# A-Level Biology

## Cell Transport

## Question Paper

**Time available: 66 minutes**
**Marks available: 52 marks**

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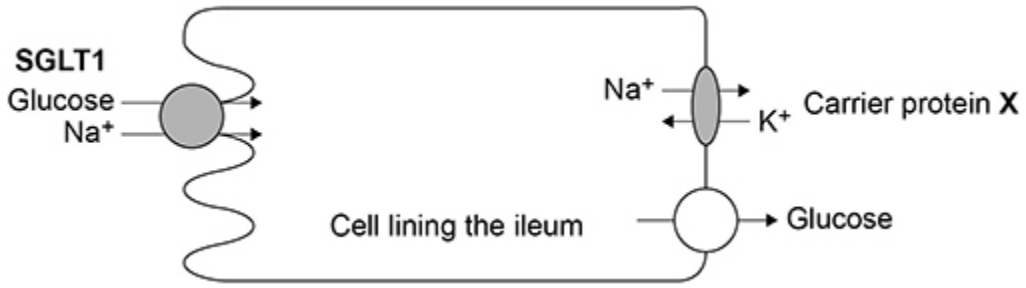
**1.** **Figure 1** shows a cell from the lining of the ileum specialised for absorption of products of digestion.

SGLT1 is a carrier protein found in the cell-surface membrane of this cell, it transports glucose and sodium ions ($Na^+$) into the cell.

**Figure 1**




(a) 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.

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**(2)**

(b) The movement of $Na^+$ **out** of the cell allows the absorption of glucose **into** the cell lining the ileum.

Explain how.

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**(2)**

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

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2 _____

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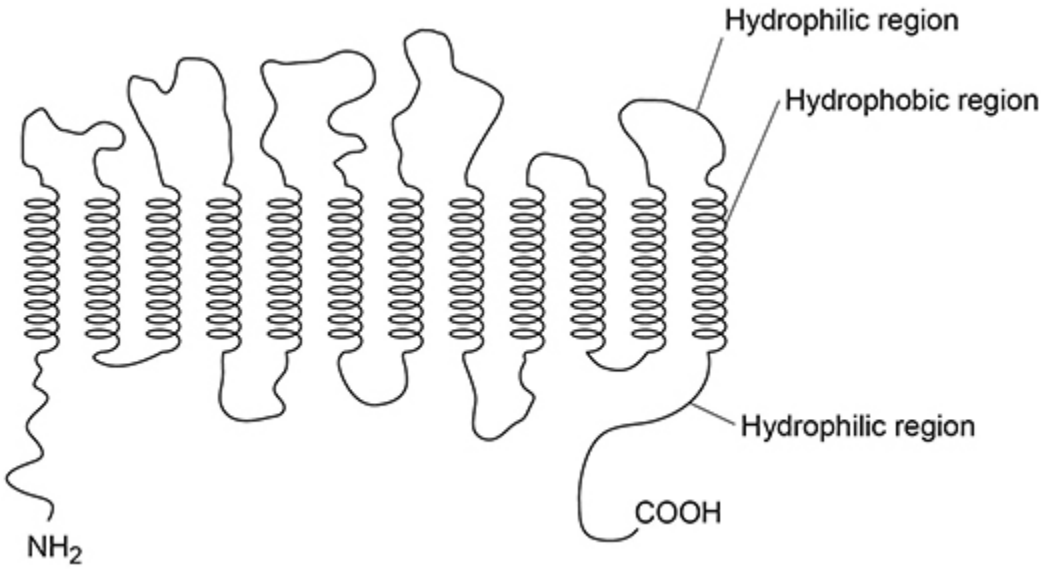
**(2)**

**Figure 2** is a diagram of one SGLT1 carrier protein.

**Figure 2**



(d) 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)**

(e) **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.

Space for diagram:

**(2)**
**(Total 10 marks)**

**2.** Anthocyanins are coloured pigments found in the cell vacuole of some plant cells. Anthocyanins cannot move across undamaged cell membranes.

A student investigated how to extract anthocyanins from blueberries.

She mixed 10 g of crushed, fresh blueberries with 100 $cm^3$ of extraction solvent for 1 hour.

She investigated three different extraction solvents:

- **E** – Ethanol, water and acid
- **F** – Ethanol and water
- **G** – Water

(a) When making up extraction solvent **E**, the student used a volume ratio of 70:30:1 ethanol:water:acid.

Tick (✓) **one** box that shows the most appropriate volumes she would use to make up 100 $cm^3$ of extraction solvent **E**.

63.6 $cm^3$ ethanol, 27.3 $cm^3$ water, 9.1 $cm^3$ acid ☐

69.3 $cm^3$ ethanol, 29.7 $cm^3$ water, 1.0 $cm^3$ acid ☐

70.0 $cm^3$ ethanol, 30.0 $cm^3$ water, 1.0 $cm^3$ acid ☐

70.7 $cm^3$ ethanol, 30.3 $cm^3$ water, 1.0 $cm^3$ acid ☐

**(1)**

(b) The student kept constant:

- the mass of fresh blueberries
- the volume of extraction solvent
- the time for the mixture to stand.

Name **two** other variables the student should have kept constant during this investigation.

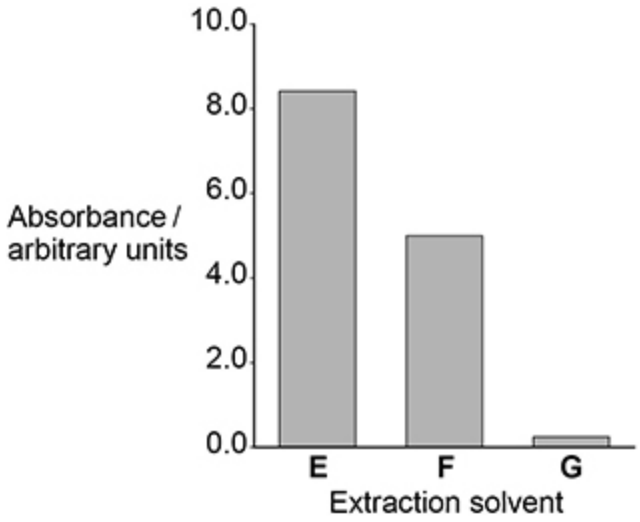
1 _____

2 _____

**(2)**

(c) After 1 hour, the student filtered the samples.
She placed the filtrate in a colorimeter and measured the light absorbance.

Her results are shown in the graph below.




Use your knowledge of membrane structure to explain the results in the graph above.

**(4)**

(d) A different student did this investigation. He did **not** have a colorimeter.

Describe a method this student could use to prepare colour standards and use them to give data for the total anthocyanin extracted.

**(3)**

**(Total 10 marks)**

**3.** (a) Give **two** similarities in the movement of substances by diffusion and by osmosis.

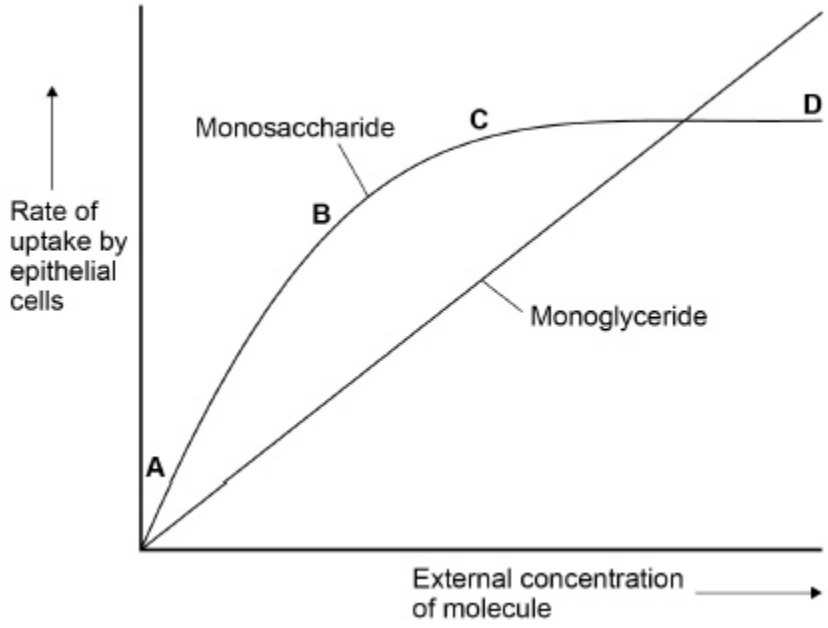
1. _____

2. _____

**(2)**

A scientist measured the rate of uptake of a monoglyceride and a monosaccharide by epithelial cells of the small intestine of mice. A monoglyceride is a molecule of glycerol with one fatty acid attached. She did this for different concentrations of monoglyceride and monosaccharide.

Her results are shown in the graph.




(b) Use your knowledge of transport across membranes to explain the shape of the curve in the graph for uptake of monosaccharides between concentrations:

**A** and **B** _____

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**C** and **D** _____

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**(3)**

(c) The graph is evidence for monoglycerides being lipid-soluble molecules.

Suggest how.

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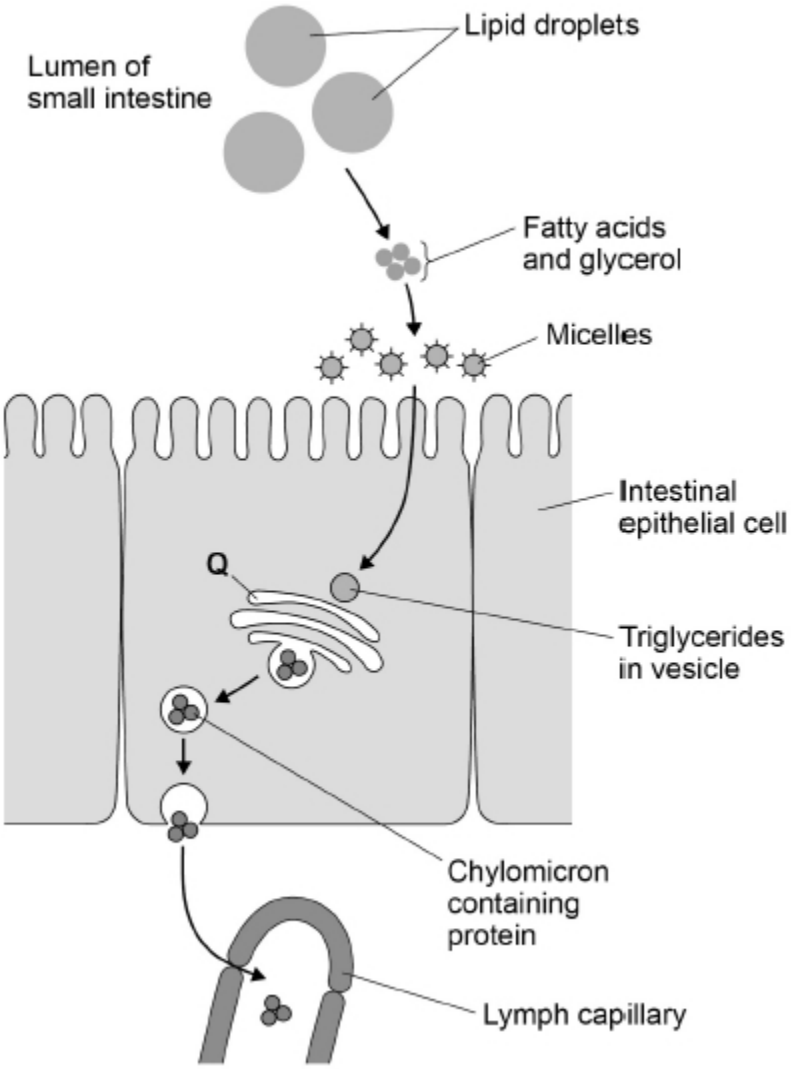
**(2)**

**(Total 7 marks)**

**4.** The diagram outlines the digestion and absorption of lipids.




(a) Tick (✓) the box by the name of the process by which fatty acids and glycerol enter the intestinal epithelial cell.

| | |
|---|---|
| Active transport | ☐ |
| Diffusion | ☐ |
| Endocytosis | ☐ |
| Osmosis | ☐ |

**(1)**

(b) Explain the advantages of lipid droplet and micelle formation.

**(3)**

(c) Name structure **Q** in the diagram above and suggest how it is involved in the absorption of lipids.

Name _____

How it is involved _____

**(4)**

**(Total 8 marks)**

**5.** (a) Sodium ions from salt (sodium chloride) are absorbed by cells lining the gut. Some of these cells have membranes with a carrier protein called NHE3.

NHE3 actively transports one sodium ion into the cell in exchange for one proton (hydrogen ion) out of the cell.

Use your knowledge of transport across cell membranes to suggest how NHE3 does this.

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**(3)**

(b) Scientists investigated the use of a drug called Tenapanor to reduce salt absorption in the gut. Tenapanor inhibits the carrier protein, NHE3.

The scientists fed a diet containing a high concentration of salt to two groups of rats, **A** and **B**.

- The rats in Group **A** were **not** given Tenapanor (0 mg $kg^{-1}$).
- The rats in Group **B** were given 3 mg $kg^{-1}$ Tenapanor.

One hour after treatment, the scientists removed the gut contents of the rats and immediately weighed them.

Their results are shown in the table.

| **Concentration of Tenapanor / mg $kg^{-1}$** | **Mean mass of contents of the gut / g** |
|---|---|
| 0 | 2.0 |
| 3 | 4.1 |

The scientists carried out a statistical test to see whether the difference in the means was significant. They calculated a P value of less than 0.05.

They concluded that Tenapanor did reduce salt absorption in the gut.

Use all the information provided and your knowledge of water potential to explain how they reached this conclusion.

**(4)**

(c) High absorption of salt from the diet can result in a higher than normal concentration of salt in the blood plasma entering capillaries. This can lead to a build-up of tissue fluid.

Explain how.

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**(2)**

**(Total 9 marks)**

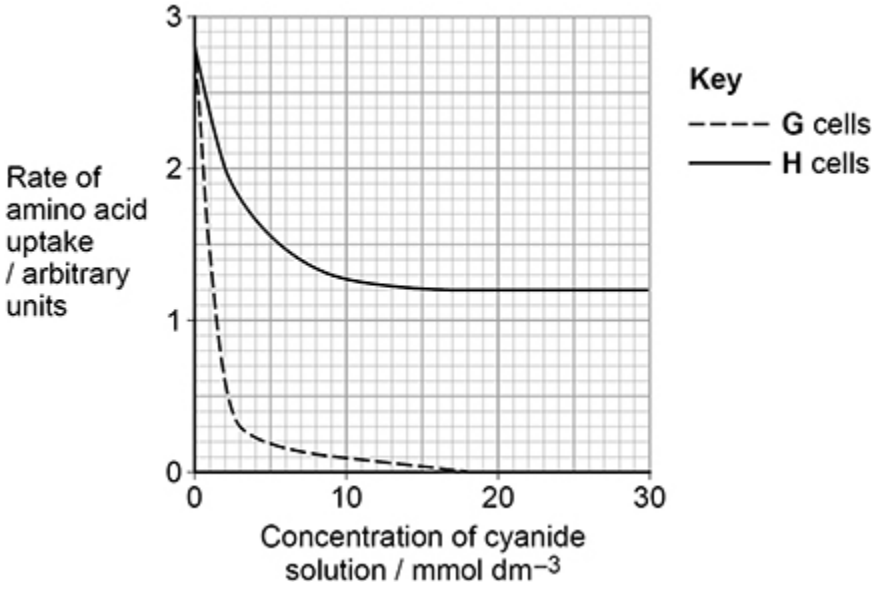
**6.** (a) Describe how an ATP molecule is formed from its component molecules.

**(4)**

A scientist investigated the effect of cyanide on the rate of amino acid uptake in two types of *Escherichia coli*, **G** and **H**.

- **G** cells produce enzymes involved in ATP production **only** on their cell-surface membrane.
- **H** cells produce enzymes involved in ATP production on their cell-surface membrane **and** in their cytoplasm.

The graph below shows her results.



(b) Use the graph above to calculate the percentage decrease in the rate of amino acid absorption by **H** cells in 30 mmol $dm^{-3}$ cyanide solution.

Answer _____ %

**(1)**

(c) Using the graph above and the information provided, what can you conclude about amino acid uptake by **G** cells and by **H** cells?

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**(3)**

**(Total 8 marks)**