Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS/A LEVEL

S23-2400U10-1

2400U10-1

MONDAY, 15 MAY 2023 – 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.	**12**	
2.	**13**	
3.	**10**	
4.	**11**	
5.	**13**	
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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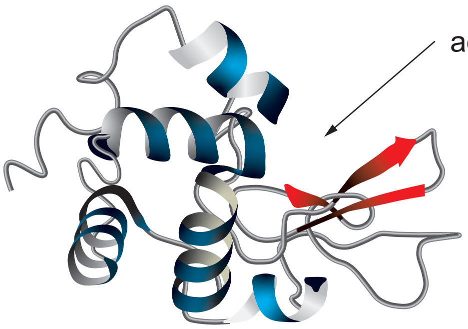
Answer **all** questions.

1. Lysozyme is an enzyme found in saliva and tears. It hydrolyses the carbohydrates in bacterial cell walls. Lysozyme, shown in **Image 1.1**, is a single polypeptide containing 129 amino acids.

Image 1.1 Ribbon diagram of lysozyme



(a) Lysozyme shows primary, secondary and tertiary structure.

(i) State what is meant by primary structure. [1]

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(ii) Use the information given and your own knowledge to **complete Table 1.2** to explain how the secondary and tertiary structures of lysozyme are illustrated in **Image 1.1**. [2]

Table 1.2

Level of structure	Explanation
Secondary	....
Tertiary	....

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(iii) The cytoplasm of bacterial cells is **hypertonic** to saliva and tears. Suggest how the destruction of the cell wall of bacteria by lysozyme results in the death of the bacteria. [3]

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(iv) Lysozyme works by an induced fit mechanism. Explain what this means. [1]

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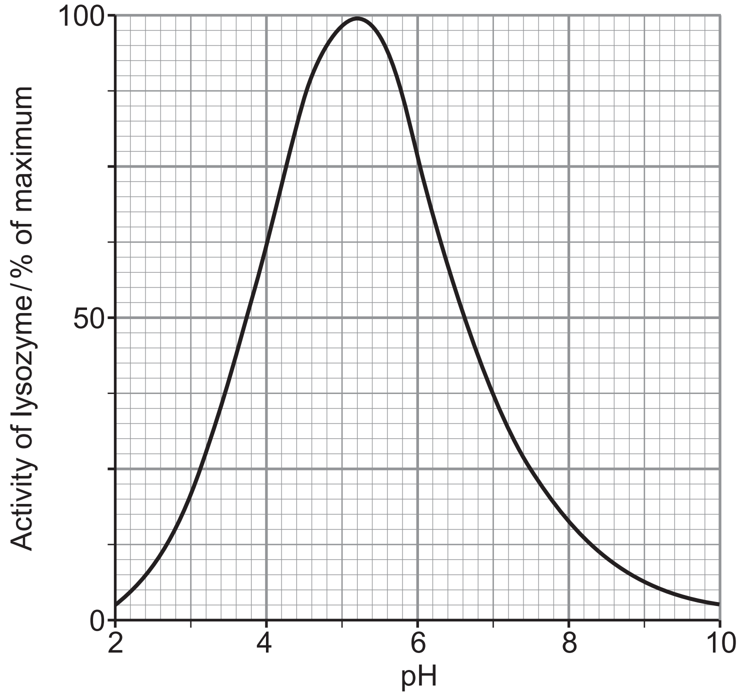
(b) The effect of pH on the activity of lysozyme is shown in **Graph 1.3**.

Graph 1.3



(i) Describe and explain the effect of pH on the activity of lysozyme. [3]

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(ii) Lysozyme has a wider range of pH activity than many other enzymes.

I. Use **Graph 1.3** to find the range of pH over which the activity of lysozyme is more than 50% of the maximum. [1]

Range = ... to ....

II. Use the information in the question to suggest **one** advantage of lysozyme having a wider range of pH activity than many other enzymes. [1]

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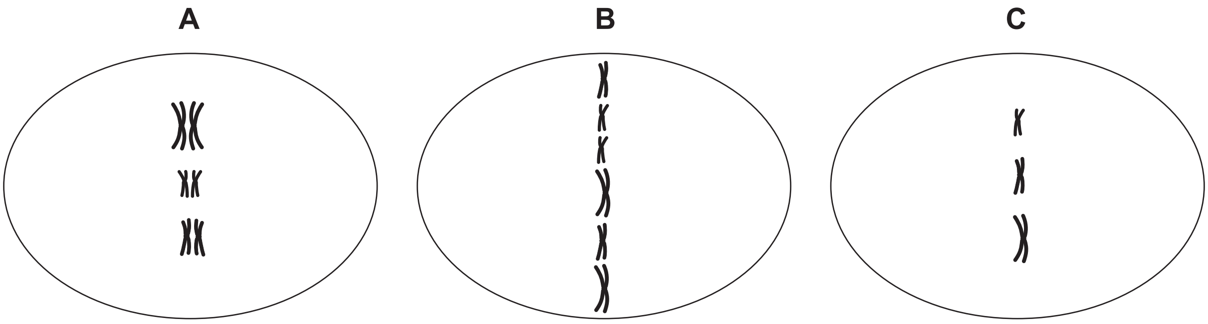
2. **Image 2.1** shows metaphase during cell division of three cells of the mosquito, *Culex pipiens.*

The mosquito has a diploid number of 2n = 6.

Image 2.1



(a) (i) Insert the correct letter (**A**, **B** or **C**) into the table to indicate which stage of cell division is represented by each cell. [2]

Metaphase of:	Letter
Mitosis	....
Meiosis I	....
Meiosis II	....

(ii) State **two** differences in the daughter cells of *Culex pipiens* following mitosis and meiosis. [2]

Difference	Mitosis	Meiosis
1.	....	....
2.	....	....

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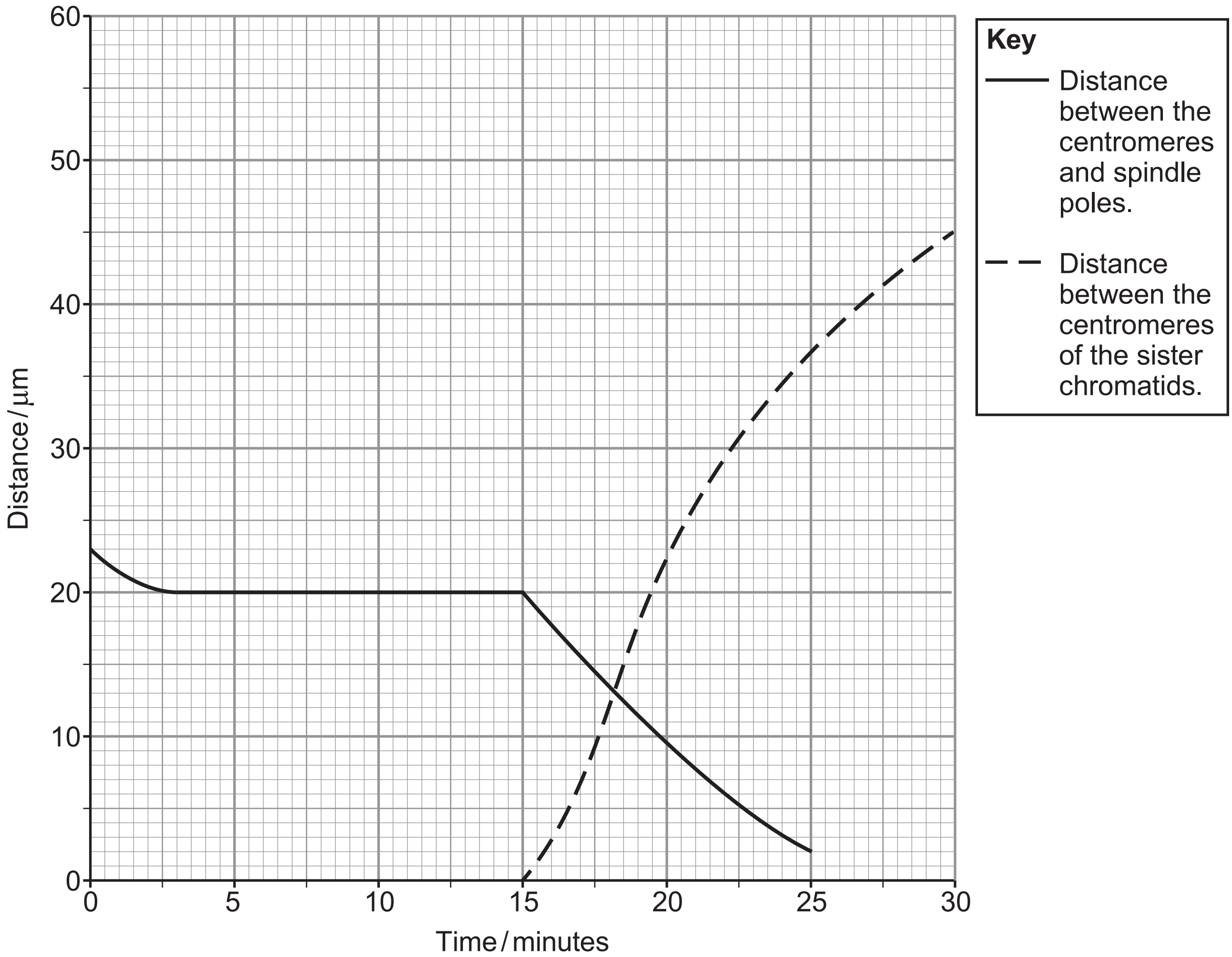
(b) **Graph 2.2** shows some changes seen in a cell undergoing mitosis.

Graph 2.2



(i) Calculate the rate of increase in distance between the centromeres of the sister chromatids between 15 and 30 minutes. [2]

Rate = ... μm $minute^{-1}$

(ii) Suggest how **Graph 2.2** provides evidence to show what happens to the chromosomes during anaphase of mitosis. [2]

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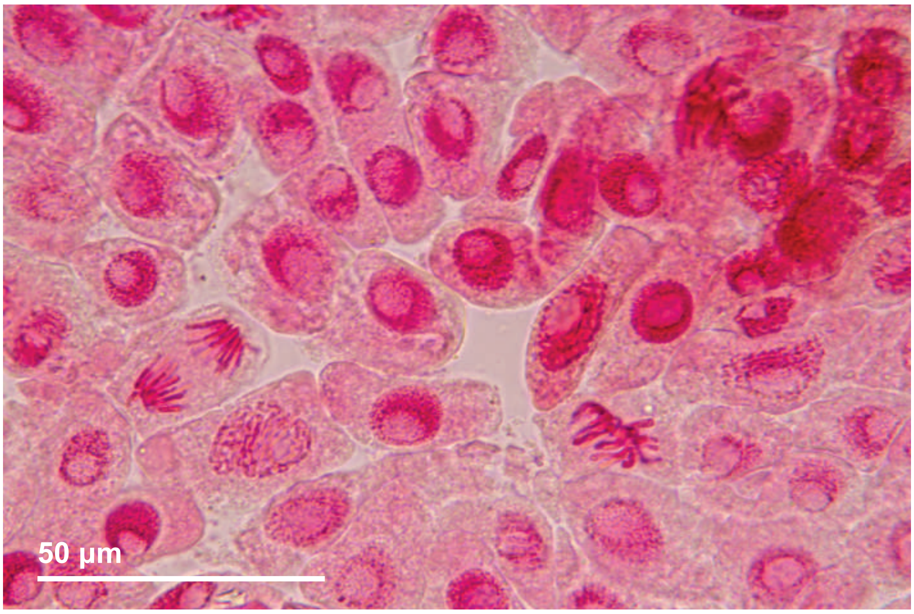
(c) The micrograph in **Image 2.3** shows onion plant cells undergoing mitosis.

Image 2.3



(i) **Use the scale bar** to calculate the magnification of **Image 2.3**. [2]

Magnification = × ....

(ii) **On Image 2.3 label:** [1]

A **one** cell in anaphase

B **one** cell in metaphase

(iii) Suggest from which part of the onion plant the cells in **Image 2.3** were taken. Explain your answer. [2]

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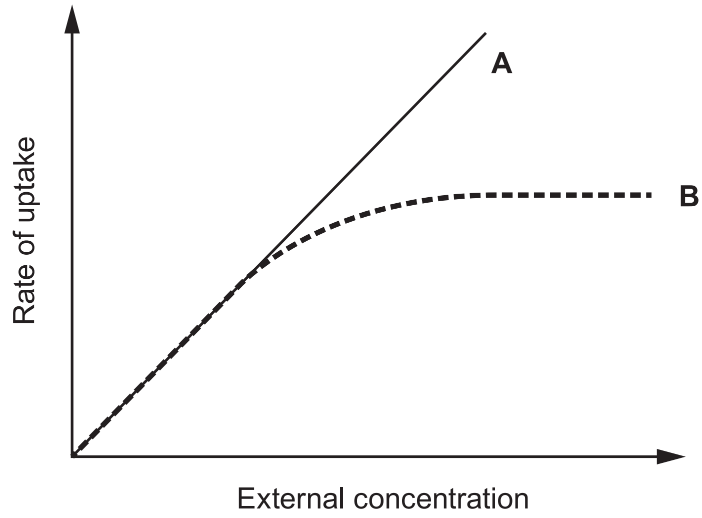
3. (a) Red blood cells need to take in glucose and oxygen from the blood plasma. Glucose is a polar molecule and oxygen is non-polar.

The uptake of glucose and oxygen by red blood cells was measured separately at increasing external concentrations of these two molecules.

Graph 3.1 shows the rate of uptake of glucose and oxygen.

Graph 3.1



(i) **Complete Table 3.2** to identify:

- which line on **Graph 3.1** represents glucose and which represents oxygen;
- the type of transport used by each substance. [2]

Table 3.2

Line	Substance	Type of transport
A	…………………………	…………………………………………………………………………
B	…………………………	…………………………………………………………………………

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(ii) Explain the difference in the shape of lines **A** and **B** shown on **Graph 3.1**. [4]

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(b) Red blood cells are packed full of haemoglobin.
When mature, they do not contain any of the organelles usually found in eukaryotic cells.

Using this information and your knowledge of **cell structure** conclude why mature red blood cells:

(i) cannot make haemoglobin; [2]

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(ii) can only transport substances across the cell membrane against a concentration gradient at very low rates. [2]

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4. Starch is made up of two molecules, amylose and amylopectin, shown in **Image 4.1**.

Image 4.1

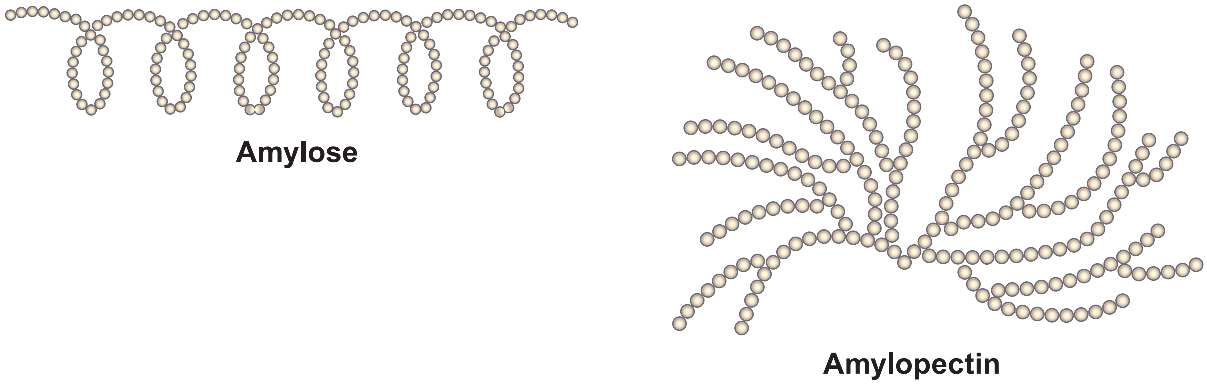
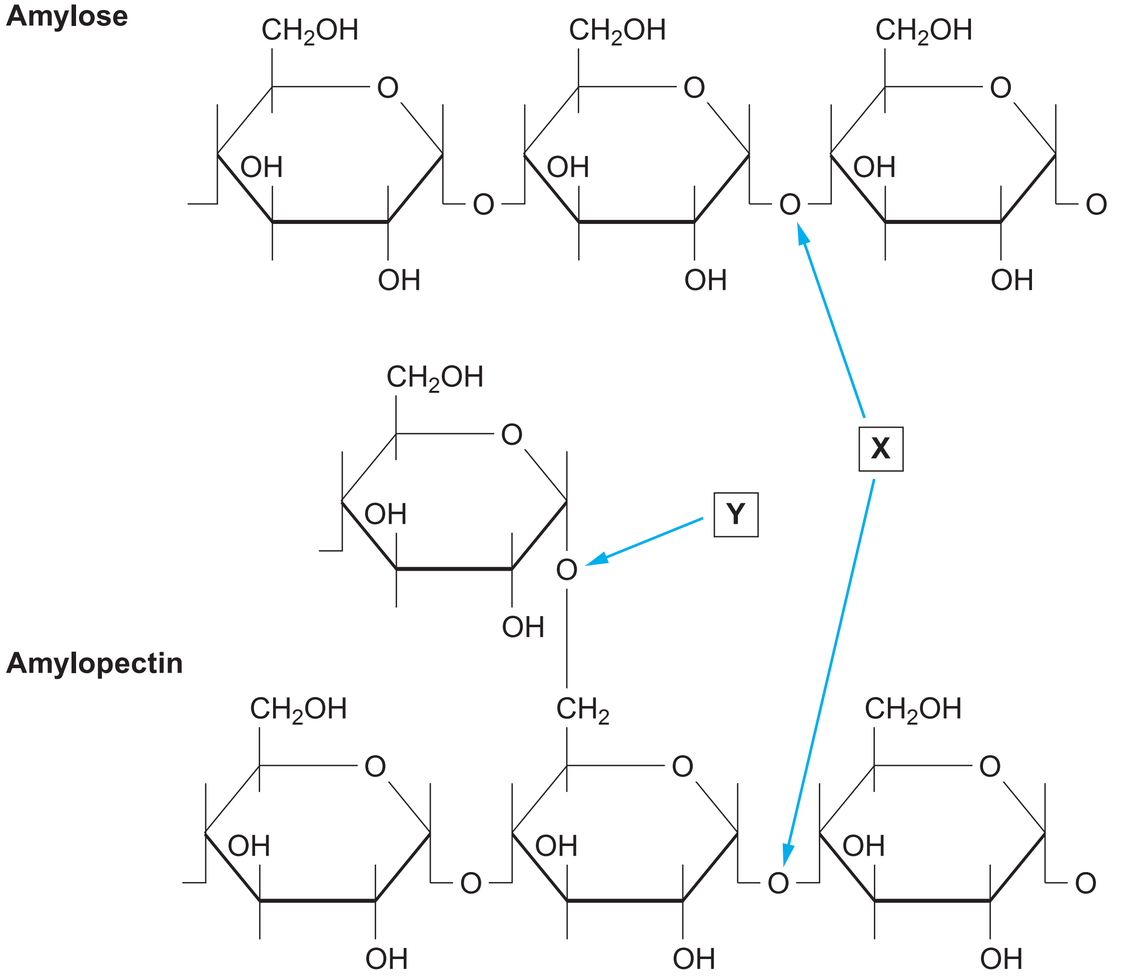


Image 4.2 shows sections of amylose and amylopectin.

Image 4.2



(a) (i) State the general name given to **bonds X** and **Y**. [1]

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(ii) State **one** similarity and **one** difference between amylose and amylopectin, shown in **Images 4.1** and **4.2**. [2]

Similarity ....

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Difference ....

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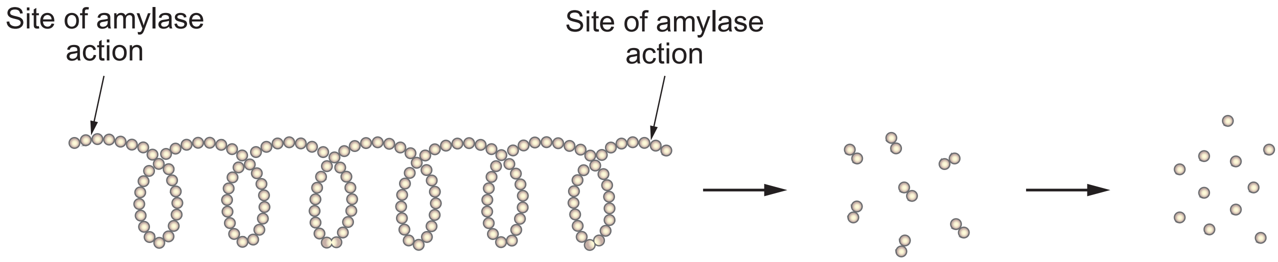
(b) In order to be absorbed into the blood, starch has to be hydrolysed to produce glucose. The digestion of amylose happens in two stages as shown in **Image 4.3**.

Image 4.3



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

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Amylopectin is digested in a similar way but needs an additional enzyme, isomaltase, for complete hydrolysis.

(ii) Explain the roles of the **three** enzymes involved in the complete hydrolysis of starch. [3]

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(iii) One variety of corn used in animal feed has a lower amylose : amylopectin ratio than other varieties. With reference to **Images 4.2** and **4.3**, suggest why this lower ratio results in an increase in the rate of starch hydrolysis. [2]

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(iv) Describe a chemical test that could be used to show that starch is no longer present at the end of hydrolysis. [2]

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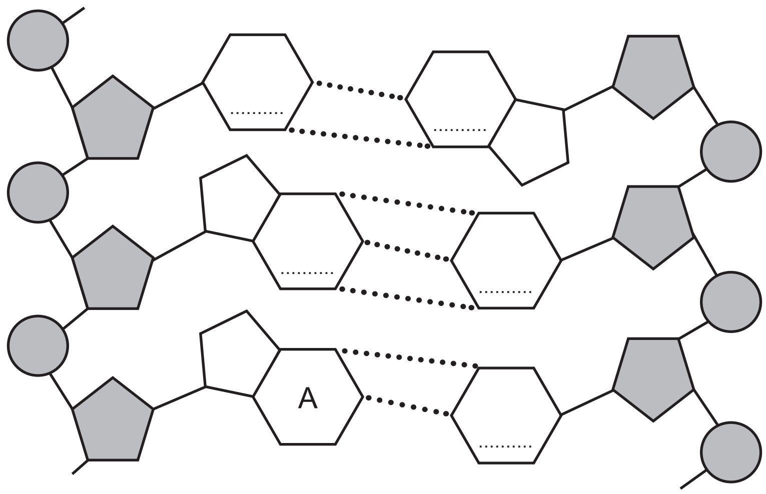
5. (a) **Image 5.1** represents part of a DNA molecule.

Image 5.1



(i) Circle **one** nucleotide in **Image 5.1**. [1]

(ii) Using the letters **A**, **C**, **T**, **G**, label **all** the organic bases in **Image 5.1**. One adenine is labelled already. [2]

(iii) In the late 1940s, Erwin Chargaff published his research into the base composition of the DNA in different species.
Some of his findings are shown in **Table 5.2**.

Table 5.2

Organism	Percentage of base			
	Adenine	Guanine	Cytosine	Thymine
maize	26.8	22.8	23.2	27.2
chicken	28.0	22.0	21.6	28.4
yeast	31.3	18.7	17.1	32.9
sea urchin	32.8	....	....	....

I. Complete **Table 5.2** to suggest values for the sea urchin. [1]

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II. Based on the results in **Table 5.2**, state the conclusion that can be made regarding the base composition of DNA. Explain your answer. [3]

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(b) Meselson and Stahl also carried out investigations on DNA in the 1950s. They proposed the theory of semi-conservative replication. State what is meant by semi-conservative replication. [2]

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(c) DNA contains only four different bases, but proteins can be made of up to 20 different amino acids. Explain how these four bases allow for the production of so many different proteins. [4]

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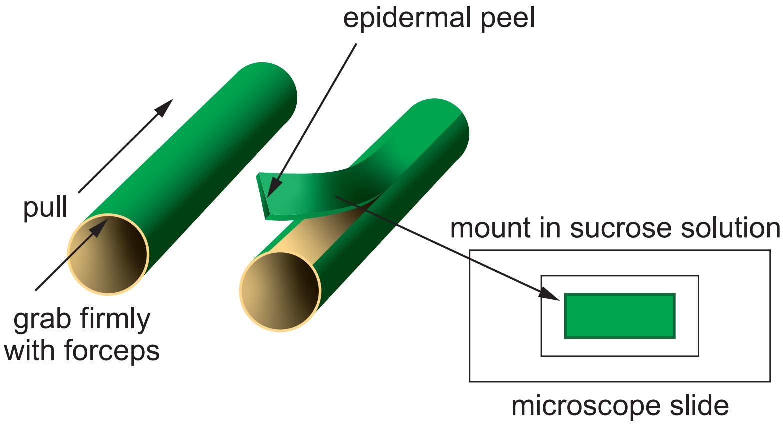
6. *Tradescantia*, shown in **Image 6.1**, is a house plant which is popular due to its ability to survive long periods without watering because its stems can store water.

Image 6.1

The solute potential of the cells of the stem was measured by using epidermal peels as shown in **Image 6.2**. Each peel was mounted on a different microscope slide in a different concentration of sucrose solution.

Image 6.2



After 10 minutes the peels were observed under a microscope. The number of plasmolysed and unplasmolysed cells in each sample was recorded. The results are shown in **Table 6.3**.

Table 6.3

Sucrose concentration/ $mol\,dm^{-3}$	Number of plasmolysed cells	Number of unplasmolysed cells	Total cells counted	Percentage of cells plasmolysed
0.0	0	165	165	0.0
0.2	20	174	194	10.3
0.4	90	105	195	46.2
0.6	87	69	156	55.8
0.8	76	54	130	58.4
1.0	172	73	....	....

(a) (i) **Complete Table 6.3** for 1.0 $mol\,dm^{-3}$ sucrose. [2]

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(ii) Use the data in **Table 6.3** to draw a graph which shows the percentage of plasmolysed cells against sucrose concentration. [4]

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(iii) I. Use your graph and the formula below to estimate the solute potential of the solution when 50% of the *Tradescantia* cells are plasmolysed. [2]

Solute potential (Ψs) = − (sucrose concentration × 24.35)

Solute potential = ... kPa

II. State the pressure potential of the cells in the tissue of *Tradescantia* at this solute concentration and identify the term that describes their condition. [2]

Pressure potential (Ψp) = ... kPa

Term = ...

(b) Suggest how the experiment could be altered to improve:

- confidence in the results
- the accuracy of the estimated solute potential in *Tradescantia* cells. [2]

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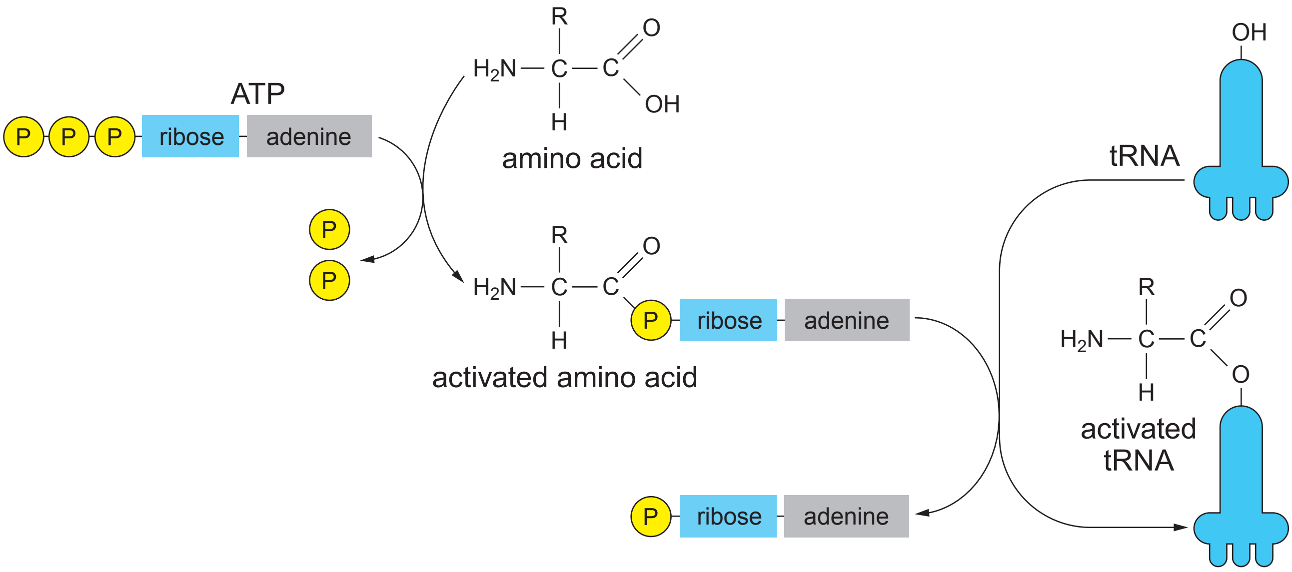
7. DNA, mRNA, rRNA and tRNA are nucleic acids involved in protein synthesis. For tRNA to carry out its role in protein synthesis it needs to undergo the process shown in **Image 7**.

Image 7



Describe the function of each of the **four** types of nucleic acid involved in protein synthesis and state where in the cell each carries out its function. (A detailed description of protein synthesis is not required.)

Using the information given, explain the role of ATP in the process shown in **Image 7**. [9 QER]

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