Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS/A LEVEL

2400U10-1

S24-2400U10-1

MONDAY, 13 MAY 2024 – MORNING

BIOLOGY – AS unit 1
Basic Biochemistry and Cell Organisation

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**10**	
2.	**10**	
3.	**14**	
4.	**16**	
5.	**9**	
6.	**12**	
7.	**9**	
Total	**80**	

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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 pages 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 the quality of extended response (QER) will take place in question **7**.

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

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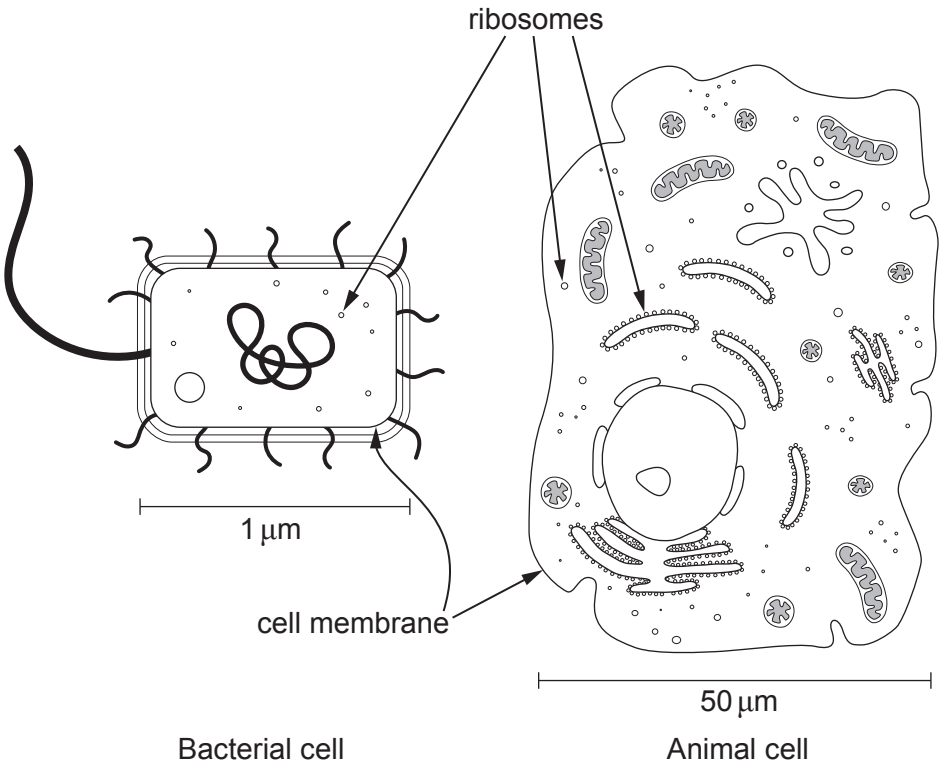
Answer **all** questions.

1. **Image 1.1** shows diagrams of two different cells. Scale bars are shown to illustrate the relative sizes of the cells.

Image 1.1



(a) Both cells produce the enzyme RNA polymerase. This is involved in the production of mRNA which is needed for translation by ribosomes.

(i) State the names of **two** other types of RNA involved in protein synthesis. [1]

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(ii) Using your knowledge of cell structure, complete **Table 1.2** to compare the sites of translation and size of ribosomes in the two cells. [2]

Table 1.2

	Bacterial cell	Animal cell
location(s) of ribosomes involved in translation	.....	.....
size of ribosome	.....	.....

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(b) Both cells contain membranes. The animal cell has considerably more membrane than the bacterial cell.
Use **Image 1.1** and your knowledge of the structure of these cells to suggest **two** reasons for this difference. [2]

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Question continued overleaf

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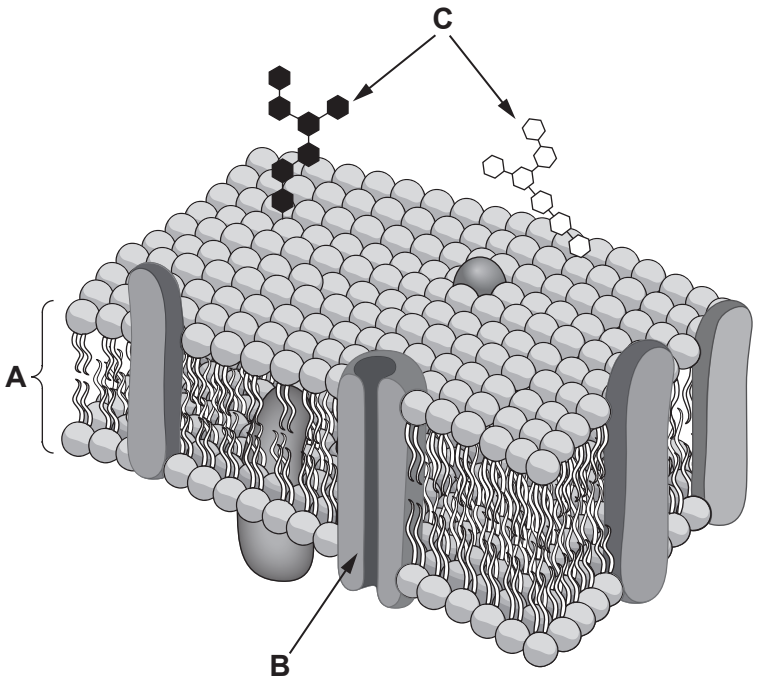
(c) **Image 1.3** shows the cell surface membrane of the animal cell.

Image 1.3



(i) Identify components **A** and **B** in **Image 1.3 and** describe their functions. [3]

A .....

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B .....

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(ii) The components labelled **C** in **Image 1.3** form the glycocalyx and are involved in cell recognition. The cell surface membranes of the animal cell have a different composition from the inner mitochondrial membrane. The percentage composition of the three components in each membrane is shown in **Table 1.4**.

Table 1.4

Membrane	Percentage composition / %		
	Component **A**	Component **B**	Component **C**
animal cell surface membrane	53	42	5
inner mitochondrial membrane	22	78	0

Using the information in **Table 1.4** and your knowledge of the function of plasma membranes, suggest why there is:

I. no component **C** in the inner mitochondrial membrane; [1]

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II. more component **B** in the inner mitochondrial membrane than the cell surface membrane. [1]

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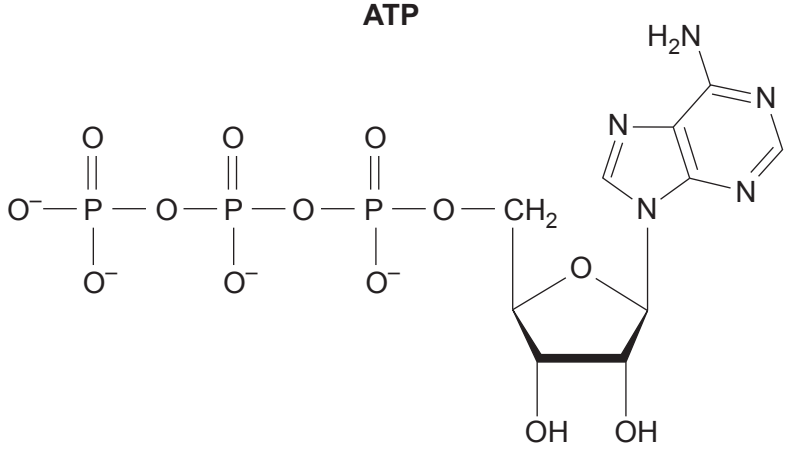
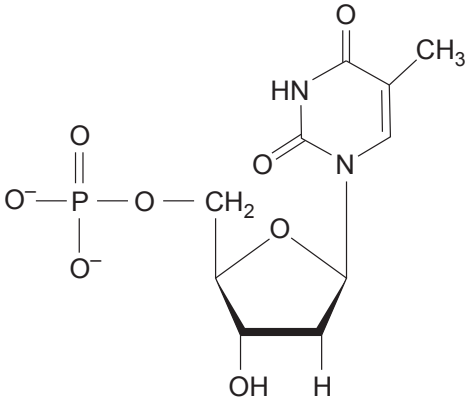
2. Nucleotides are involved in cell metabolism. Three nucleotides are shown in **Image 2.1**.

Image 2.1

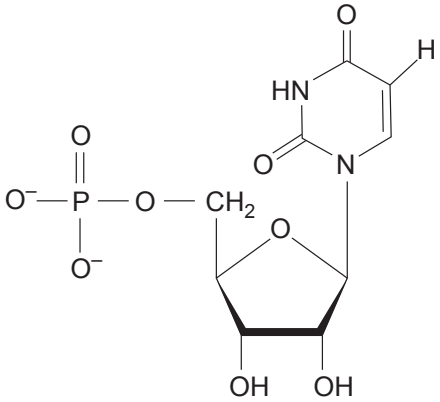
ATP



DNA nucleotide



RNA nucleotide



(a) (i) State **three** structural similarities between all three nucleotides shown in **Image 2.1**. [1]

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(ii) Complete **Table 2.2** to describe **one** structural difference between each of the pairs of nucleotides shown. [2]

Table 2.2

Nucleotides	Difference
ATP and RNA	....
DNA and RNA	....

(iii) Name **two** inorganic ions needed by plant cells in order to synthesise the molecules shown in **Image 2.1**. [1]

....

(b) (i) Each human body cell contains 2.6×10^{-11} g of nucleic acid, of which approximately 2.0×10^{-11} g is RNA.
Calculate the percentage of nucleic acid that is RNA in a human cell.
Give your answer to one decimal place. [2]

Percentage of nucleic acid that is RNA = ...

(ii) Explain why the percentage of nucleic acid that is RNA in a human cell is variable. [1]

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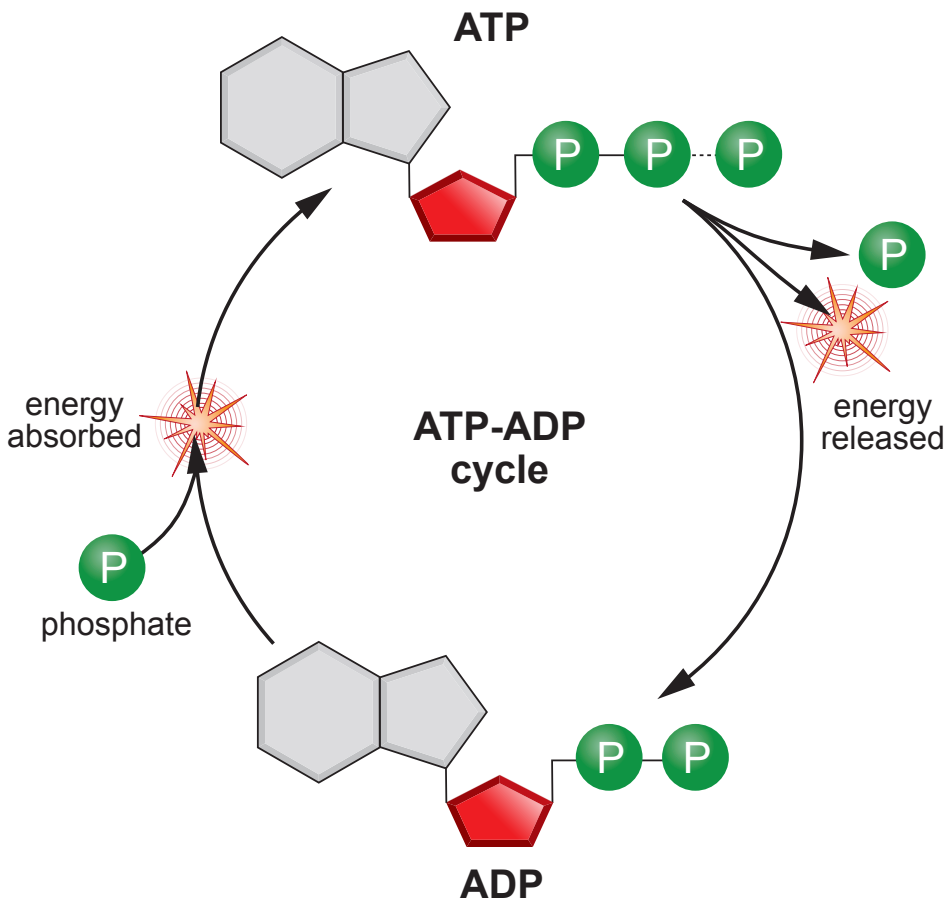
(c) **Image 2.3** shows how ATP is used in a cell.

Image 2.3



Use **Image 2.3** to explain how ATP is used in cells **and** state why it is described as the **universal energy currency**. [3]

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3. Hydrogen peroxide is a product of respiration and is made in all cells. It is harmful and therefore removed as soon as it is produced. Catalase is an intracellular enzyme that converts hydrogen peroxide into water and oxygen.

(a) Hydrogen peroxide decomposes slowly without catalase. Explain how catalase speeds up the decomposition **and** suggest why this is so important in living cells. [2]

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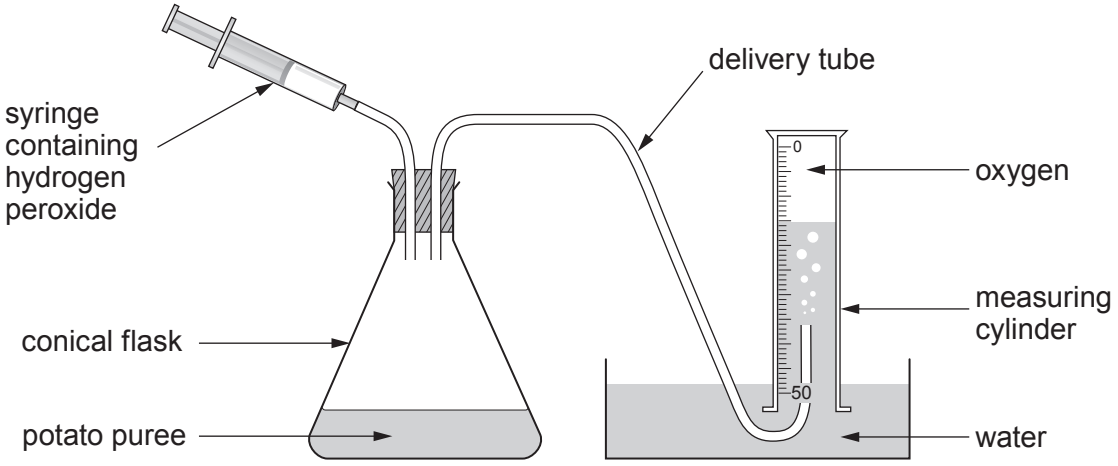
(b) Some students investigated how the concentration of hydrogen peroxide affected the rate of oxygen production. They used fresh potato puree and different concentrations of hydrogen peroxide.
The apparatus was set up as shown in **Image 3.1**.

Image 3.1



- A measuring cylinder was used to measure 20 cm^3 potato puree which was poured into the conical flask.
- A 50 cm^3 measuring cylinder was filled with water and inverted over the open end of the delivery tube.
- 2 cm^3 of 5.0 vol hydrogen peroxide was drawn up into the syringe and attached to the apparatus in the position shown.
- The plunger was pushed in and a timer was started immediately.
- After 30 seconds the volume of oxygen collected was measured using the scale on the measuring cylinder and recorded.
- The rate of oxygen production in $cm^3\ s^{-1}$ was calculated.
- The experiment was repeated using 3.5 vol, 2.0 vol, 1.5 vol, 1.0 vol and 0 vol hydrogen peroxide.

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The results are shown in **Table 3.2**.

Table 3.2

Concentration of hydrogen peroxide / vol	Volume of oxygen collected in 30 seconds / cm^3	Rate of oxygen production / $cm^3\ s^{-1}$
0	0	0.0
1.0	18	0.6
1.5	26	.....
2.0	35	1.2
3.5	42	1.4
5.0	43	1.4

(i) Calculate the rate of oxygen production in $cm^3\ s^{-1}$ for **1.5 vol hydrogen peroxide**, **to one decimal place**, and **write your answer in Table 3.2**. [2]

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(ii) Use the data from **Table 3.2** to complete **Graph 3.3** to show the rate of oxygen production against the concentration of hydrogen peroxide. [4]

Graph 3.3

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(iii) Describe **and** explain the trend shown in **Graph 3.3**. [3]

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(iv) Suggest **two** ways in which the validity of the data could be improved. [2]

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(v) Copper sulfate is a non-competitive inhibitor of catalase.
On **Graph 3.3**, **draw a labelled line** to show how the result would be different if the experiment was repeated in the presence of copper sulfate. [1]

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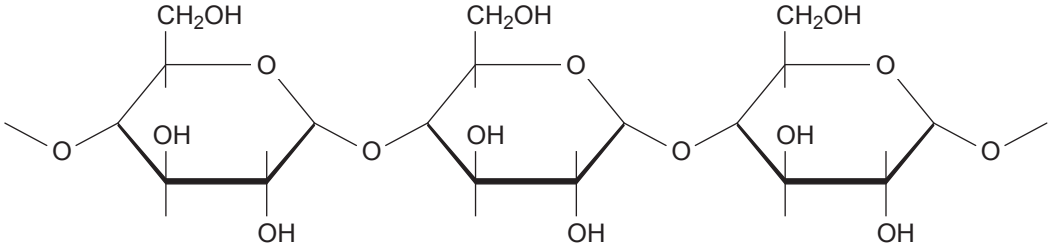
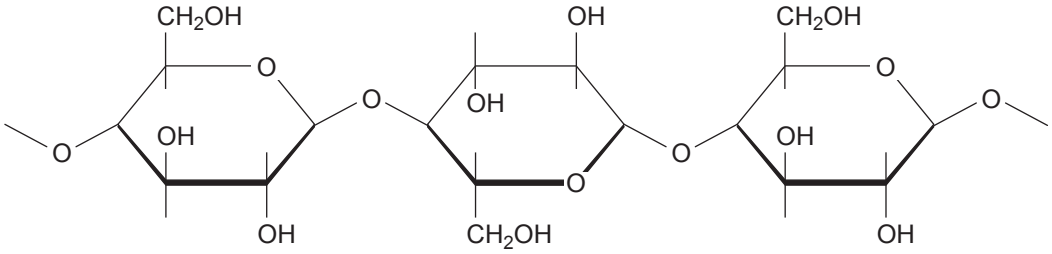
4. (a) Different structural isomers of glucose are found in polysaccharides with very different properties. Parts of two polysaccharides (**A** and **B**) which are found in plants are shown in **Image 4.1**.

Image 4.1

A



B



(i) State what is meant by the term structural isomer. [1]

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(ii) Complete **Table 4.2** to describe the structure and function of the polysaccharides **A** and **B**, found in plants. [6]

Table 4.2

	Polysaccharide **A**	Polysaccharide **B**
Name of polysaccharide	.....	.....
Isomer of glucose present	.....	.....
Description of structure	....	....
Function in a plant cell	....	....

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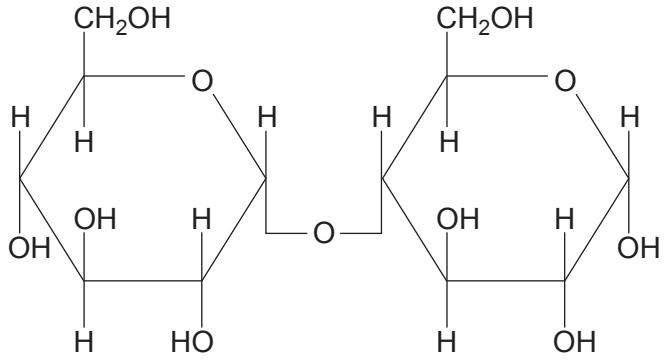
(iii) Polysaccharide **A** is hydrolysed by an enzyme which results in production of the disaccharide shown in **Image 4.3**.

Image 4.3



State the meaning of the term hydrolysis **and** name the disaccharide shown in **Image 4.3**.

[2]

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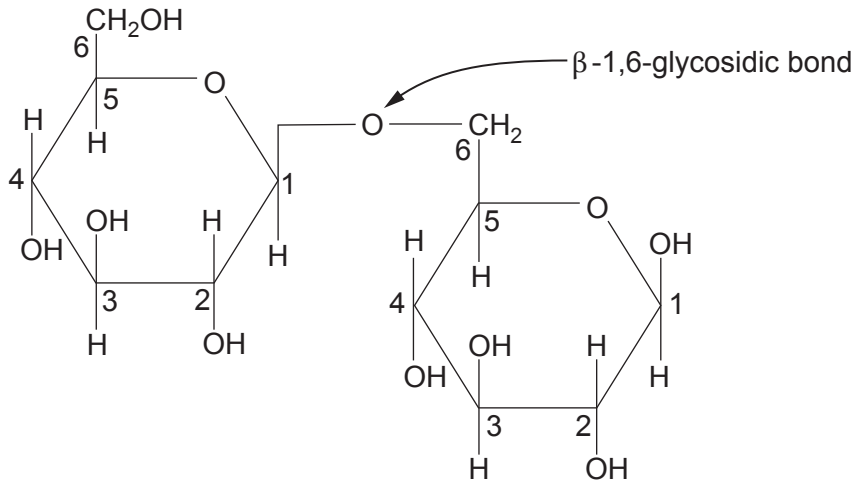
(b) Gentiobiose, shown in **Image 4.4**, is a disaccharide which consists of two glucose monomers joined by a β-1,6-glycosidic bond.

Image 4.4



Identify **one** structural similarity and **two** structural differences in the disaccharides shown in **Images 4.3** and **4.4**. [3]

Structural similarity .....

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Structural difference 1 .....

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Structural difference 2 .....

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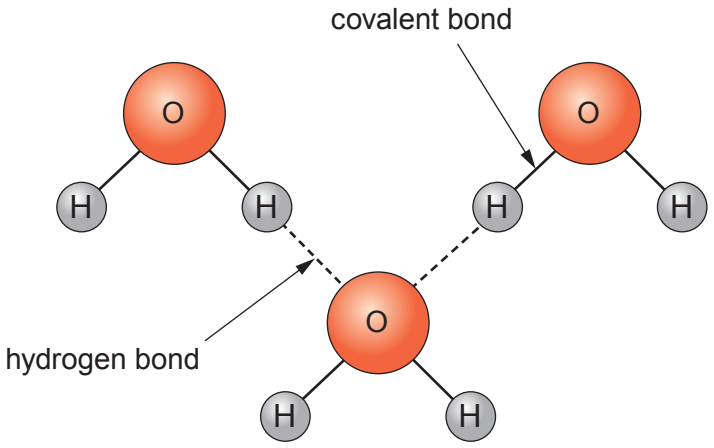
(c) Monosaccharides and disaccharides are polar molecules, they are soluble in water.

Image 4.5 shows some water molecules and their bonds.

Image 4.5



(i) **Annotate Image 4.5**, to show the polarity of a water molecule. [1]

(ii) With reference to **Images 4.3, 4.4** and **4.5**, explain why monosaccharides and disaccharides are soluble in water. [1]

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(iii) State why it is important to plants that sugars are soluble. [2]

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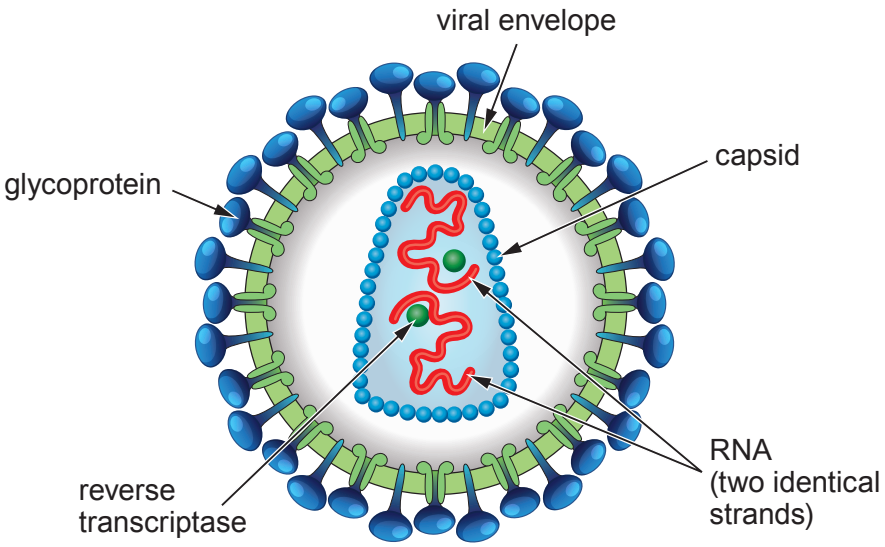
5. The Human Immunodeficiency Virus (HIV) was identified in the 1980s. It targets cells called lymphocytes which are part of the immune system.
Image 5.1 shows a diagram of HIV.

Image 5.1



- HIV contains reverse transcriptase, an enzyme involved in viral RNA replication.
- RNA and reverse transcriptase are contained within a capsid which is surrounded by a viral envelope.
- The viral envelope contains a phospholipid bilayer.
- Glycoproteins, projecting from the viral envelope, allow the virus to infect lymphocytes.

(a) (i) Use your knowledge of the one gene one polypeptide hypothesis and **Image 5.1** to identify the **minimum** number of genes within the viral RNA. Explain your answer. [3]

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(ii) Use your knowledge of viral structure to give **two** reasons why HIV cannot reproduce without infecting a host cell. [2]

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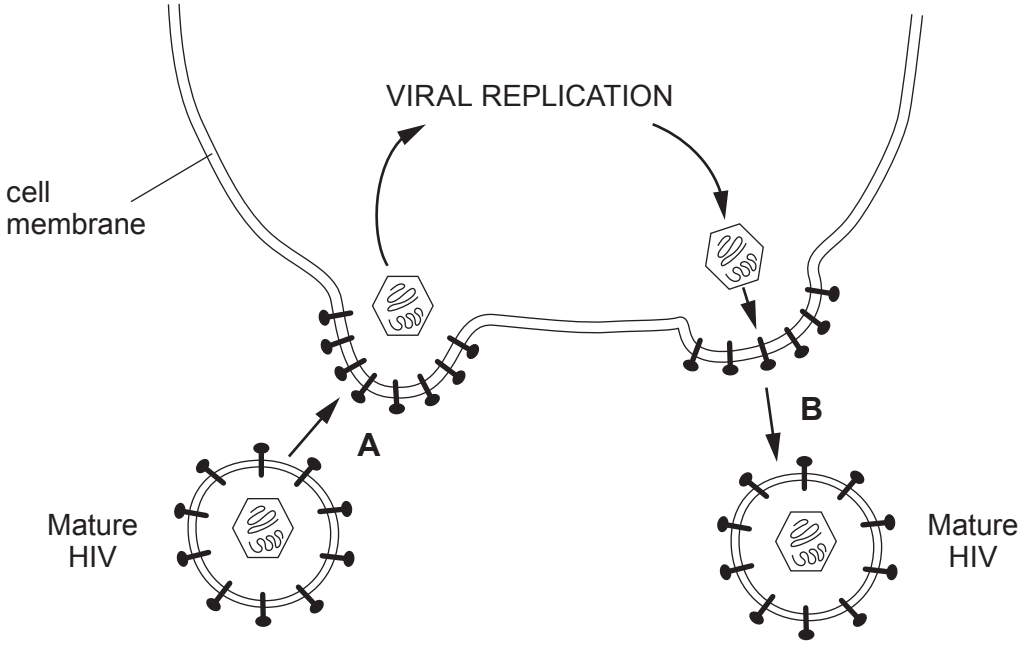
(b) **Image 5.2** shows how HIV infects a human cell and makes copies of itself.

Image 5.2



(i) Assuming the virus is spherical and that the diameter of HIV across the viral envelope is 120 nm, use the formula below to calculate the surface area of HIV. [2]

Surface area of a sphere = $4\pi r^2$.
$\pi = 3.14$

Surface area = ... nm^2

(ii) With reference to **Image 5.2**, state the names of the processes occurring at **A** and **B**. Explain the effect each process has on the total surface area of the infected cell. [2]

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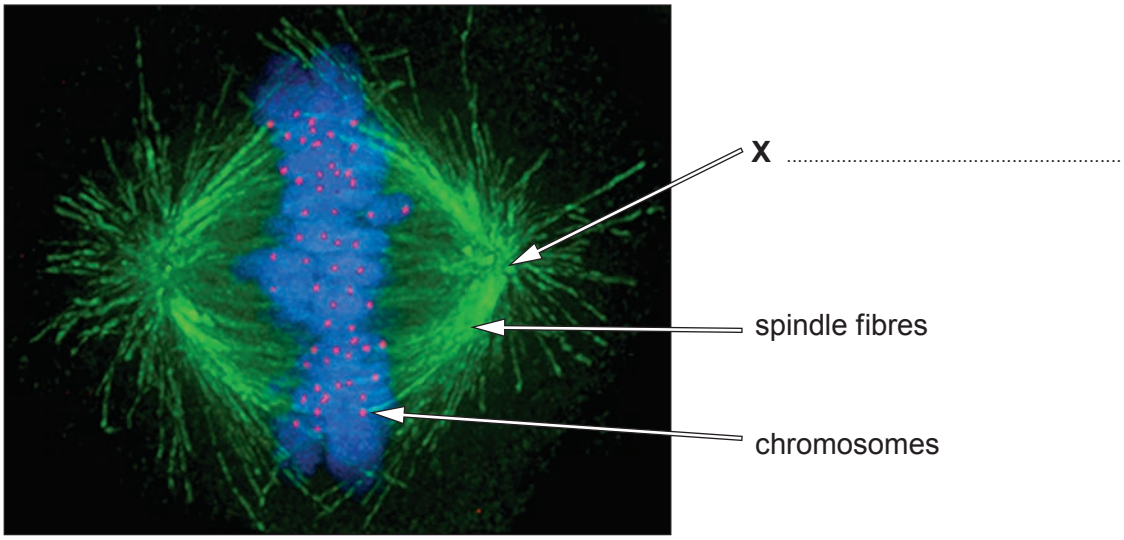
6. **Image 6.1** shows a eukaryotic cell undergoing mitosis. Different structures have been stained with different fluorescent dyes.

Image 6.1



(a) (i) On **Image 6.1**, name the origin of the spindle fibres, labelled **X**. [1]

(ii) I. Name the stage of mitosis shown in **Image 6.1**. Explain your reasoning. [2]

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II. In the space below **draw a labelled diagram** of **one chromosome** as it would appear at this stage of mitosis. Your diagram should have **two** labels. [2]

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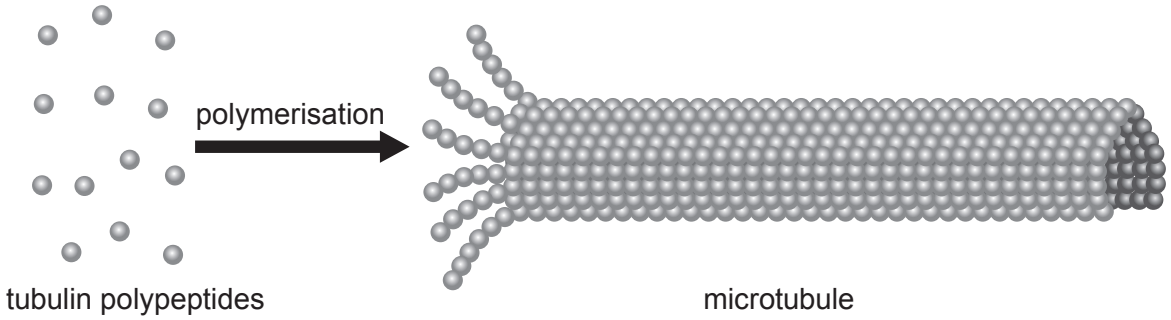
(b) The mitotic spindle is formed at the start of mitosis, it is made up of many small polypeptides called tubulin which are found in the cytoplasm of eukaryotic cells. Before cell division, the tubulin polypeptides must be assembled and joined together to form microtubules. This is shown in **Image 6.2**.

Image 6.2



(i) Use the information provided to state the highest level of protein structure shown by the microtubule in **Image 6.2**. Explain your answer. [2]

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(ii) Colchicine is a chemical which prevents the polymerisation of tubulin to form microtubules.
Suggest how this would affect the growth of organisms. Explain your answer. [3]

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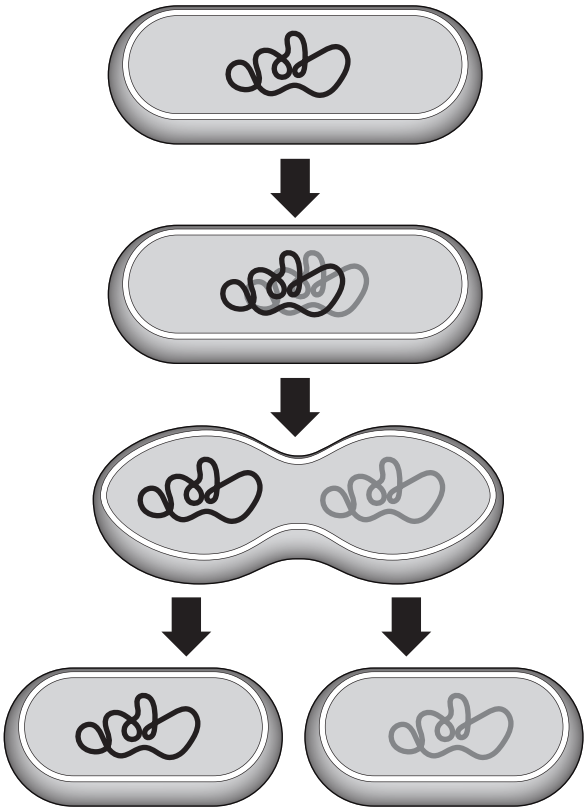
(c) When bacteria reproduce, they undergo a process called binary fission. This is shown in **Image 6.3**.

Image 6.3



Use **Image 6.3** and your knowledge of eukaryotic cell division to give **two** reasons why cell division in bacteria is not referred to as mitosis. [2]

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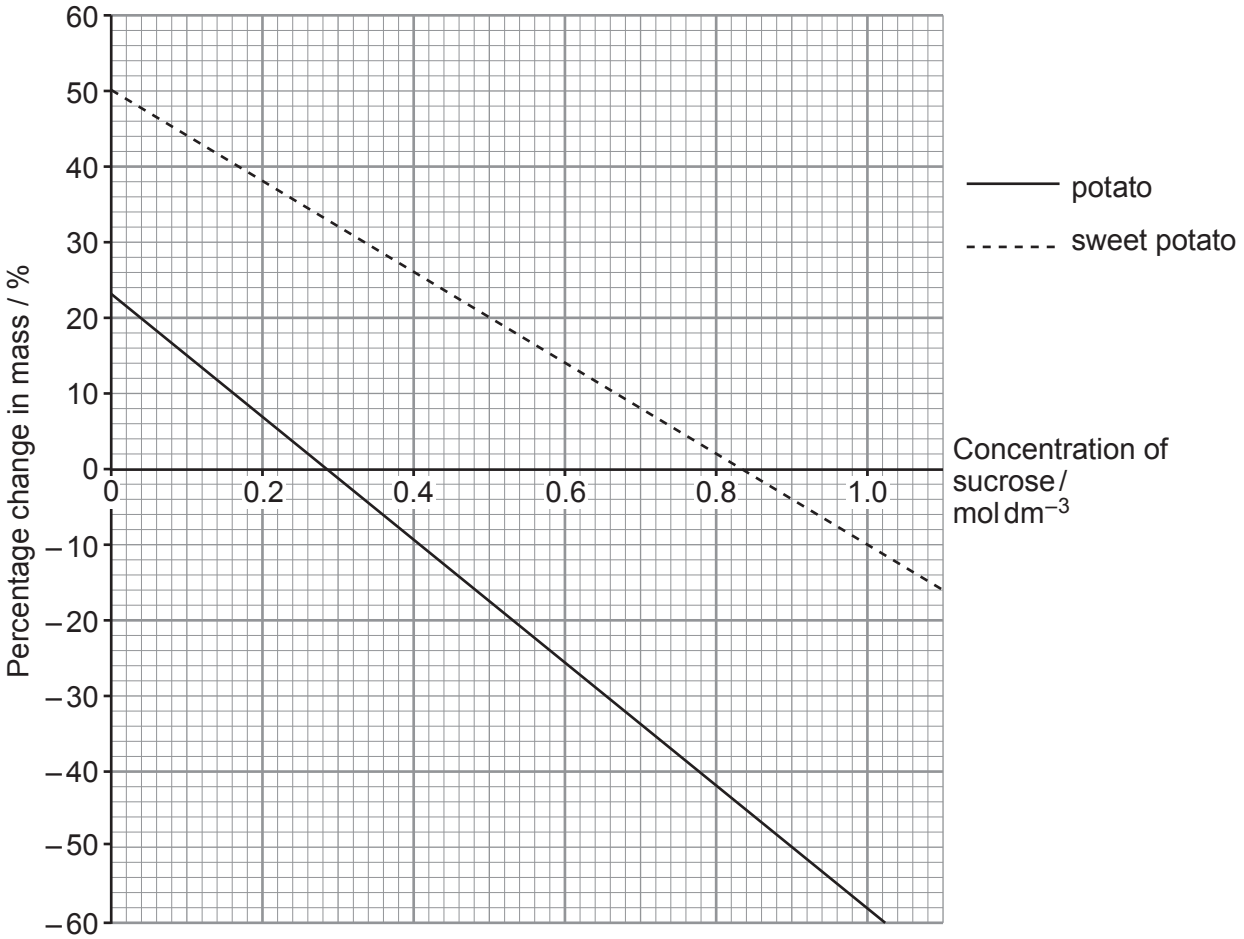
7. A student carried out an experiment to investigate osmosis in plant tissues.
The student used the same volume of sucrose solutions of different concentrations.
Pieces of potato and sweet potato were weighed, added to each sucrose concentration and left for 20 minutes. The change in mass was recorded and the percentage change in mass calculated then plotted on a graph as shown in **Graph 7**.

Graph 7



Use your knowledge of osmosis, describe and explain the general trend of the data plotted in **Graph 7**.
Use information from **Graph 7** to explain why there is a difference between the data for potato and sweet potato.
Give a description of the expected results if animal tissue was used instead of plant tissue and explain why the results might be different. [9 QER]

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