# Cell Structure - Microscopes

**1.**

During a bacterial infection, activated white blood cells multiply by mitosis.

In order to study the behaviour of chromosomes during mitosis, higher resolution images are needed.

i. Complete the table below about microscopes and their images.

| | **Laser scanning confocal microscope** | **Scanning electron microscope** | **Transmission electron microscope** |
|---|---|---|---|
| **Maximum resolution** | 200 nm | 3–10 nm | 0.5 nm |
| **Image appearance** | 2D / 3D | ..... | ..... |
| **Image colour** | ..... | ..... | black and white |

**[2]**

ii. A transmission electron microscope image of a white blood cell was studied. It was concluded that the cell had stopped dividing at the G2 checkpoint.

Suggest **two** observations that would have led to this conclusion.

1 ----------

2 ----------

**[2]**

**2.** Which of the following, **A** to **D**, is a feature of **both** light microscopy **and** confocal microscopy?

**A** can be used to observe ribosomes
**B** can be used with live tissues
**C** obtain images using laser light
**D** require a great deal of training to use

Your answer ☐

**[1]**

**3(a).** A small, permanent pond is the habitat for a climax community of producers (aquatic plants and algae) and consumers (bacteria, protoctista, worms, snails, arthropods and small vertebrates like newts and fish).

Why might ecologists call this a 'climax community'?

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**[1]**

**(b).** The protoctist *Paramecium caudatum* is usually between 200 and 300 μm in length. An accurate measurement would help in the correct identification of a specimen from this pond.

What laboratory equipment would you select to make an accurate measurement of the length of *Paramecium caudatum*?

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**[2]**

**(c).** An animal fell into the pond. It drowned and decayed. Within a year the biological compounds in its body had been completely recycled.

i. What nitrogenous excretory molecule from the decomposers would pass to the next stage of the nitrogen cycle?

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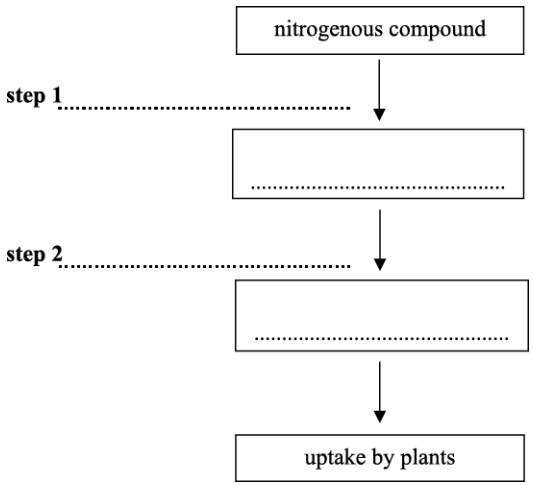
**[1]**

ii. Complete the flow chart to show what happens to this nitrogenous compound, and name the groups of bacteria involved at steps 1 and 2, as it is converted to a form that plants can take up and use.




**[4]**

**4.** Fig. 17.2 is an image of a Kupffer cell from the liver.

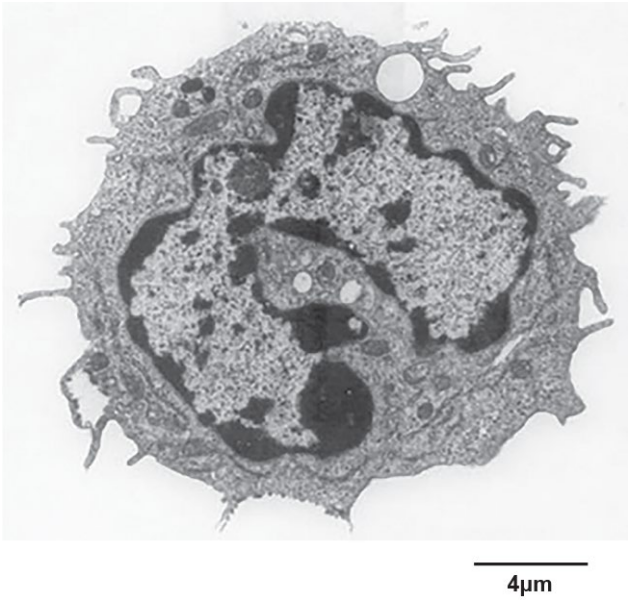



**Fig. 17.2**

i. The diameter of the Kupffer cell in the image is 9.1 cm. Assuming it is spherical, calculate the actual volume of this cell.

Give your answer to **four** significant figures. Show your working.

Answer =

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**[3]**

ii. Which type of microscope has been used to obtain this image? Explain your answer.

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**[2]**

**5.** Sago pondweed is an underwater plant that grows in many regions of the world.

Fig. 1.1 shows a transmission electron micrograph of a sago pondweed cell.

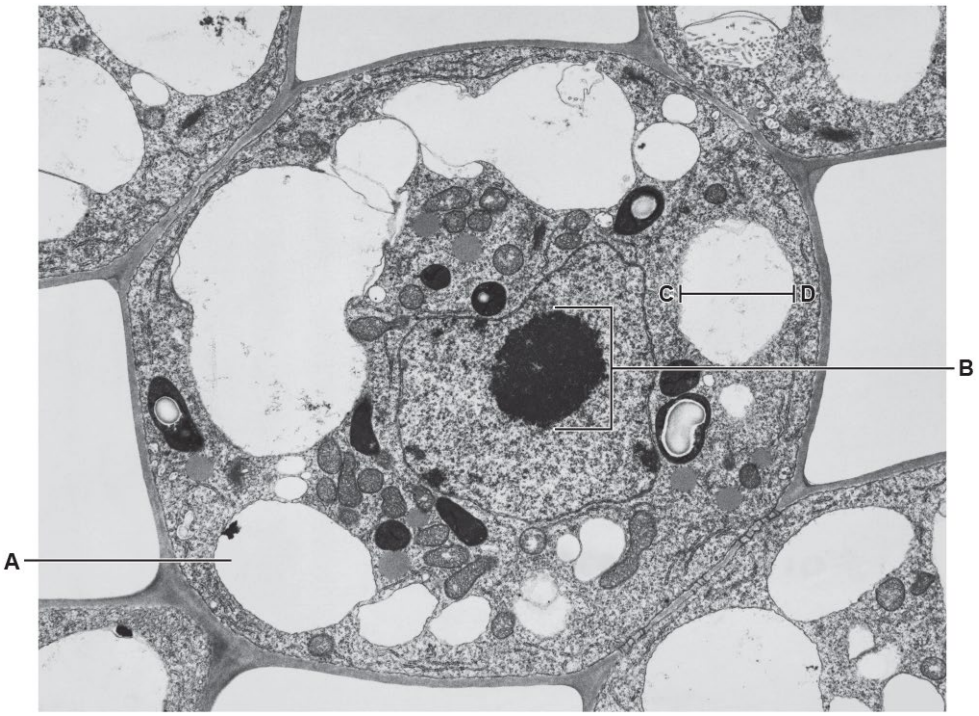


**Fig. 1.1**

i. Identify the **cellular components** shown at **A** and **B**.

**A** ----------

**B** ----------

**[2]**

ii. The real size of the line between **C** and **D** on Fig. 1.1 is $1.4 \times 10^{-6}$ m.

Calculate the magnification that was used to produce the image in Fig. 1.1.

Give your answer to **2 significant figures**.

magnification = ..... **[2]**

iii. Fig. 1.2 shows a student's drawing of another sago pondweed cell, which was observed under a light microscope. The student used a sharp pencil but did not label the drawing.

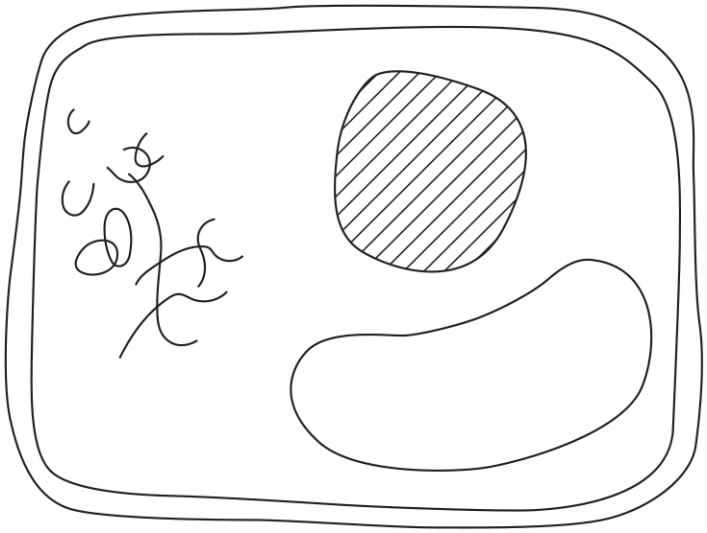

**Fig. 1.2**

Describe **two other** ways in which the drawing could be improved.

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iv. The student stained a sago pondweed sample to improve the contrast between cellular components when viewed under a microscope.

The student used the following procedure to stain the sample:

- Use forceps to place the sample on a glass slide.
- Use a pipette to place two drops of the stain in the centre of the sample.
- Carefully lower a cover slip onto the sample, ensuring that the cover slip is parallel with the slide as it is lowered.

1

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2

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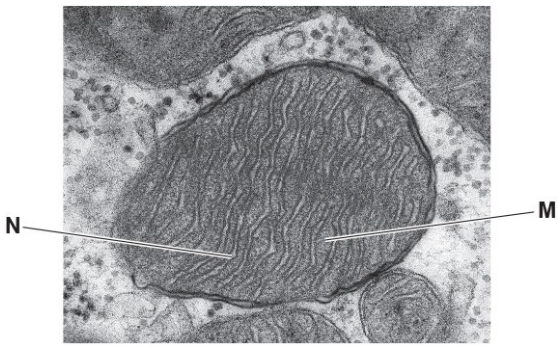
**[2]**

**6.** The image below is a photomicrograph of a mitochondrion.




i. State the type of microscope used to produce this image.

_____ **[1]**

ii. Identify the structures labelled **M** and **N** in the photomicrograph.

**M** .....

**N** .....

**[2]**

**7.** Which of the following statements, **A** to **D**, about microscopes is correct?

**A** A light microscope with an eyepiece lens magnification of × 10 and an objective lens magnification of × 50 will have an overall magnification of × 60.

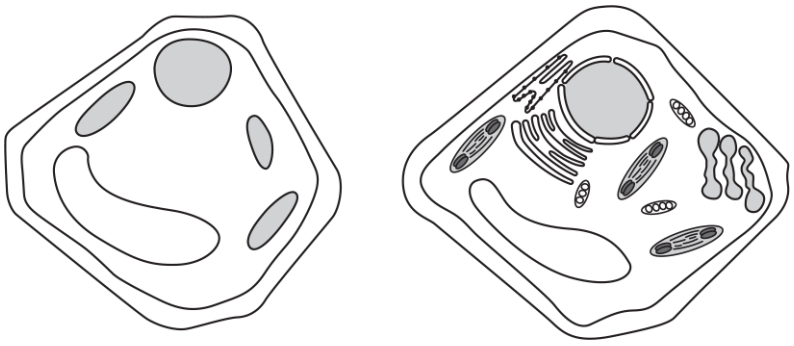
**B** Scanning electron microscopes and laser scanning confocal microscopes can both produce three dimensional images.

**C** The maximum resolution of a scanning electron microscope is lower than that of a light microscope.

**D** Transmission electron microscopes and laser scanning confocal microscopes can both produce three dimensional images.

Your answer ☐ **[1]**

**8.** Fig. 1.1 shows a student's diagrams of two plant cells. Each cell was observed using a different type of microscope. The cells are not drawn to scale.



Cell A Cell B

**Fig. 1.1**

i. **Cell B** in Fig. 1.1 was observed using an electron microscope.
Give one piece of evidence from Fig. 1.1 that supports this.

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**[1]**

ii. Give one way that an image produced by a laser scanning confocal microscope differs from that produced by an electron microscope.

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**[1]**

**9(a).** Table 3.1 lists the **maximum** magnification and resolution of three different types of microscope.

| Microscope | Magnification | Resolution (nm) |
|---|---|---|
| **X** | × 1500 | 200 |
| **Y** | × 100 000 | 20 |
| **Z** | × 500 000 | 1 |

**Table 3.1**

Which microscope, **X, Y** or **Z**, is a **transmission** electron microscope?

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**[1]**

**(b).** Fig. 3.1(a) and Fig. 3.1(b) below show root hairs on the surface of roots. The two images were taken using different types of microscope.

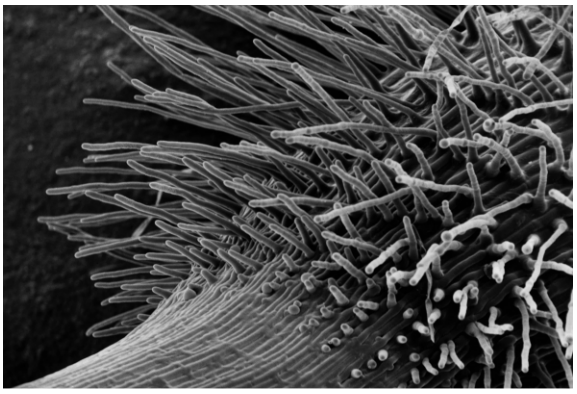

**Fig. 3.1(a)**

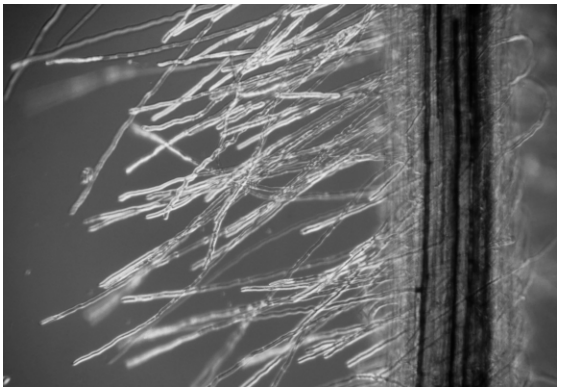

**Fig. 3.1(b)**

One of the images was taken using a scanning electron microscope.

Identify which image, **Fig. 3.1(a)** or **Fig. 3.1(b)**, was taken using a scanning electron microscope.

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Justify your choice.

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**[2]**

**10. Fig. 22.1** shows a transverse section of the stem of a typical pondweed viewed using a × 10 objective lens. Part of a graticule is shown below the stem. The markings on the graticule are 0.1 mm apart.

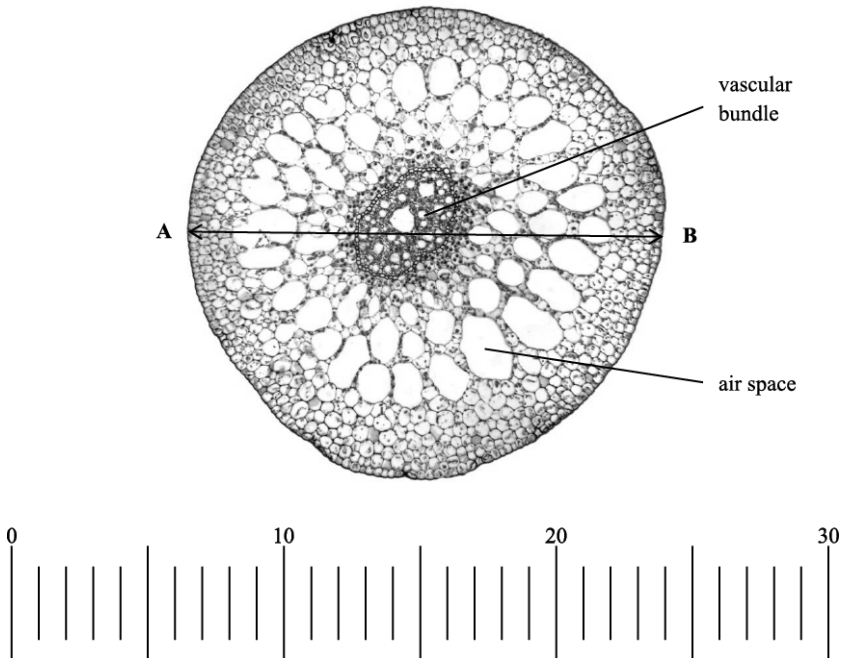


**Fig. 22.1**

i. Measure the width of the stem between points **A** and **B**.
Give your answer to the nearest 0.1 mm.

Answer ..... **[1]**

ii. Calculate the magnification of the image in **Fig. 22.1**.

Answer ..... **[2]**

iii. The thin stem and thin cell walls do not provide much support for the leaf. Suggest how the leaf is supported.

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**11.** Three types of microscope are listed below.

Select the row that shows the correct use for each type of microscope.

| | Type of microscope and what it is used to observe | | |
|---|---|---|---|
| | **Light microscope** | **Transmission electron microscope** | **Laser scanning confocal microscope** |
| **A** | an object at a certain depth within a cell | cell surfaces | organelles |
| **B** | an object at a certain depth within a cell | cell surfaces | whole cells and tissues |
| **C** | whole cells and tissues | organelles | cell surfaces |
| **D** | whole cells and tissues | organelles | an object at a certain depth within a cell |

Your answer ☐

**[1]**

**12.** A student looked at a slide containing onion root tip cells under a light microscope in order to identify cells in different stages of mitosis. Fig. 21 shows a diagram of what they observed.

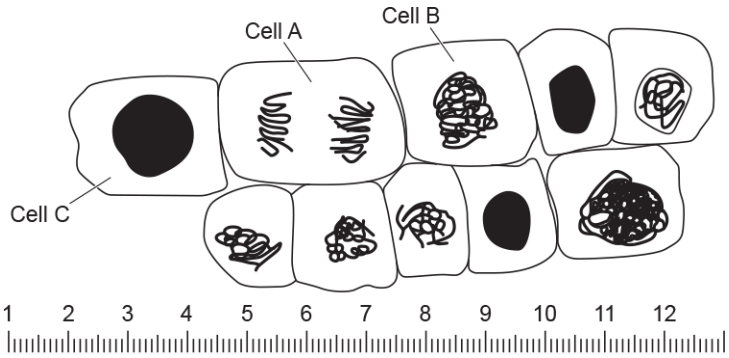



**Fig. 21**

The student used an eyepiece graticule, which is shown in Fig. 21. The student calibrated the graticule before carrying out the root tip squash. He observed that 20 μm measured 2.35 divisions on the graticule.

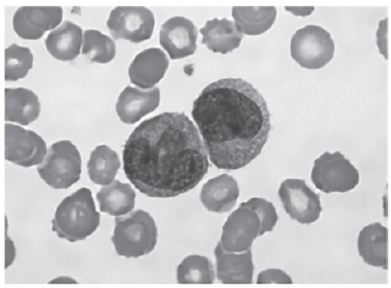
Calculate the diameter of the nucleus in cell **C** in Fig. 21.

Answer

_____ **[2]**

**13.**

The image below shows two white blood cells in a blood sample, seen using a light microscope.



Explain how to measure the diameter of the nucleus of one of the white blood cells, when observing the cells through a light microscope.

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_____ **[4]**

**14.** *Heliamphora*, shown in Fig. 18.1, is a genus of carnivorous plant. Its leaves are adapted to form water-filled traps for insects. The insects are attracted by nectar, then fall into the traps and drown. The plants digest the insects and absorb the mineral ions produced. This allows *Heliamphora* to survive in soils with low mineral content.

**Fig. 18.1**

A student prepared slides of *Heliamphora* vascular tissue for viewing under a light microscope.

The method the student used is outlined below:

1. Select a blade.
2. Cut *Heliamphora* tissue.
3. Select best pieces.
4. Place on slide.
5. Add cover slip.

i. Suggest **three** improvements to this method. For each improvement, explain how it would increase the **validity** of the slides produced.

Improvement 1:

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Explanation:

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Improvement 2:

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Explanation:

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Improvement 3:

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Explanation:

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**[6]**

ii. Discuss the benefits of using stains when making slides for light microscopy.

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**[3]**

**15.** Which of the following statements, **A** to **D**, about differential staining is **not** true?

**A** Differential staining can distinguish between different organelles.
**B** Differential staining can distinguish between types of cell.
**C** Differential staining can distinguish between types of organism.
**D** Differential staining is a common feature of electron microscopy.

Your answer ☐ **[1]**

**16.** Which of the stains, **A** to **D**, would be chosen to bind to the phosphate group of DNA to make chromosomes more visible when using a light microscope?

**A** carbolfuchsin – a non-polar dye
**B** nigrosin – a negatively charged dye
**C** methylene blue – a positively charged dye
**D** Sudan 111 – a lipid-soluble dye

Your answer ☐ **[1]**

**17.** Please refer to Fig. 2 in Insert H020/02, Depth in biology, June 2019, which is a photomicrograph of a mammalian blood smear.

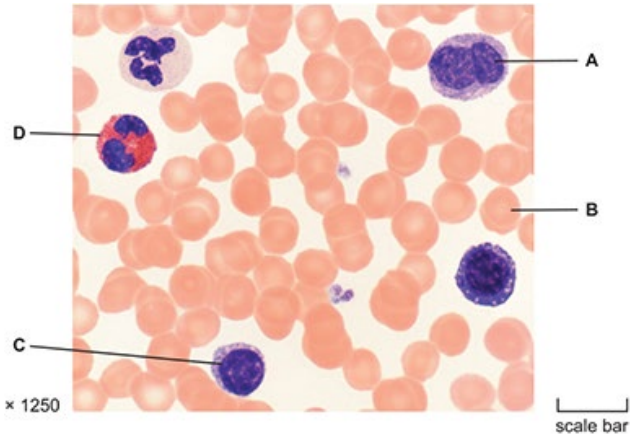


**Fig 2**

The smear has been stained with haematoxylin and eosin stain. This is a differential stain.

- Haematoxylin stains nucleic acid blue.
- Eosin stains protein (including cytoplasmic proteins) pink or red.

i. Explain why it is important to use a differential stain when examining a blood smear under the microscope.

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**[3]**

ii. Using Fig. 2, and the information provided, suggest **and** explain why the cytoplasm of cell **C** and cell **D** reacted differently to the stain.

**[4]**

**18.** Cells are usually stained before viewing under a light microscope.

Explain why cells need to be stained.

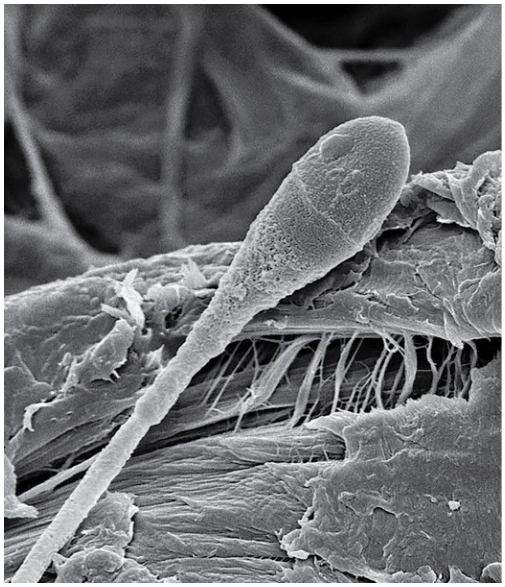
**[2]**

**19.** Both a transmission electron microscope (TEM) and a scanning electron microscope (SEM) can be used to view the same cell. However, the images formed will be different.

Compare the resolutions of these microscopes **and** the images formed by them.

**[4]**

**20.** The image below is a scanning electron micrograph of part of a sperm cell.



The actual diameter of the sperm head is 5.1 μm. The diameter of the sperm head in the image is 1.9 cm.

Which row, **A** to **D**, correctly describes the resolution and magnification of the image above?

| | **Resolution** | **Magnification** |
|---|---|---|
| **A** | 5 nm | 3725 |
| **B** | 37250 | 1 μm |
| **C** | 0.1 mm | 26840 |
| **D** | 2684 | 50 nm |

Your answer ☐

**[1]**

**21.** Which of the following best describes a microscope with *high resolution*?

**A** The microscope can distinguish structures that are very close together.
**B** The microscope can view structures that are very small.
**C** The microscope is capable of high magnification.
**D** The microscope has an in-built eyepiece graticule.

Your answer ☐ **[1]**

**22.** Microscopes vary in their magnification and resolution.

Which of the rows, **A** to **D**, in the table below is correct?

| | Light microscope | | Transmission electron microscope | | Scanning electron microscope | |
|---|---|---|---|---|---|---|
| | **Magnification** | **Resolution (nm)** | **Magnification** | **Resolution (nm)** | **Magnification** | **Resolution (nm)** |
| **A** | × 1500 | 200 | × 10 000 | 0.2 | × 50 000 | 0.2 |
| **B** | × 400 | 100 | × 500 000 | 10.0 | × 100 000 | 0.2 |
| **C** | × 1500 | 200 | × 500 000 | .02 | × 100 000 | 0.2 |
| **D** | × 1500 | 100 | × 500 000 | 10.0 | × 100 000 | 10.0 |

Your answer ☐

**[1]**

**23. Fig. 22.1** shows a transverse section of the stem of a typical pondweed viewed using a × 10 objective lens. Part of a graticule is shown below the stem. The markings on the graticule are 0.1 mm apart.

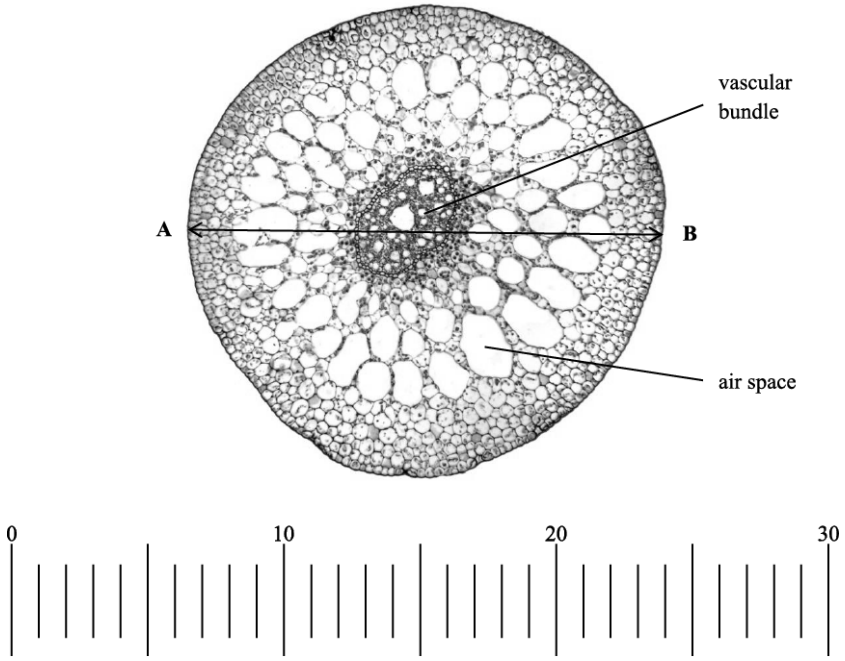



**Fig. 22.1**

A student was asked to view cells from the phloem in transverse section using a high power objective lens. **Fig. 22.2** shows two diagrams of phloem tissue.

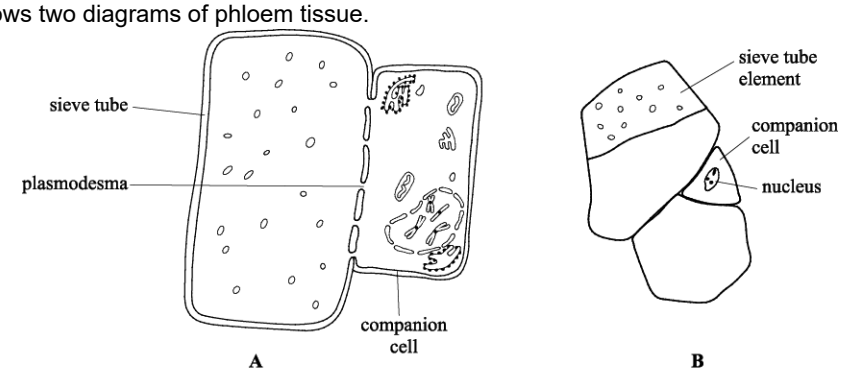



**Fig. 22.2**

i. Which diagram is the more accurate representation of what the student could see?
Justify your decision using **two** separate features of the diagrams.

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**[2]**

ii. State what is meant by the *resolution* of a microscope.

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---**[1]**

iii. The slide viewed to draw the diagrams in **Fig. 22.2** had been stained.

**Table 22.1** shows a list of stains and the cell feature that can be stained.

| Stain | Cell feature stained |
|---|---|
| Nile blue | nuclei |
| eosin | cytoplasm |
| Sudan red | cell membrane |
| iodine | starch |

**Table 22.1**

Which stain had the student used? Explain your answer.

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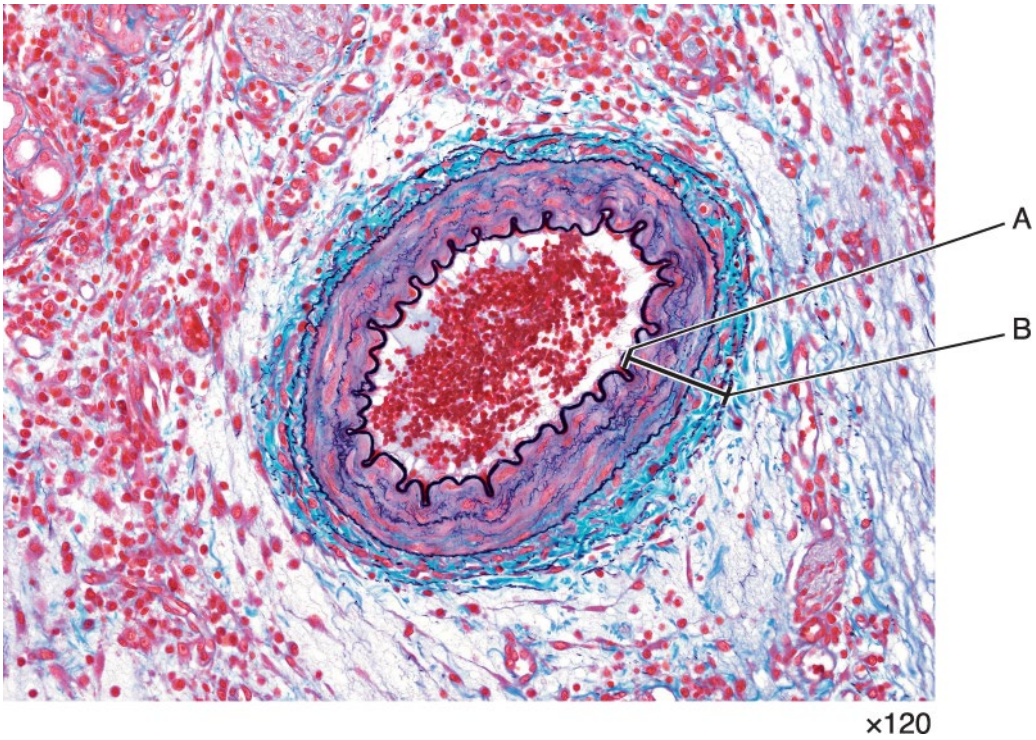
---**[2]**

**24.** The figure shows a small artery. These small arteries are found linking the larger arteries with the arterioles that carry blood into the capillary beds of an organ or tissue.

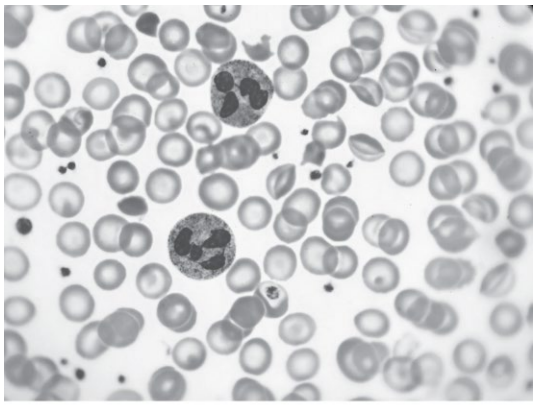



Calculate the thickness of the wall of the artery between the points marked **A** and **B** on the figure.

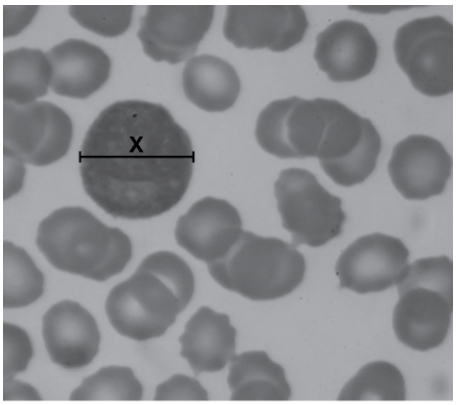
Show your working and express your answer to the nearest **micrometre**.

Answer =..... μm **[2]**

**25.** Fig. 1 shows two blood smears, **A** and **B**.



**A**




**B**

**Fig. 1**

i. Which of the two images, **A** or **B**, shows a non-specific immune response?

Explain your answer.

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**[1]**

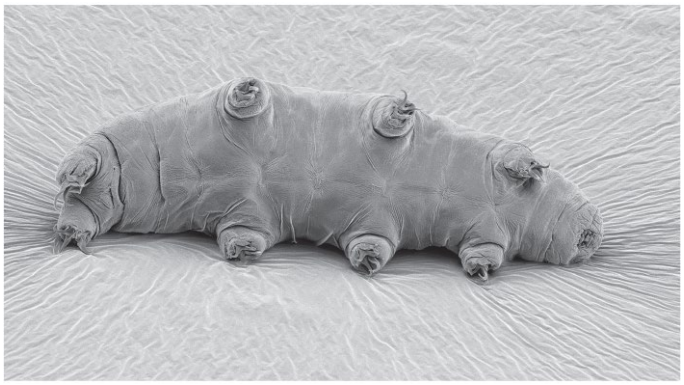
ii. The actual width of **X** in Fig. 1 image **B** is 15 µm.

Calculate the magnification used to produce image **B** in Fig. 1.

Give your answer to **two** significant figures.

Answer = ..... **[2]**

**26.** The image below shows a tardigrade, *Echiniscus granulatus*, viewed from the underneath. The magnification is × 110.



How long is the tardigrade in real life?

**A** 115 μm
**B** $1.14 \times 10^{-5}$ m
**C** $8.64 \times 10^{-4}$ m
**D** 0.116 mm

Your answer ☐ **[1]**

**27.** Please refer to Fig. 2 in Insert H020/02, Depth in biology, June 2019, which is a photomicrograph of a mammalian blood smear.

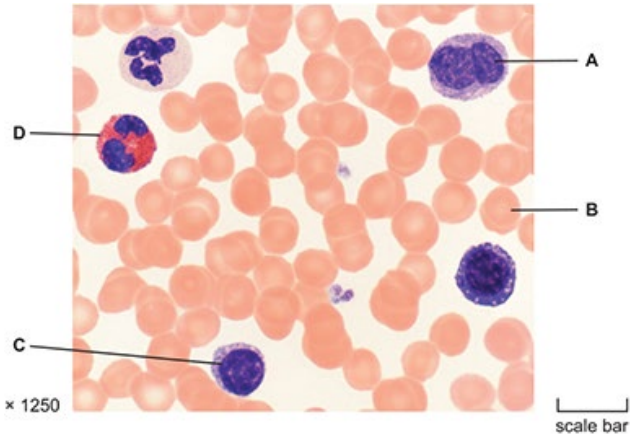



**Fig 2**

Calculate the image length, in μm, represented by the scale bar.

Give your answer to **2** significant figures.

length = ..... μm **[2]**

**28.** Fig. 23 shows a microscope image of a cross section taken from the stem of a sunflower, *Helianthus annuus*.

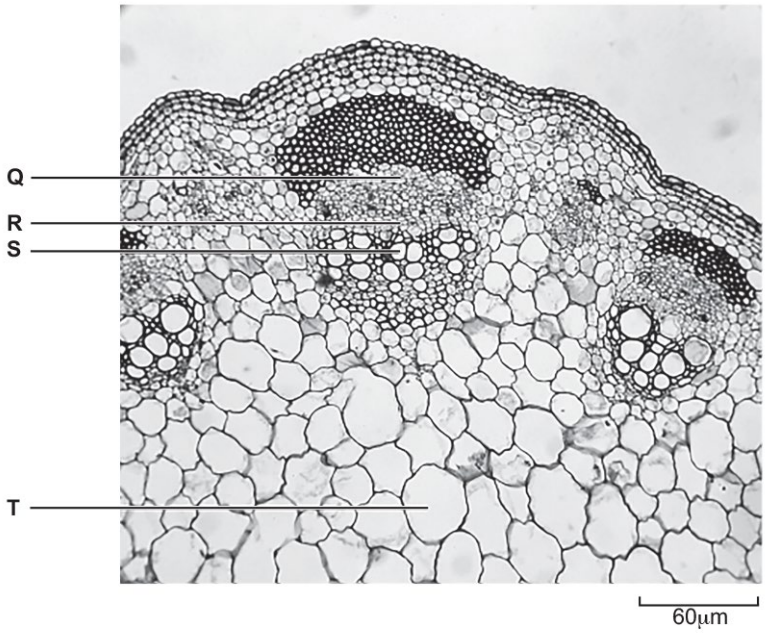



**Fig. 23**

Calculate the magnification of this image.

**[2]**