Movement of substances

Question Paper 3

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Cell Membranes and Transport
Sub Topic	Movement of substances
Booklet	Theory
Paper Type	Question Paper 3

Time Allowed : **70 minutes**

Score : **/ 58**

Percentage : **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 *Staphylococcus aureus* is a bacterium that is the cause of many different infectious diseases.

(a) Fig. 4.1 is a diagram of *S. aureus*.

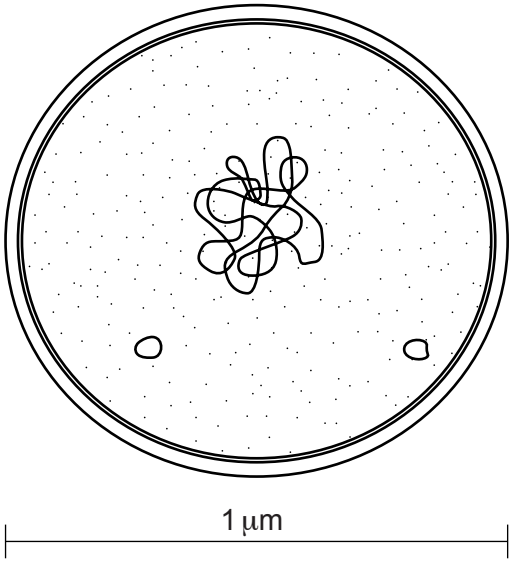

Fig. 4.1

(i) Cell structures, such as mitochondria, endoplasmic reticula (ER), Golgi apparatus, lysosomes and chloroplasts are found only in eukaryotic cells. These are not present in Fig. 4.1.

With reference to Fig. 4.1, describe **other features** that support the fact that *S. aureus* is a prokaryote.

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(ii) State the main difference in the composition of the plant cell wall compared to the bacterial cell wall.

plant cell wall .....

bacterial cell wall .....[2]

(b) Bacterial cells behave in a similar way to plant cells when immersed in solutions of different water potential.

Suggest **and** explain what would happen to bacteria placed in a solution with a water potential more negative than their cell contents.

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(c) Some strains of *S. aureus* have become resistant to one or more of the antibiotics used to treat infections.

The mechanisms of antibiotic resistance involve proteins, for example:

- enzymes to breakdown antibiotics
- membrane proteins that inactivate antibiotics
- membrane proteins that pump out antibiotics.

Explain why antibiotic resistance arises as a result of mutation.

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[Total: 10]

2 Red blood cells are suspended in plasma which has a concentration equivalent to that of 0.9% sodium chloride (NaCl) solution.

A student investigated what happens to red blood cells when placed into sodium chloride solutions of different concentration.

A small drop of blood was added to 10cm^3 of each sodium chloride solution. Samples were taken from each mixture and observed under the microscope. The number of red blood cells remaining in each sample was calculated as a percentage of the number in the 0.9% solution. The results are shown in Fig. 3.1.

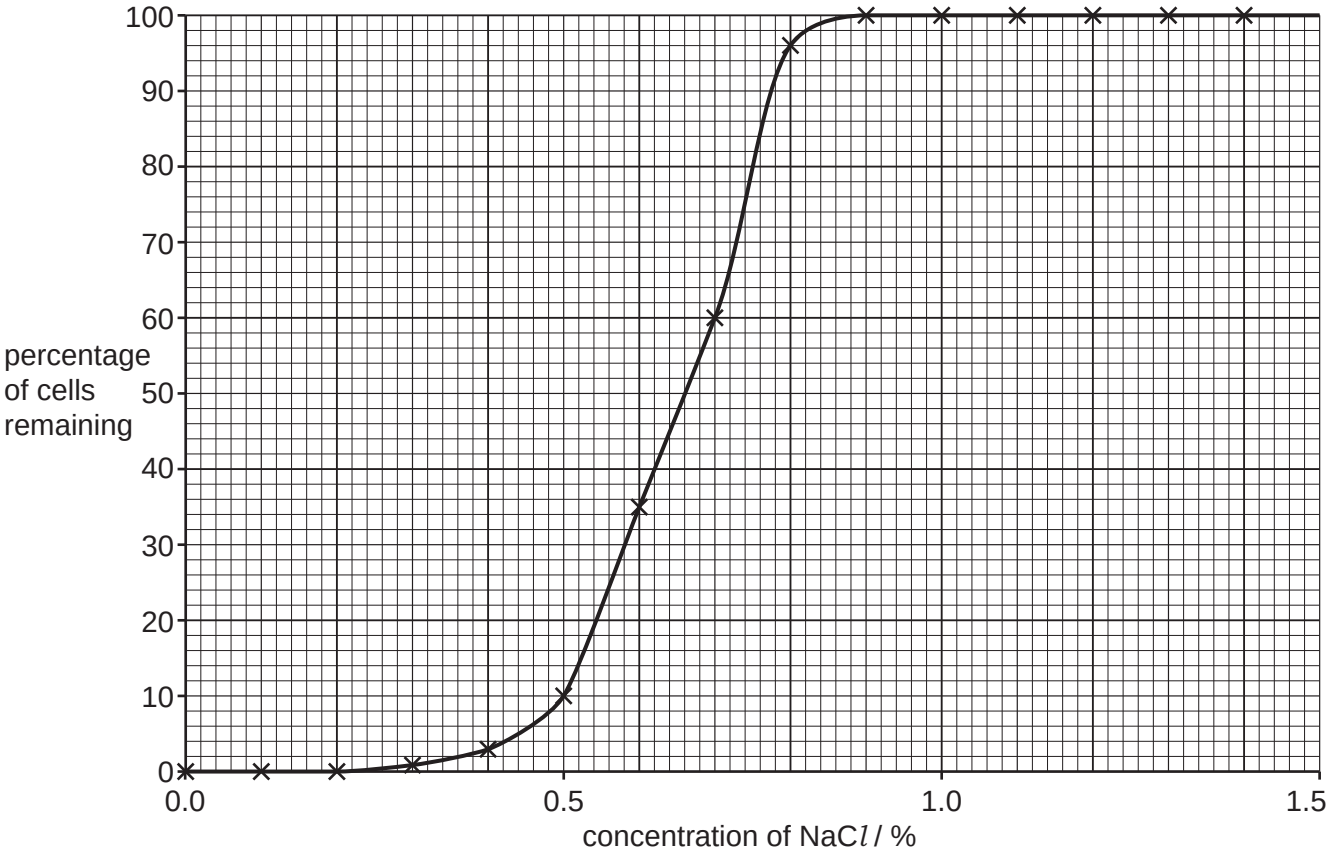

Fig. 3.1

(a) With reference to Fig. 3.1, describe the student's results.

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The student also measured the cell volumes of the red blood cells in three of the sodium chloride solutions. The results are shown in Table 3.1.

Table 3.1

concentration of sodium chloride /%	mean red cell volume /μm^3
0.7	120
0.9	90
1.5	65

Fig. 3.2 shows the appearance of some red blood cells removed from the 1.5% sodium chloride solution.

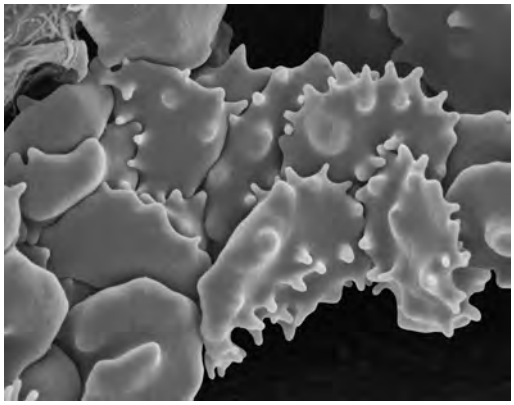

Fig. 3.2

(b) Explain the results shown in Fig. 3.1, Table 3.1 and Fig. 3.2, in terms of **water potential**.

0% NaCl solution .....

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0.7% NaCl solution .....

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1.5% NaCl solution .....

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Red blood cells each contain about 240 million molecules of haemoglobin that transport oxygen and carbon dioxide.

(c) Describe the role of haemoglobin in the **transport** of oxygen and carbon dioxide.

oxygen .....

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carbon dioxide .....

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(d) The haematocrit is the proportion of the blood that is composed of red blood cells. Samples of blood were taken from an athlete who lived at sea level since birth and moved to live and train at an altitude of 5000 m for three weeks. The haematocrit and the number of red blood cells per mm^3 were determined before moving to high altitude and after three weeks at that altitude. The results are shown in Table 3.2.

Table 3.2

altitude	haematocrit	number of red blood cells × 10^6 per mm^3
sea level	0.45	6.1
5000 m (after three weeks)	0.53	7.3

(i) Calculate the percentage increase in the number of red blood cells per mm^3 after three weeks at 5000 m. Show your working.

Answer = ... % [2]

(ii) Explain why the haematocrit increases at altitude.

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[Total: 18]

3 **(a)** Enzymes are globular proteins that catalyse metabolic reactions.

Describe the features of globular proteins.

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(b) Enzymes can be used to remove cell walls from plant and fungal cells. The cells are incubated in a solution that contains a mixture of enzymes.

(i) Suggest an explanation for the fact that a different mixture of enzymes is required to remove the walls of plant cells compared to the walls of fungal cells.

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(ii) Explain why, when plant cells are incubated with enzymes to remove their cell walls, it is important to maintain an optimum pH.

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(c) A student carried out an investigation into osmosis using red blood cells.

Red blood cells were placed in sodium chloride (salt) solutions at five different concentrations. For each concentration, a sample was added immediately to a microscope slide and the cells were viewed using a light microscope for a period of time. The observations recorded are shown in Table 3.1.

Table 3.1

concentration of salt solution / %	observation of red blood cells
0.0	swell and burst, numbers decrease
0.4	increase in size
0.9	remain the same size
1.5	decrease in size
3.0	smaller and shrivelled

Explain, in terms of **water potential** and osmosis, the results that the student obtained.

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(d) The student also carried out a similar investigation using plant cells with cell walls removed. These cells were suspended in a 12% mannitol solution so that the water potential inside and outside of the cells was equal.

Fig. 3.1 is a photomicrograph of these cells.

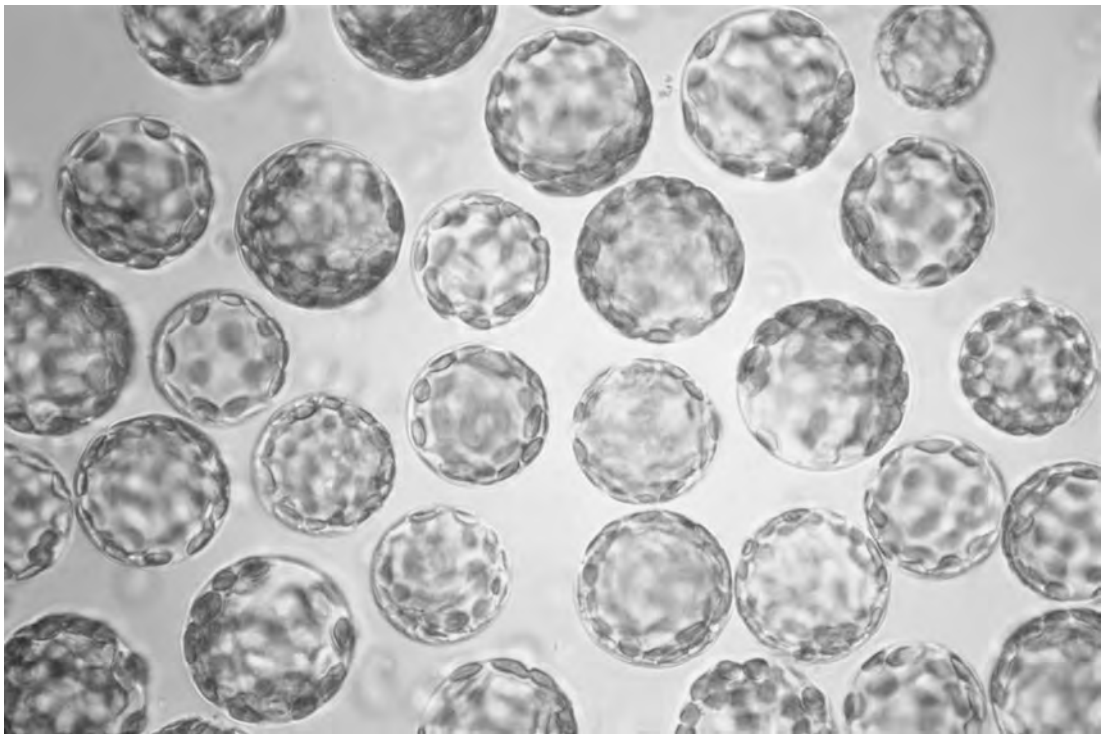

Fig. 3.1

The student removed a sample of these cells. The sample was placed into distilled water and was viewed using a light microscope.

Describe what you would expect the student to observe and explain why this would not occur with normal plant cells.

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[Total: 14]

4 Maize, *Zea mays*, is a cereal crop that is adapted for growth at high temperatures. However, it does not cope with drought as well as some other crops, such as sorghum.

An investigation was carried out into the effect of low water availability on the activity of mitochondria taken from maize seedlings.

Young seedlings were uprooted and left in dry air for varying periods of time to reduce the water potential of their tissues.

(a) Explain why this treatment reduced the water potential of the maize seedling tissues.

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(b) After drying in air, mitochondria were extracted from the tissues of the seedlings. The extracted mitochondria were provided with succinate, which is one of the intermediate compounds in the Krebs cycle, and also with ADP and inorganic phosphate. The rate at which the extracted mitochondria took up oxygen was measured. The results are shown in Fig. 4.1.

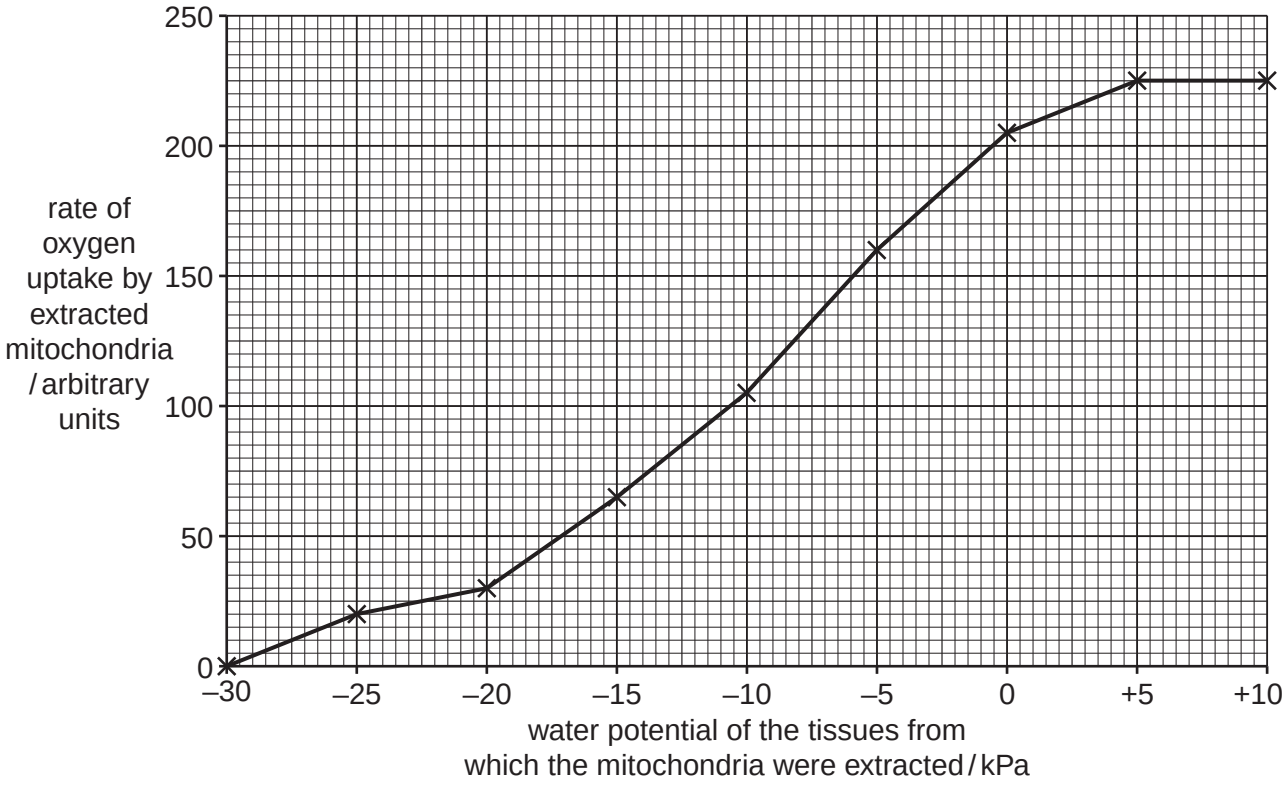

Fig. 4.1

(i) Describe the results shown in Fig. 4.1.

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(ii) The mitochondria take up oxygen. Explain how this oxygen, plus the succinate, ADP and inorganic phosphate, are used by the mitochondria.

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(c) In a further experiment, it was found that mitochondrial membranes lost their normal structure when the water potential was low.

(i) Suggest why membranes in cells lose their normal structure when the water potential is low.

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(ii) Suggest how this could explain the results shown in Fig. 4.1.

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(d) In tissues where water potential is low, the mitochondria of sorghum are affected in a very similar way to those of maize.

Describe **two** ways in which sorghum plants are adapted to prevent the development of low water potentials in their tissues during drought conditions.

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2. .....

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[Total: 16]