2021 ASSESSMENT MATERIALS

A-Level
BIOLOGY
Biological Molecules/Cells

Total number of marks: 48

10.3 Describe the chemical reactions involved in the conversion of polymers to monomers and monomers to polymers.

Give **two** named examples of polymers and their associated monomers to illustrate your answer.

[5 marks]

01.1 The action of the carrier protein **X** in **Figure 1** is linked to a membrane-bound ATP hydrolase enzyme.

Explain the function of this ATP hydrolase.

[2 marks]

01.2 The movement of Na^+ **out** of the cell allows the absorption of glucose **into** the cell lining the ileum.

Explain how.

[2 marks]

01.3 Describe and explain **two** features you would expect to find in a cell specialised for absorption.

[2 marks]

01.4 Draw phospholipids on **Figure 2** to show how the carrier protein, SGLT1, would fit into the cell-surface membrane.

Do **not** draw more than eight phospholipids.

[2 marks]

01.5 **Figure 2** shows the SGLT1 polypeptide with NH_2 at one end and COOH at the other end.

Describe how amino acids join to form a polypeptide so there is always NH_2 at one end and COOH at the other end.

You may use a diagram in your answer.

[2 marks]

04.1 Formation of an enzyme-substrate complex increases the rate of reaction.

Explain how.

[2 marks]

04.2 A scientist measured the rate of removal of amino acids from a polypeptide with and without an enzyme present. With the enzyme present, 578 amino acids were released per second. Without the enzyme, 3.0×10^{-9} amino acids were released per second.

Calculate by how many times the rate of reaction is greater with the enzyme present. Give your answer in standard form.

[2 marks]

$\frac{578}{3.0 \times 10^{-9}} = 1.9267 \times 10^{11}$

$\simeq 1.93 \times 10^{11}$

Answer = 1.93×10^{11} times faster

10.3 Polymers are converted to monomers through hydrolysis. Polymers can form from monomers through condensation reactions.

Polypeptides are formed from condensation reaction between amino acids. The carboxylic group of one amino acid reacts with an amino group. A water molecule is eliminated and a peptide bond is formed. During hydrolysis, the peptide bond is broken.

Starch is formed from glucose monomers through condensation. Glycosidic bonds are formed, which are broken down during hydrolysis of starch to give glucose molecules.

01.1 To catalyse the hydrolysis of ATP to ADP and Pi for energy release. This reaction is coupled to the transport of Na^+ and K^+ across the cell membrane.

01.2 Glucose is transported into the cell via facilitated diffusion, by a cotransporter transporting glucose and sodium into the cell. The movement of Na^+ helps to maintain the concentration gradient required for the facilitated diffusion of glucose.

01.3 Cells have microvilli which increases the surface area for absorption. They also have a rich blood supply so that the molecules absorbed can be carried away in the blood quickly to maintain a steep concentration gradient. These increases the rate of diffusion.

01.4

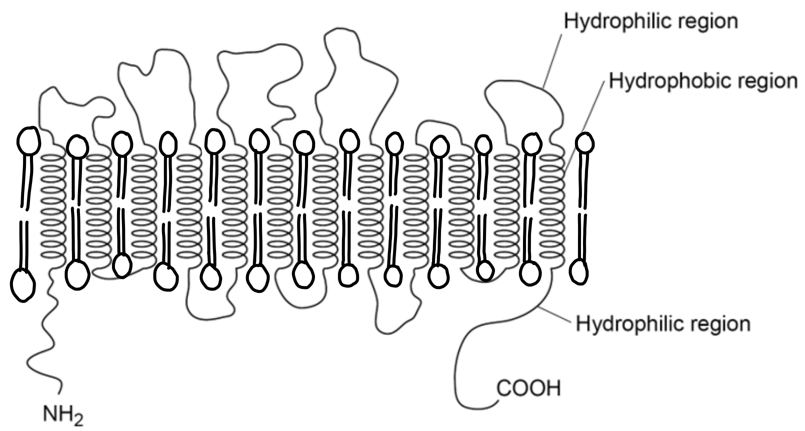
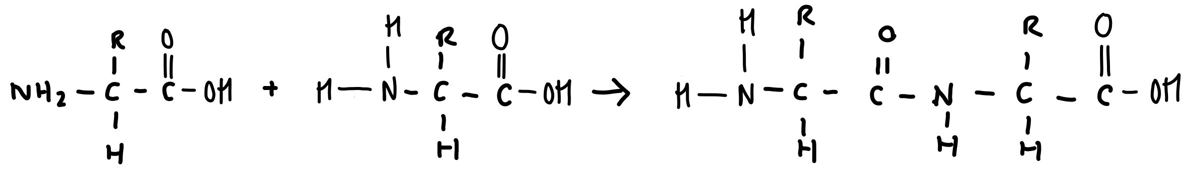


Figure 2.

01.5



The carboxyl group of an amino acid will react with the amino group of the neighbouring amino acid, so there will always be a free amino group at one end and a free carboxyl group in the other end.

04.1 When enzyme-substrate complexes form, the enzyme will catalyse the reaction by reducing the activation energy required. If enzyme-substrate complexes are not formed, few substrates will have sufficient energy for reaction to take place.

Another scientist investigated an enzyme that catalyses the following reaction.

$$ATP \rightarrow ADP + Pi$$

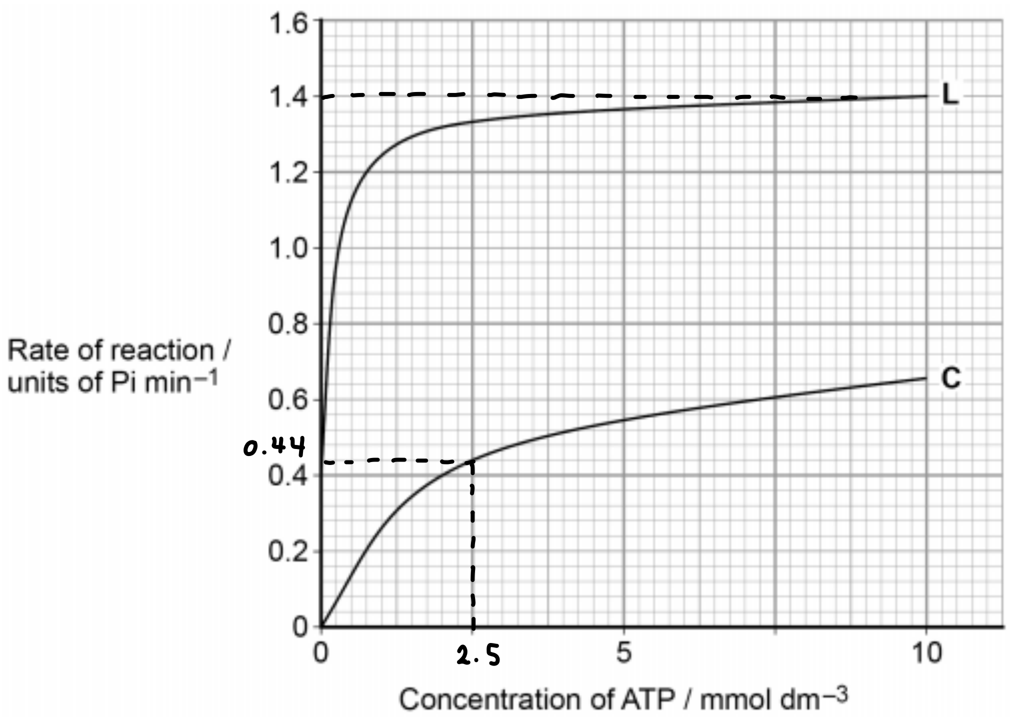
The scientists set up two experiments, **C** and **L**.

Experiment **C** used
- the enzyme
- different concentrations of ATP.

Experiment **L** used
- the enzyme
- different concentrations of ATP
- a sugar called lyxose.

The scientists measured the rate of reaction in each experiment. Their results are shown in **Figure 5**.

Figure 5



0 4 . 3 Calculate the rate of reaction of the enzyme activity with no lyxose at 2.5 mmol dm^{-3} of ATP as a percentage of the maximum rate shown with lyxose.

[2 marks]

$\frac{0.44}{1.4} \times 100 = 31.428... \%$

$\approx 31.4\%$

Answer = 31.4 %

0 4 . 4 Lyxose binds to the enzyme.

Suggest a reason for the difference in the results shown in **Figure 5** with and without lyxose.

[3 marks]

Lyxose might be a cofactor which binds to the enzyme to change its tertiary structure. The shape of the active site is altered and allows substrates to bind more easily. More enzyme-substrate complexes are formed so rate of reaction is higher.

0 7 . 1 Alpha-gal is a disaccharide found in red meat.

Alpha-gal is made of two galactose molecules. Galactose has the chemical formula $C_6H_{12}O_6$

Give the chemical formula for the disaccharide, alpha-gal, and describe how it is formed from two galactose molecules.

[2 marks]

Formula $C_{12}H_{22}O_{11}$

Description formed by condensation reaction, a glycosidic bond is formed and a water molecule is eliminated

1 0 . 2 Mucus produced by epithelial cells in the human gas exchange system contains triglycerides and phospholipids.

Compare and contrast the structure **and** properties of triglycerides and phospholipids.

[5 marks]

0 9 . 1 Describe the role of **two** named enzymes in the process of semi-conservative replication of DNA.

[3 marks]

0 8 . 1 Complete **Table 2** to show **three** differences between DNA in the nucleus of a plant cell and DNA in a prokaryotic cell.

[3 marks]

Table 2

DNA in the nucleus of a plant cell	DNA in a prokaryotic cell
1 linear DNA	circular DNA
2 histone proteins involved in packaging of DNA	no histone proteins
3 majority of DNA is non-coding	has very little non-coding region

10.2 In triglycerides, there are 3 fatty acids joined to a glycerol through ester bonds. In fatty acids, there are only 2 fatty acids joined to glycerol and there is also a phosphate group.

Triglycerides are hydrophobic and insoluble in water. Phospholipids are amphiphilic as they have a hydrophobic tail and a hydrophilic head group. This allows phospholipids to form a lipid bilayer in cell membrane.

9.1 DNA helicase binds to DNA and unwinds the double stranded DNA by breaking hydrogen bonds between bases. DNA polymerase synthesise new strands by adding complementary bases in the 5' to 3' direction.

0 2 . 1 **Table 1** shows cell wall components in plants, algae, fungi and prokaryotes.
Complete **Table 1** by putting a tick (✓) where a cell wall component is present.

[3 marks]

Table 1

Cell wall component	**Plants**	**Algae**	**Fungi**	**Prokaryotes**
Cellulose	✓	✓		
Murein				✓
Chitin			✓	

0 6 Scientists investigated the cell cycle in heart cells taken from mice 6 days before their birth and then at 4, 14 and 21 days after their birth.

Their results are shown in **Table 4**. Age 0 days = day of birth.

Table 4

Age / days	**Percentage of heart cells undergoing mitosis**	**Percentage of heart cells undergoing DNA replication**
–6	13.9	8.5
4	8.5	2.6
14	1.6	0.2
21	0.6	0.0

0 6 . 1 Describe and explain the data in **Table 4**.

[2 marks]

Percentage of heart cells undergoing mitosis and percentage of heart cells undergoing DNA replication. During growth and development, more cells undergo mitosis. Cells need to undergo DNA replication before mitosis so there is a positive correlation between percentage of cells undergoing mitosis and cells undergoing DNA replication.

0 8 . 1 The scientists needed solutions of known water potential to generate their calibration curve.

Table 5 shows how to make a sodium chloride solution with a water potential of −1.95 MPa

Complete **Table 5** by giving all headings, units and volumes required to make 20 cm^3 of this sodium chloride solution.

[2 marks]

Table 5

Water potential / MPa	Concentration of sodium chloride solution / mol dm^{-3}	Volume of 1 mol dm^{-3} sodium chloride solution / cm^3	Volume of distilled water / cm^3
−1.95	0.04	0.8	19.2

Table 6 shows some of the concentrations of sodium chloride solution the scientists used and the water potential of each solution.

Table 6

Concentration of sodium chloride solution / mol dm^{-3}	Water potential / MPa
0.04	−1.95
0.10	−4.87
0.12	−5.84

0 8 . 2 There is a linear relationship between the water potential and the concentration of sodium chloride solution.

Use the data in **Table 6** to calculate the concentration of sodium chloride solution with a water potential of −3.41 MPa

[2 marks]

$-4.87 \div 0.10 = -48.7$

$-3.41 \div -48.7 = 0.070$

Answer = 0.070 mol dm^{-3}

The water potential of leaf cells is affected by the water content of the soil.

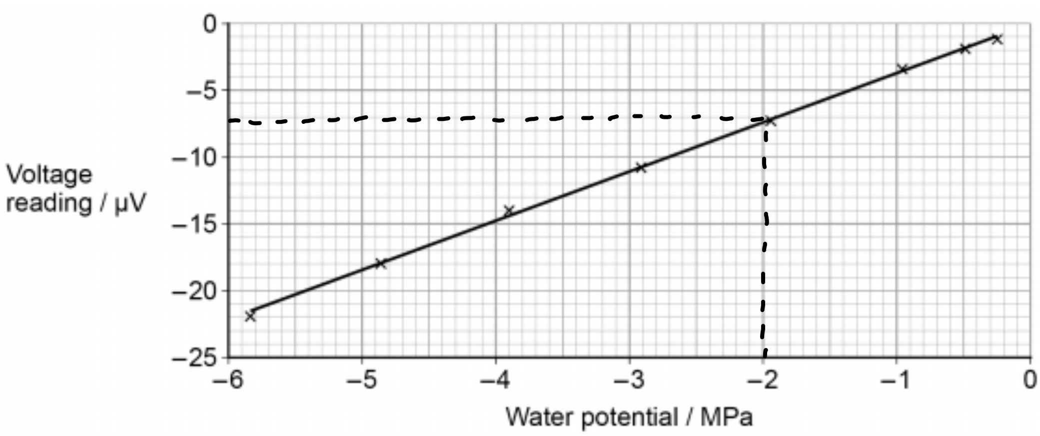
Scientists grew sunflower plants. They supplied different plants with different volumes of water.

After two days, they determined the water potential in the leaf cells by using an instrument that gave a voltage reading.

The scientists generated a calibration curve to convert the voltage readings to water potential.

Figure 8 shows their calibration curve.

Figure 8

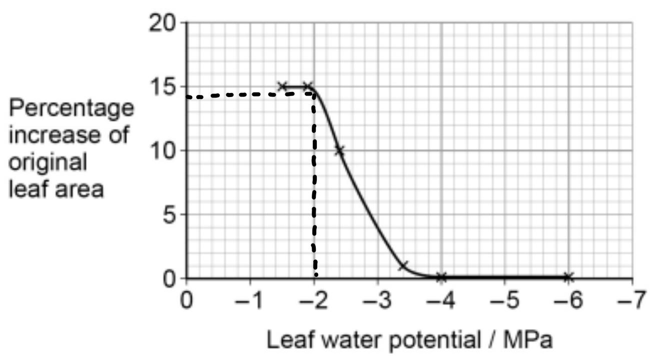


In addition to determining the water potential in the leaf cells, the scientists measured the growth of the leaves.

They recorded leaf growth as a percentage increase of the original leaf area.

Their results are shown in **Figure 9**.

Figure 9



0 8 . 3 One leaf with an original area of 60 cm^2 gave a voltage reading of −7 μV

Use **Figure 8** (on page 28) and **Figure 9** to calculate by how much this leaf increased in area.
Give your answer in cm^2

[2 marks]

percentage increase of original leaf area = 14.5%

60 x 114.5% = 68.7 cm²