Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS

B400U10-1

S25-B400U10-1

MONDAY, 12 MAY 2025 – 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.	**13**	
2.	**9**	
3.	**15**	
4.	**16**	
5.	**13**	
6.	**9**	
Total	**75**	

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ADDITIONAL MATERIALS

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 **6**.

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

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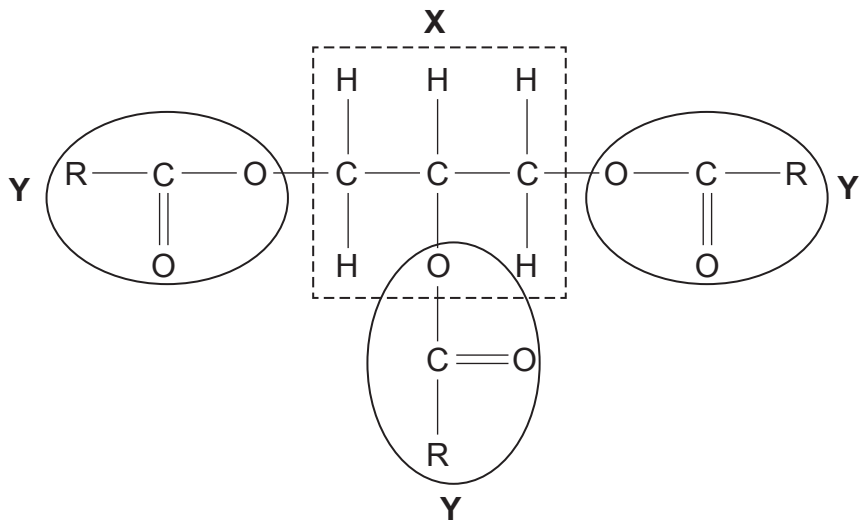
Answer **all** questions.

1. Lipids have many functions in organisms. Molecules of lipids are formed by combining several other molecules. The general structure of one type of lipid is shown in **Image 1.1**.

Image 1.1



(a) The lipid shown in **Image 1.1** was formed by condensation reactions between molecule **X** and three of the molecules labelled **Y**.

(i) State the names of the molecules labelled **X** and **Y** in **Image 1.1**. [1]

X .....

Y .....

(ii) With reference to **Image 1.1**, explain why up to four **structurally different** molecules could be combined to form a lipid of this type. [2]

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(iii) Draw the structural formula of the molecule labelled **X** in **Image 1.1 before** the condensation reactions took place. [1]

(b) **Table 1.2** gives information on four different molecules that could be molecule **Y** in **Image 1.1**.

Table 1.2

	Formula of molecule **Y**	Melting point /°C	Saturated or unsaturated	Solid or liquid at room temperature
A	$C_{17}H_{35}COOH$	69.6	Saturated	.....
B	$C_{17}H_{33}COOH$	13.0	Unsaturated	.....
C	$C_{17}H_{31}COOH$	-5.0	Unsaturated	.....
D	$C_{17}H_{29}COOH$	-14.5	Unsaturated	.....

(i) Complete **Table 1.2** to show whether molecules **A** to **D** would be **solid** or **liquid** at a room temperature of 20 °C. [1]

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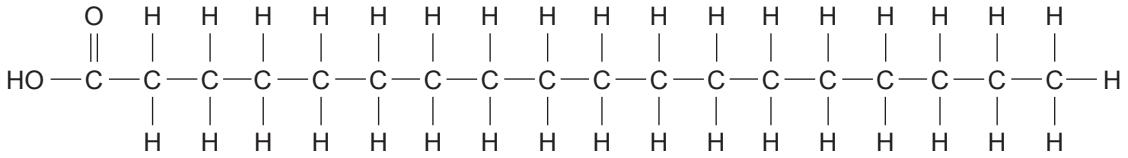
(ii) **Image 1.3** shows the structural formula of molecule **A**.

Image 1.3



Use the formulae from **Table 1.2** and **Image 1.3** to explain the classification of molecules **A** to **D** as being saturated or unsaturated. [3]

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(iii) Suggest and explain how eating lipids containing only molecule **D** in **Table 1.2** may impact human health. [2]

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(iv) In order to improve human health, people who drink milk have been advised to drink skimmed or plant-based milks.

I. Describe how ethanol can be used to show the presence of lipid in a food sample. [2]

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II. Explain why this test cannot be used to test for lipid in milk. [1]

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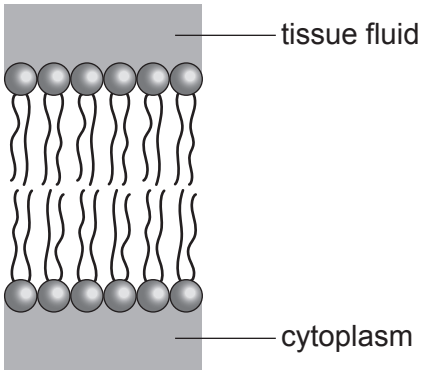
2. Cell membranes contain phospholipids. **Image 2.1** shows a simplified drawing of the arrangement of phospholipids in a cell membrane.

Image 2.1



(a) With reference to the properties of phospholipids and water, describe and explain the arrangement of phospholipids in a cell membrane as shown in **Image 2.1**. [4]

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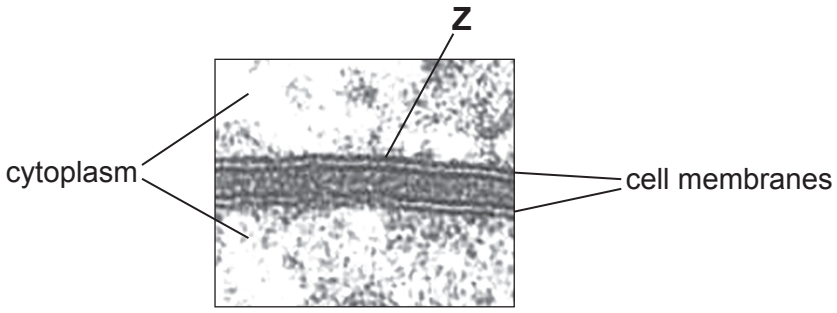
(b) **Image 2.2** shows the appearance of a section through the cell membranes of two adjacent cells at high magnification using an electron microscope.

Image 2.2



(i) The currently accepted model of the cell membrane structure is called the fluid mosaic model. Phospholipids are the main component of cell membranes.

State the name of a molecule that increases the stability of animal cell membranes. [1]

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(ii) At the point labelled **Z** on **Image 2.2**, the actual thickness of the cell membrane was found to be 7.5 nm. On the original photomicrograph, the thickness of the cell membrane was 0.8 mm.

Calculate the magnification of the photomicrograph.
Give your answer to **two significant figures** in **standard form**. [3]

Magnification = × .....

(iii) Fick's Law states that:

$$\text{Rate of diffusion} = \frac{\text{surface area of exchange surface} \times \text{difference in concentration}}{\text{thickness of exchange surface}}$$

State how an increase in the thickness of the cell membrane would affect the rate of diffusion. [1]

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3. Phenolphthalein is a pH indicator that is pink in alkaline solutions but colourless in neutral or acid conditions.

An investigation was carried out to determine the optimum temperature of the enzyme lipase. In this investigation, fatty acids are released by the digestion of the fats found in milk. This lowers the pH and causes a colour change.

Method

1 Add 5 cm^3 of milk, 0.5 cm^3 of phenolphthalein and 4 cm^3 of sodium carbonate solution to a boiling tube.
2 Place the boiling tube in a thermostatically controlled water bath at 25 °C.
3 Add 1 cm^3 of lipase solution to a test tube.
4 Place the test tube in the same water bath.
5 After 10 minutes, pour the lipase solution into the boiling tube and start a stop clock.
6 Record the time taken for the solution to lose its pink colour.
7 Repeat steps 1–5 to obtain two further results at this temperature.
8 Repeat the experiment using water baths set at 15 °C, 35 °C, 45 °C and 75 °C.

(a) (i) State **two** variables which were controlled in this investigation. [1]

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(ii) Explain why the investigation would be invalid if **steps 2** and **4** in the method were not followed. [1]

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(iii) Identify the **main** source of inaccuracy in this investigation. [1]

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(b) The results of the investigation are shown in **Table 3.1**.

Table 3.1

Temperature of water bath /°C	Time taken for solution to lose its pink colour / s			
	Trial 1	Trial 2	Trial 3	Mean
15	65	64	61	.....
25	48	46	45	46.3
35	38	41	37	38.7
45	26	28	29	27.7
75	102	114	109	108.3

(i) Calculate the mean for **15 °C**. Write your answer in **Table 3.1**. [1]

(ii) Plot a graph of the mean results on **Graph 3.2**. Range bars are not required. [4]

(iii) I. Explain why it is not possible to identify the optimum temperature for the lipase used in this experiment using the method outlined. [2]

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II. Suggest how you could modify the method to enable more accurate determination of the optimum temperature. [1]

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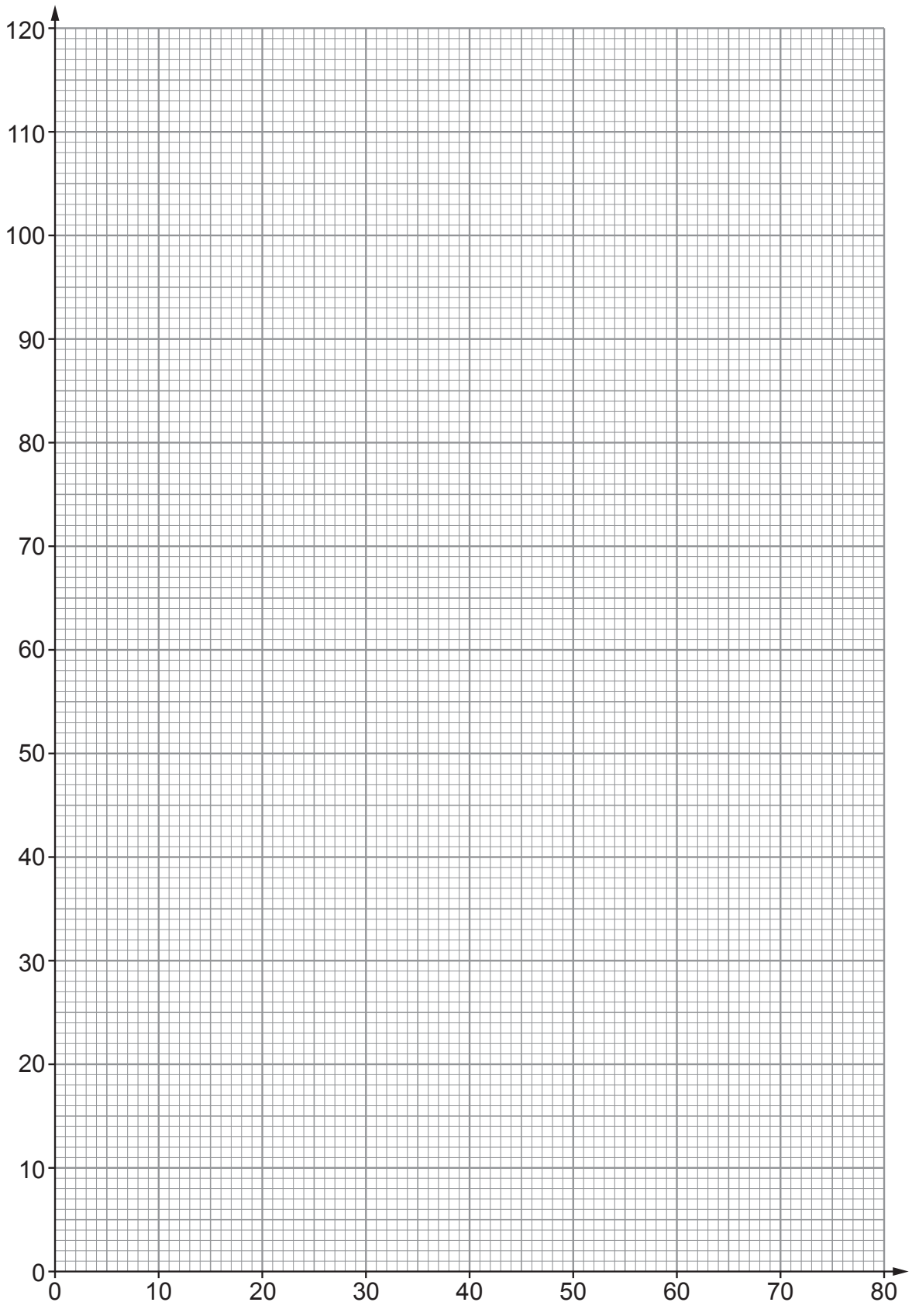
Graph 3.2



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Turn over.

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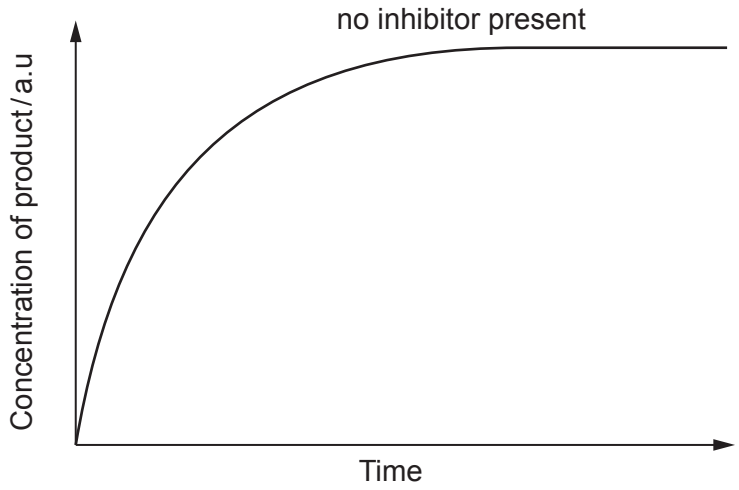
(c) **Graph 3.3** shows how the **concentration of product** changed in this experiment over time.

Graph 3.3



(i) **Draw a line** on **Graph 3.3** to show the effect of the presence of a low concentration of a **non-competitive inhibitor** of lipase on the **concentration of product**. [1]

(ii) Use your knowledge of non-competitive inhibitors to explain why you have drawn the line in that position. [3]

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4. There are many definitions of what is meant by a living organism.
Read the definitions below and then answer the questions that follow.

Definition A:
An organism is considered as living when it performs the different life processes in one form or another. These include nutrition, movement, growth, reproduction, respiration, sensitivity and excretion.

Definition B:
A living organism is an individual form of life composed of one or more cells containing organelles which work together to carry out different life processes.

Definition C:
A living organism is any biological entity capable of transferring or replicating genetic material.

(a) (i) Explain why definitions **A** and **B** would not include viruses as being living organisms. [2]

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(ii) Suggest why definition **C** would include viruses as living organisms. [1]

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(b) Definition **A** lists several different life processes which are said to be characteristics of a living organism. In unicellular organisms, each of these life processes must take place within a single cell.

Since the appearance of the first living organisms on Earth, two different cell types have evolved, prokaryotic and eukaryotic.

Complete **Table 4.1** to identify where some of the life processes listed in Definition **A** take place in these types of cells. [3]

Table 4.1

Life process	Where the life process takes place in a cell	
	prokaryote	eukaryote
synthesis of most ATP during respiration	.....	.....
synthesis of proteins for growth and metabolism	.....	.....
replication of DNA during asexual reproduction	.....	.....

Question continued overleaf

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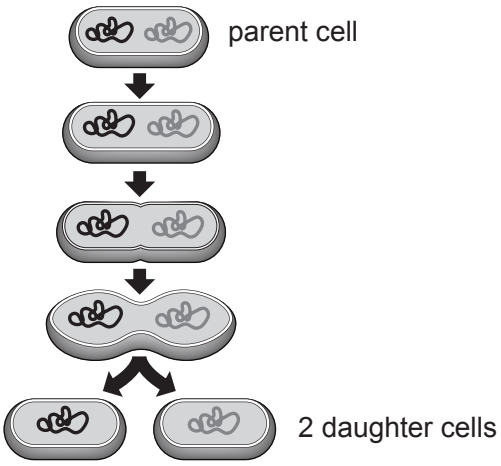
(c) Prokaryotic cells reproduce asexually by a process called binary fission. Unicellular eukaryotes reproduce asexually by mitosis.

Image 4.2 shows stages in binary fission following DNA replication.

Image 4.2



(i) State **one** way in which the daughter cells produced in meiosis differ from those produced in binary fission and mitosis. [1]

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(ii) Explain why binary fission is not the same as mitosis. [1]

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(iii) The process of cell division can be observed using a light microscope at a high magnification.

I. Suggest why an objective lens of a higher magnification would be needed to observe the division of prokaryotic cells than would be needed to observe eukaryotic cells. [1]

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II. Explain why a microscope needs to be recalibrated when using different objective lenses. [1]

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(d) A cell undergoing mitosis was observed and the following measurements taken over a 30-minute period:

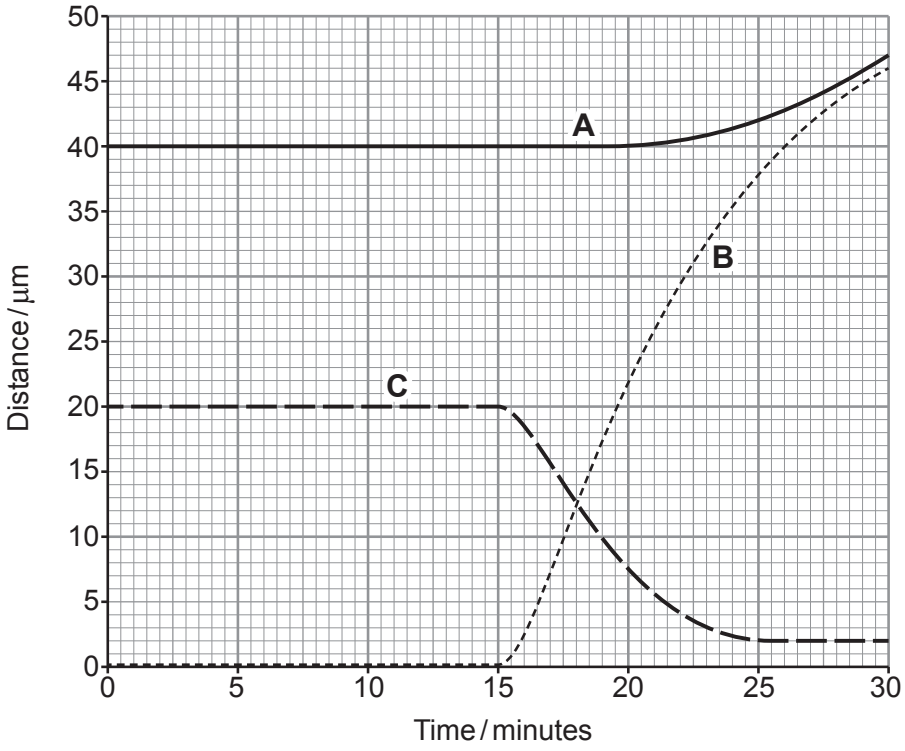
A the distance between the poles of the spindle apparatus

B the distance between the centromeres of sister chromatids

C the distance between the centromeres and the poles of the spindle.

Graph 4.3 shows how each of these distances changed over the 30 minutes of observation.

Graph 4.3



Use your knowledge of mitosis and the information shown in **Graph 4.3** to answer the following questions.

(i) Conclude when anaphase started in this cell. Explain your answer. [2]

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(ii) Suggest what stage of mitosis is taking place between 20 and 30 minutes. [1]

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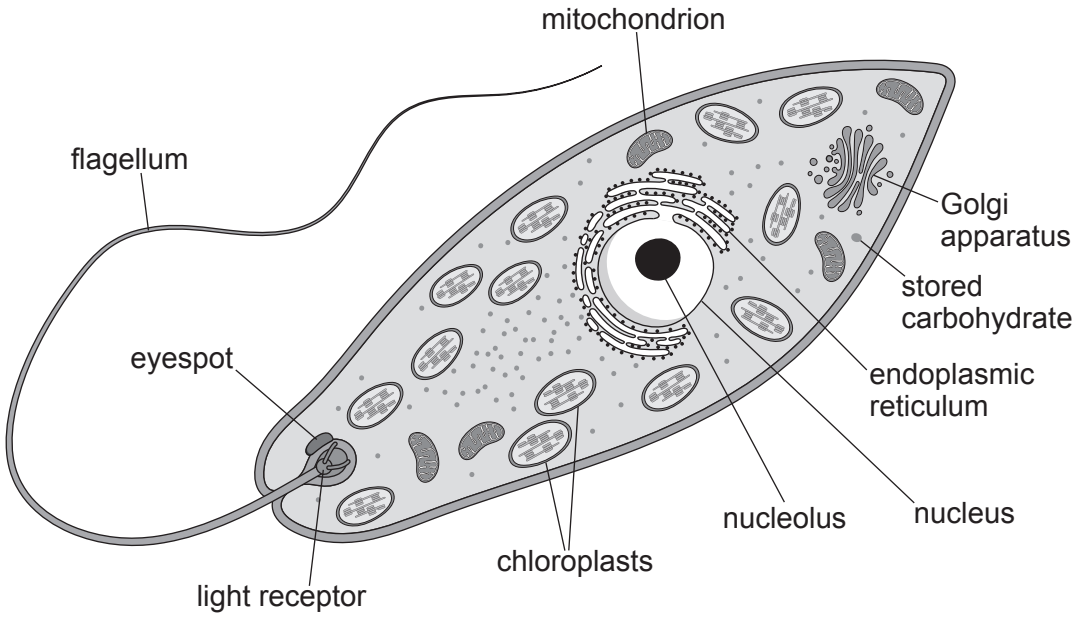
(e) **Image 4.4** shows a diagram of a unicellular organism called *Euglena*.

Image 4.4



(i) Use information from **Image 4.4** to explain why *Euglena* has, at different times, been classified as a plant and as an animal. [2]

Plant

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Animal

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(ii) Suggest into which Kingdom *Euglena* may be classified. [1]

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5. Motor neurone disease (MND) is a progressive condition that affects the function of the nervous system.

Researchers have identified a protein called FUS which is vital for nerve cells to work properly.

(a) **Image 5.1** shows a section of mRNA that codes for six amino acids in the FUS protein.

Image 5.1

--------- **AUG CCG GCA CGG AUU CUG** ---------
met thr ser cyt ala thr

(i) **Complete** the **DNA sequence** that would have acted as the template strand for the mRNA shown in **Image 5.1**. [1]

Coding strand	**ATG**	**CCG**	**GCA**	**CGG**	**ATT**	**CTG**
Template strand						

(ii) State **one** feature of the genetic code demonstrated by the base sequences that code for **thr** (threonine) in **Image 5.1**. [1]

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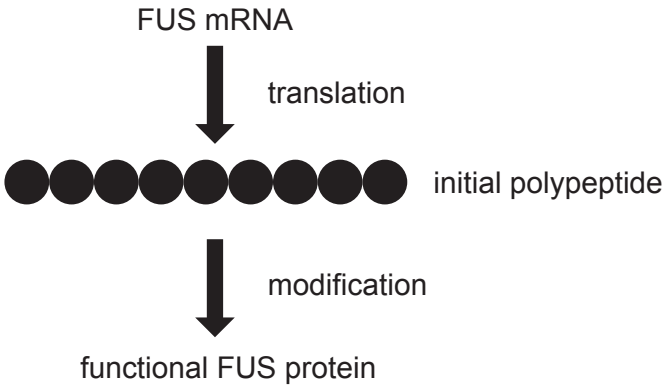
(b) The polypeptide produced from the mRNA molecule needs to undergo further modification before a functional protein is produced. This is summarised in **Image 5.2**.

Image 5.2



The functional FUS protein produced is globular consisting of a single polypeptide chain.

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During the translation of mRNA into the initial FUS polypeptide, energy is provided in the form of the triphosphonucleotide GTP which has a similar structure to ATP.

(i) I. Suggest the nitrogenous base found in GTP. [1]

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II. Write an equation to show the exergonic reaction in which GTP would release energy. [1]

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(ii) I. State where in a cell the initial FUS polypeptide chain would be modified to produce functional FUS protein. [1]

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II. Name **two** types of molecule that could be added to the polypeptide chain to produce functional FUS protein. [1]

Molecule 1: .....

Molecule 2: .....

(iii) I. State the highest level of protein structure that would be present in the functional protein. [1]

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II. Explain how this structure is maintained. [2]

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(c) In MND, a single base substitution in the FUS gene produces a polypeptide chain which is significantly shorter than normal.

Suggest how a single base change could result in such a shortened polypeptide chain. [2]

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(d) The FUS gene contains 15 exons, from which several different versions of the FUS protein can be synthesised.

Suggest how this is possible and why it might provide evidence against the one gene-one polypeptide theory. [2]

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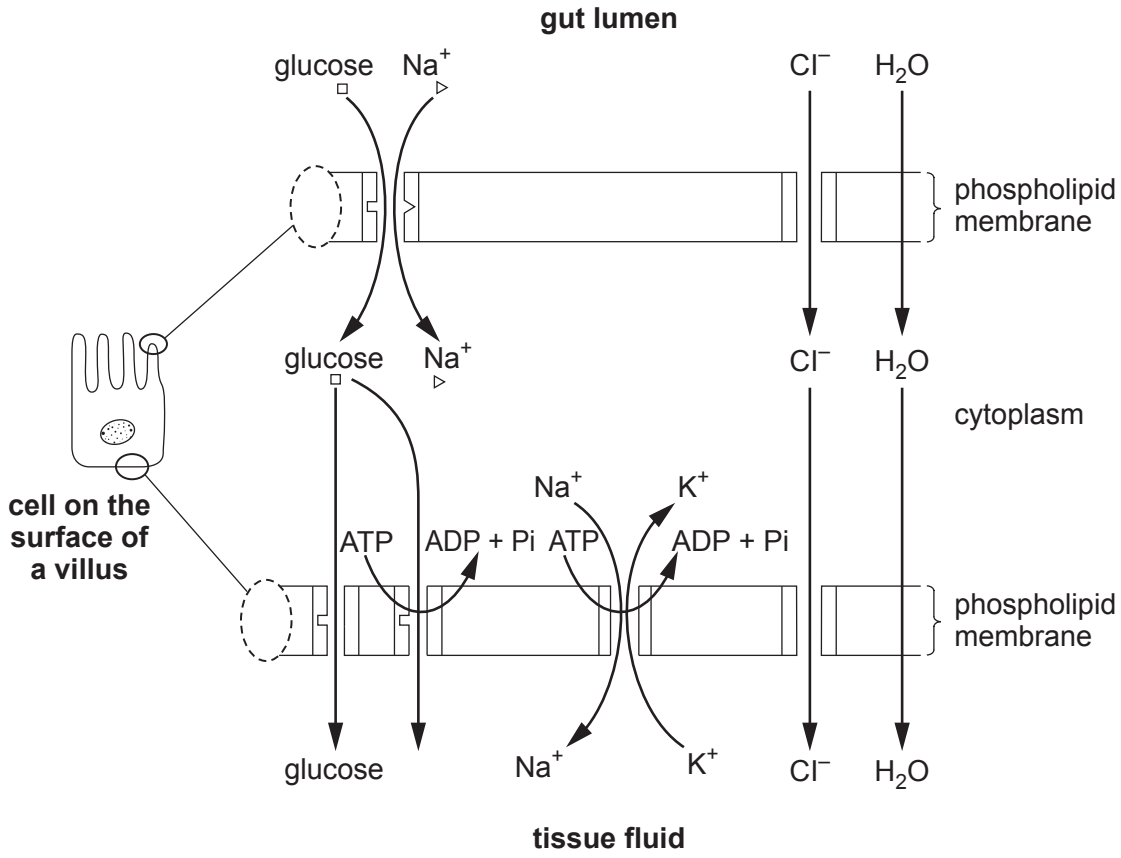
6. **Image 6** shows how cells covering the surface of a villus in the small intestine transport some molecules from the gut lumen into tissue fluid.

Image 6



Identify the main transport methods shown in **Image 6** and state which molecules are transported by each method.

Describe the key features of each of these transport methods.

Explain how the efficiency of glucose transport into tissue fluid is increased by using a combination of transport methods. [9 QER]

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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