1. Cell Structure

1.1 The Microscope in Cell Studies

Paper 2

Question Paper

1 Smooth muscle is a tissue composed of smooth muscle cells. The cells contain cytoplasm packed with proteins that are involved in contraction and relaxation.

(b) When viewed in longitudinal section (LS), smooth muscle cells are elongated and taper at both ends. This is known as a fusiform shape. Each cell has a central nucleus, which also appears elongated.

Fig. 1.1 is a diagram of a smooth muscle cell to show the fusiform shape.

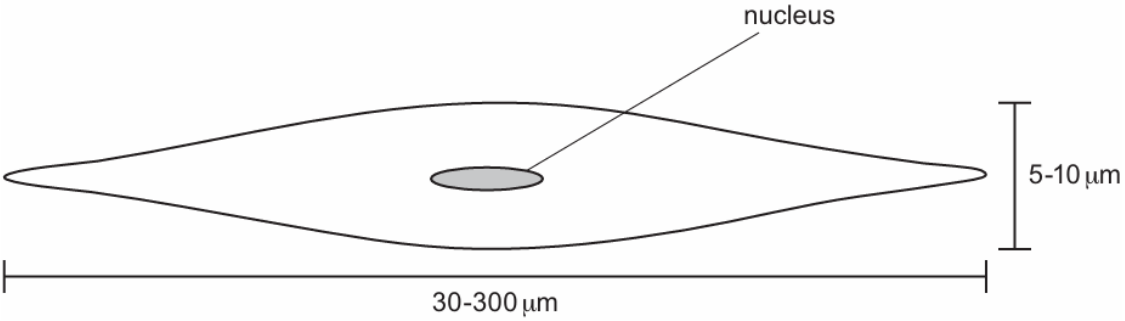


Fig. 1.1

A student used a microscope fitted with a calibrated eyepiece graticule to estimate that the length of one smooth muscle cell was 250 micrometres (μm).

(i) Name the type of microscope slide that the student used to calibrate the eyepiece graticule.

..... [1]

(ii) The smallest object the student can see without the use of a microscope is 0.2 mm in length.

Explain whether the student would be able to see a cell of length 250 μm without the use of a microscope.

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..... [1]

2 People who become infected with human immunodeficiency virus (HIV) are at risk of developing HIV/AIDs, particularly if antiretroviral therapy (ART) is not available.

In people with HIV/AIDs, a serious lung disease known as pneumocystis pneumonia can result from infection by an opportunistic pathogen known as *Pneumocystis jirovecii*.

Fig. 2.1 shows *P. jirovecii* cells in one stage of their life cycle, as seen using a light microscope at a magnification of ×600.

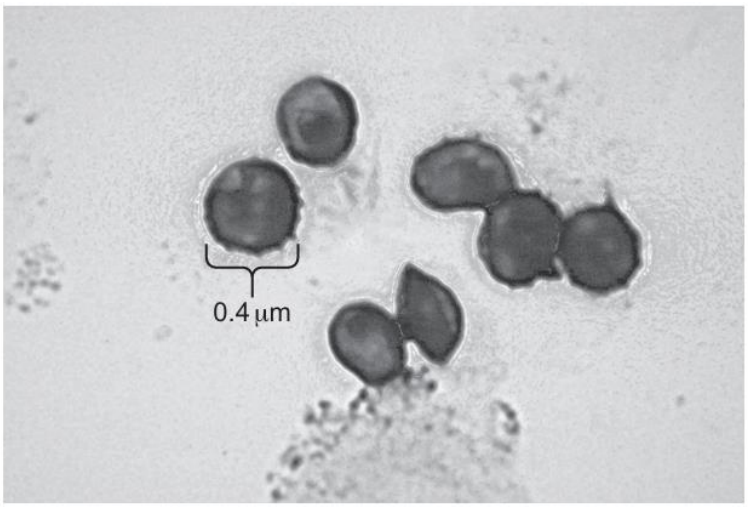


Fig. 2.1

(b) Define magnification.

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..... [1]

3 Epithelial cells in the small intestine have cell structures known as microvilli. The microvilli of these cells are found only on the surface that borders the gut lumen.

Fig. 1.1 shows images of microvilli of intestinal epithelial cells. These images have been obtained using a scanning electron microscope and a transmission electron microscope.

Fig. 1.1**A** is at a different magnification to Fig. 1.1**B**.

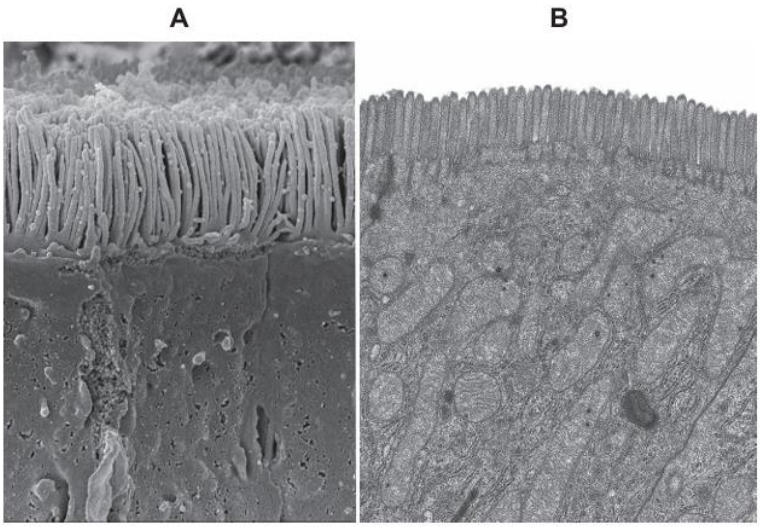


Fig. 1.1

(a) With reference to Fig. 1.1, state how it is possible to distinguish between a scanning electron micrograph and a transmission electron micrograph.

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..... [1]

(b) The approximate length of a microvillus is 1 μm.

Outline the method you would use to estimate the magnifications of the images shown in Fig. 1.1.

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..... [2]

4 **(b)** *Vibrio cholerae* is the bacterium that causes cholera.

Fig. 5.1 is a transmission electron micrograph of *V. cholerae*.

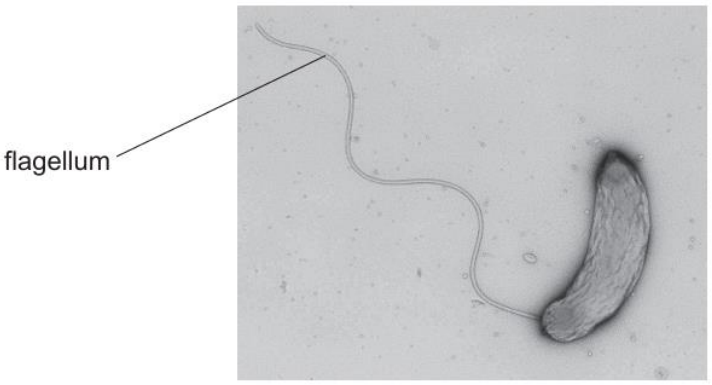


Fig. 5.1

A student wanted to know the actual length of the flagellum shown in Fig. 5.1.

State the information that is needed so that the student can calculate the actual length of the flagellum.

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..... [2]

5 Human cytomegalovirus (HCMV) is a common virus affecting humans. In people with a fully functioning immune system, infection by HCMV usually causes no, or only mild, symptoms.

Fig. 2.1**A** is a diagram of a section through HCMV. In Fig. 2.1**B**, only the outer part of HCMV is sectioned.

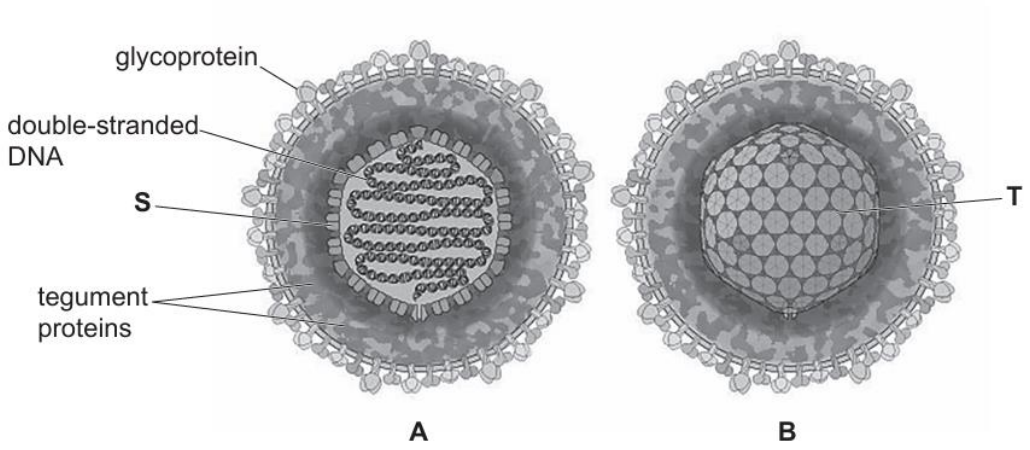


Fig. 2.1

The viral DNA shown in Fig. 2.1 contains genes that code for proteins important in viral replication and viral structure, including viral DNA polymerase and proteins known as tegument proteins.

Viruses can only replicate in host cells as they need to use processes and contents of the host cell. Complete viral particles that are released from the host cell are known as virions.

(b) The actual diameter of the HCMV shown in Fig. 2.1 is 0.17 micrometres (μm).

Calculate the actual diameter of the virus in nanometres (nm).

..... [1]

6 **(b)** Explain the advantages of using a transmission electron microscope compared with a light microscope when viewing a liver cell.

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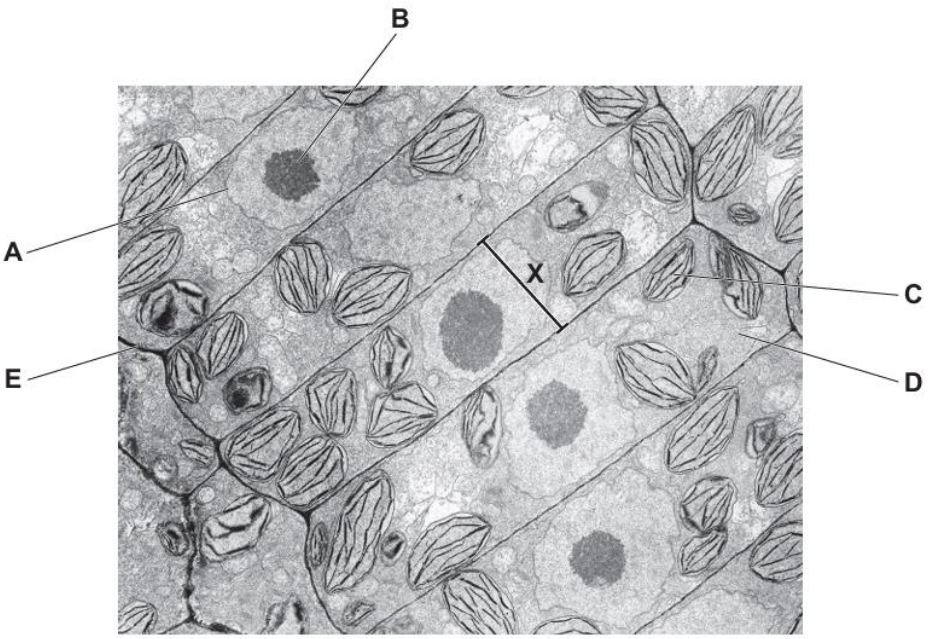
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..... [3]

7 Fig. 1.1 is a transmission electron micrograph of cells from duckweed, *Spirodela oligorrhiza*.



magnification ×4275

Fig. 1.1

(a) Calculate the actual width of the cell labelled **X**.

Write down the formula you will use to make your calculation.

Show your working and give your answer in micrometres to one decimal place.

formula

..... μm [3]

(c) Describe the evidence from Fig. 1.1 that shows that the image is a transmission electron micrograph.

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..... [2]

8 Picornaviruses are small viruses that are 30 nm in diameter. Picornaviruses are able to enter the cells of mammals and birds and can replicate within these cells.

Fig. 1.1 shows the entry of a picornavirus into its host cell.

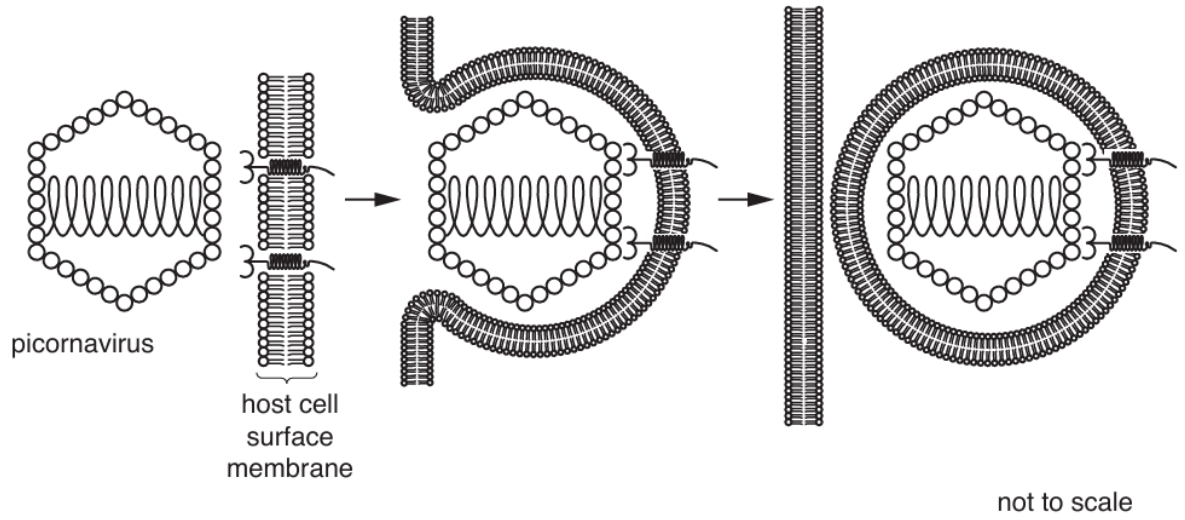


Fig. 1.1

(b) State, with reasons, whether a picornavirus can be seen using the light microscope.

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..... [3]

9 Fig. 1.1 is a diagram drawn from a photomicrograph of a transverse section through part of a leaf.

The arrows in Fig. 1.1 show the movement of water through the cells of the leaf after it has left the xylem.

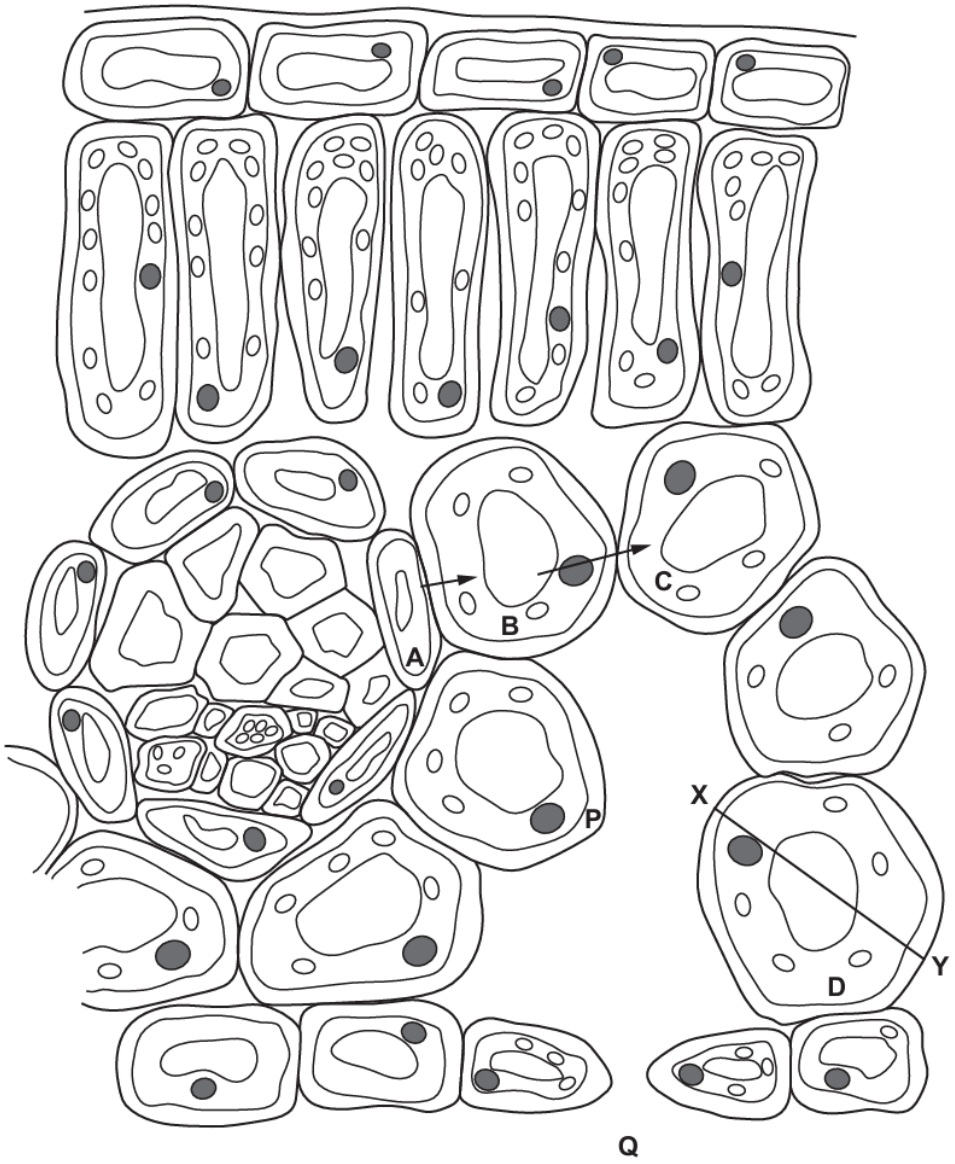


Fig. 1.1

(c) The actual diameter of cell **D** in Fig. 1.1 along the length **X**–**Y** is 25 μm.

Calculate the magnification of the image.

Write down the formula used to make your calculation. Show your working.

formula

answer = × ..... [3]

10 In the immune system, a plasma cell develops from an activated B-lymphocyte. Mature plasma cells synthesise and secrete antibody molecules.

(a) Fig. 4.1 is a diagram of a transmission electron micrograph of a plasma cell.

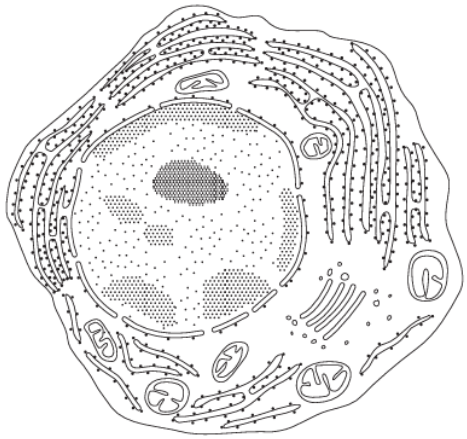


Fig. 4.1

The plasma cell can be seen in greater detail using an electron microscope compared with using a light microscope.

(i) Describe the **extra** detail of the nucleus that can be seen using an electron microscope.

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(ii) Explain why cell structures, such as ribosomes and the rough and smooth endoplasmic reticulum, cannot be seen using a light microscope.

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..... [2]

11 A red blood cell goes through a number of stages in the bone marrow before it is released into the circulation to carry out its role of oxygen transport.

Fig. 3.1 is a transmission electron micrograph of developing red blood cells in the bone marrow. Each cell is known as an erythroblast.

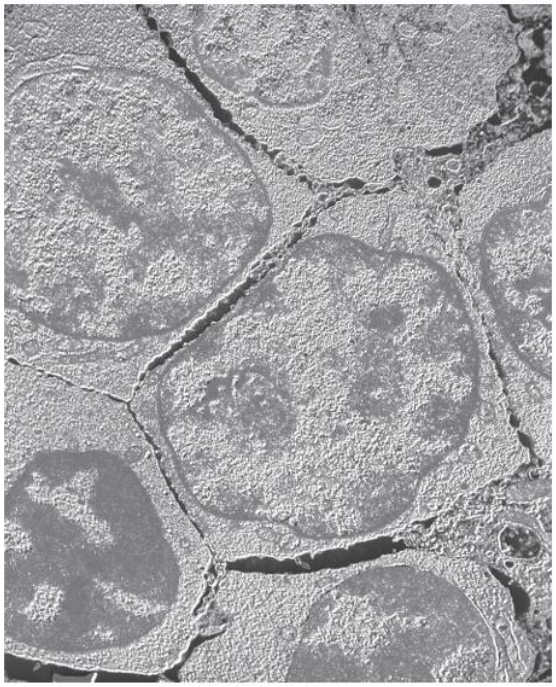


Fig. 3.1

(a) Fig. 3.1 shows erythroblasts at a higher magnification than can be obtained using the light microscope.

Explain the advantages of using an electron microscope to obtain images such as that in Fig. 3.1.

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12 Fig. 1.1 is a drawing of a photomicrograph of a spongy mesophyll cell from a leaf.

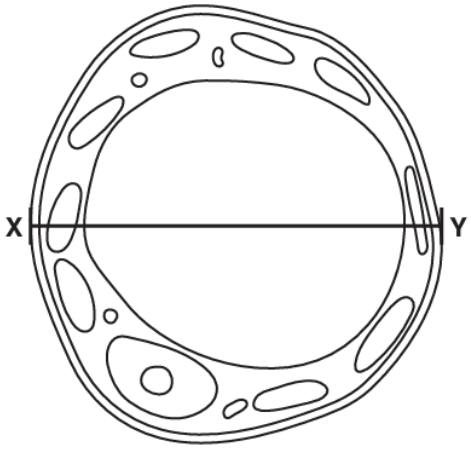


Fig. 1.1

(b) The drawing in Fig. 1.1 is 2000 times larger than the actual size of the cell.

Describe the steps you would follow to determine the actual diameter of the cell in micrometres (μm), at **X**—**Y**.

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.....[2]

13 Fig. 1.1**A** is a photomicrograph of healthy lung tissue.

Fig. 1.1**B** is a photomicrograph of lung tissue from a person with emphysema, a chronic obstructive pulmonary disease (COPD). The images are both at magnification ×40.

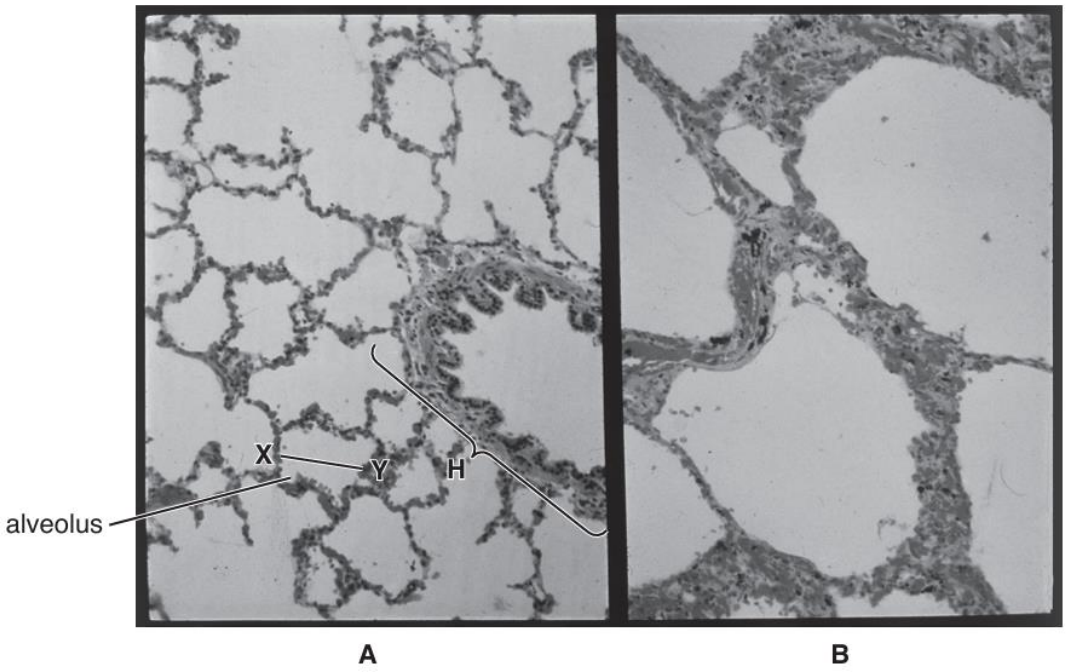


Fig. 1.1

(b) Calculate the actual diameter of the alveolus at **X**–**Y**.

Write down the formula and use it to make your calculation.

Give your answer to the nearest whole micrometre (μm).

formula

actual size ..... μm [2]

14 Fig. 4.1 is a photomicrograph of a cross-section of a tubular structure in the kidney made from epithelial cells.

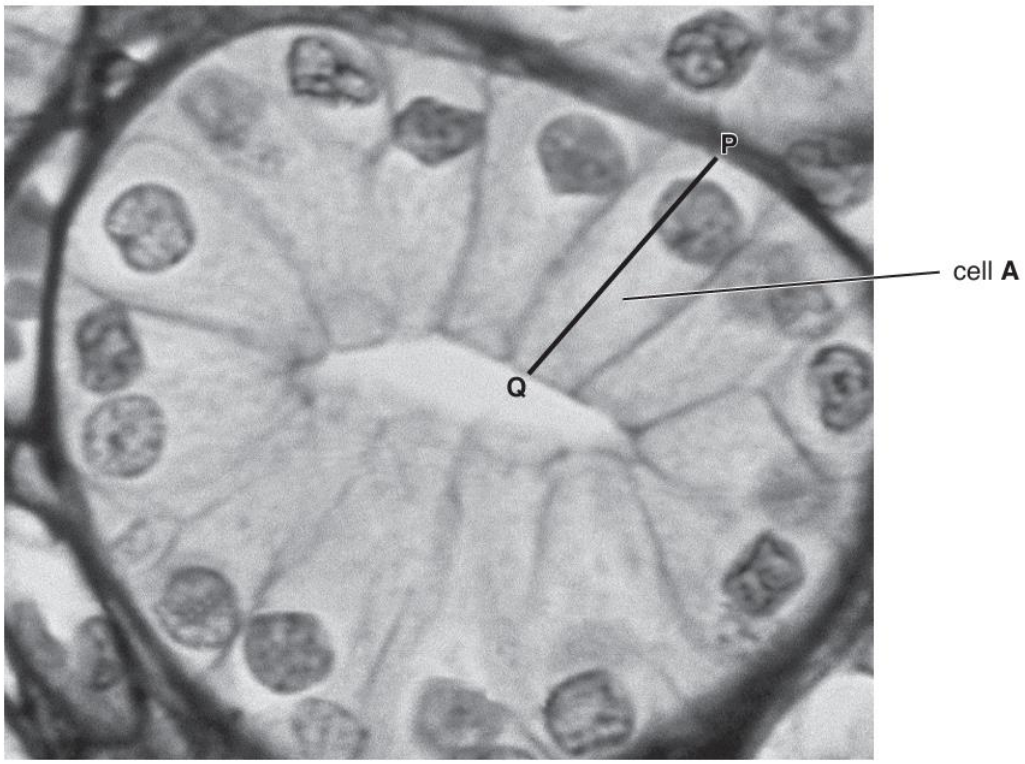


Fig. 4.1

(a) The actual length of epithelial cell **A** along the line **P**–**Q** is 35 μm.

Calculate the magnification of the image shown in Fig. 4.1. Write down the formula and use it to make your calculation. Show your working.

formula

magnification × ..... [2]