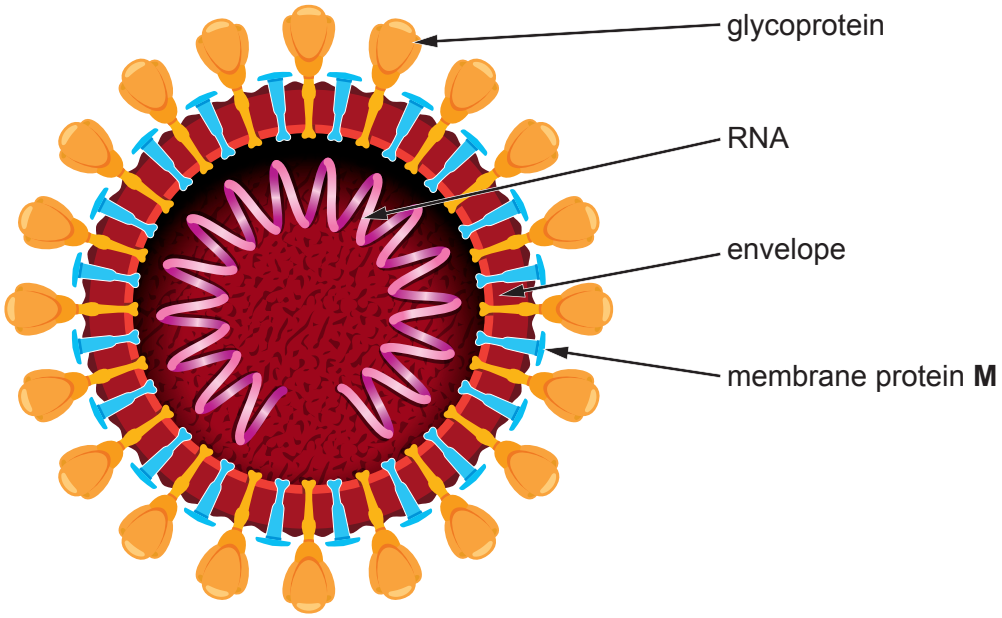
4. SARS is a type of virus which causes a respiratory disease. **Image 4** shows the structure of the virus. All viruses contain a nucleic acid within their core and are surrounded by a protein coat called a capsid.

The SARS virus infects human cells and takes over the cells' metabolism. It is replicated by the human cells, which make the viral proteins using the same organelles as they would for normal protein synthesis within a cell.

Image 4



(a) The genetic material within the SARS virus is RNA. State **two** ways in which the structure of RNA differs from DNA. [2]

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(b) Membrane protein **M** is coded for by a section of the viral RNA. This section of the viral RNA is used to form a complementary mRNA molecule in the cytoplasm of the host cell. This mRNA is then processed in a similar way to host cell mRNA.

(i) Part of the viral RNA is shown below. **Write the sequence of bases** for the complementary mRNA molecule formed from the viral RNA. [1]

Viral RNA A U G G C C A G U U A A

Complementary mRNA .....

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(ii) Using your own knowledge of protein synthesis suggest how the host cell uses the mRNA to produce viral membrane protein **M**. [5]

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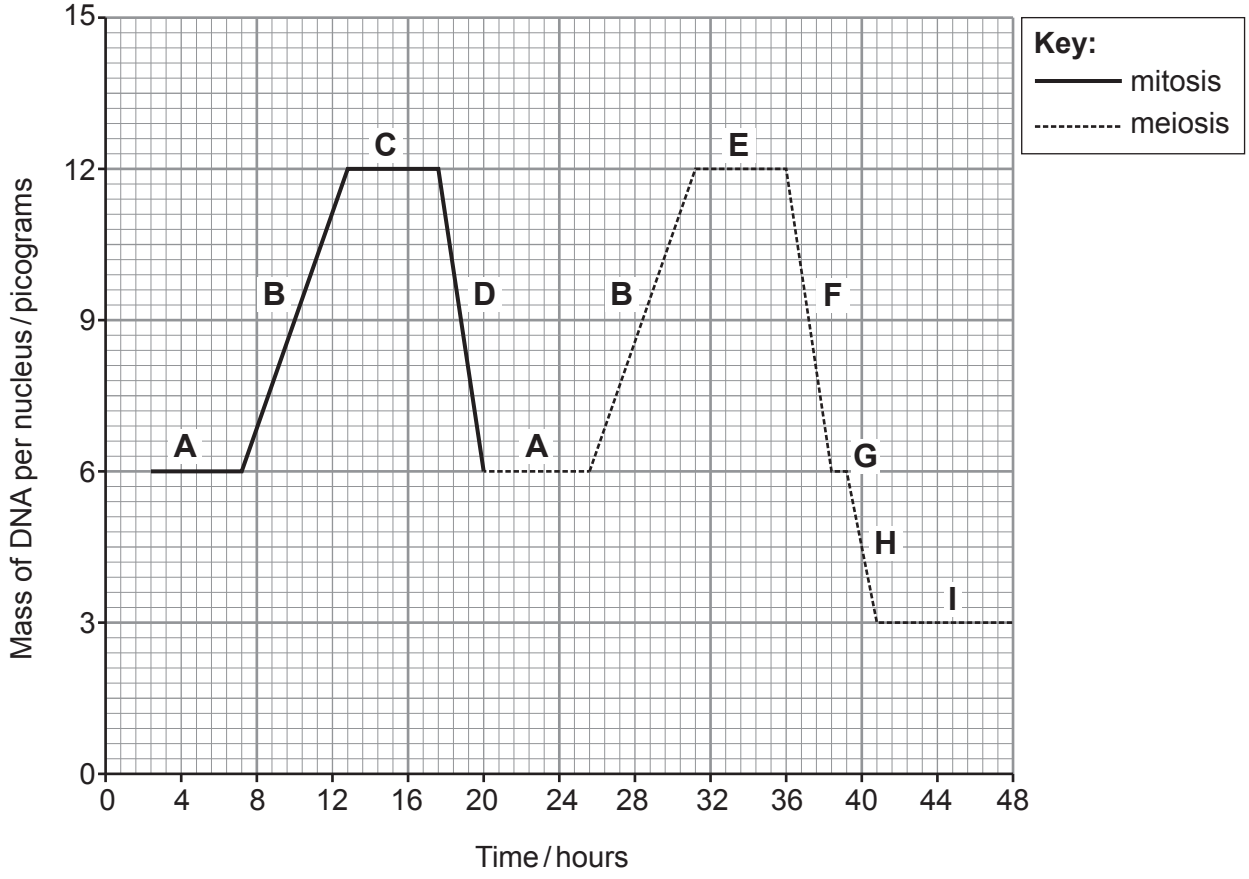
5. Cells within the human male testes produce sperm through the processes of mitosis and meiosis.

Graph 5 shows the mass of DNA found in the nucleus of one of these cells as it undergoes mitosis and then meiosis to form a single sperm cell. The letters (**A–I**) indicate stages before and during cell division by mitosis and meiosis.

Graph 5



Use the information in **Graph 5** and your knowledge of cell division to explain the changes in the DNA mass of the nucleus for both mitosis and meiosis. Explain how meiosis increases the genetic variation of offspring. [9 QER]

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