The Microscope in Cell Studies (1.1): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic

22 questions · 38 marks · about 46 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · information from earlier in the question

1 *Smilax china* is a herbaceous plant.

Fig. 1.1 shows part of a transverse section of a root of *S. china* with root hair cells visible.

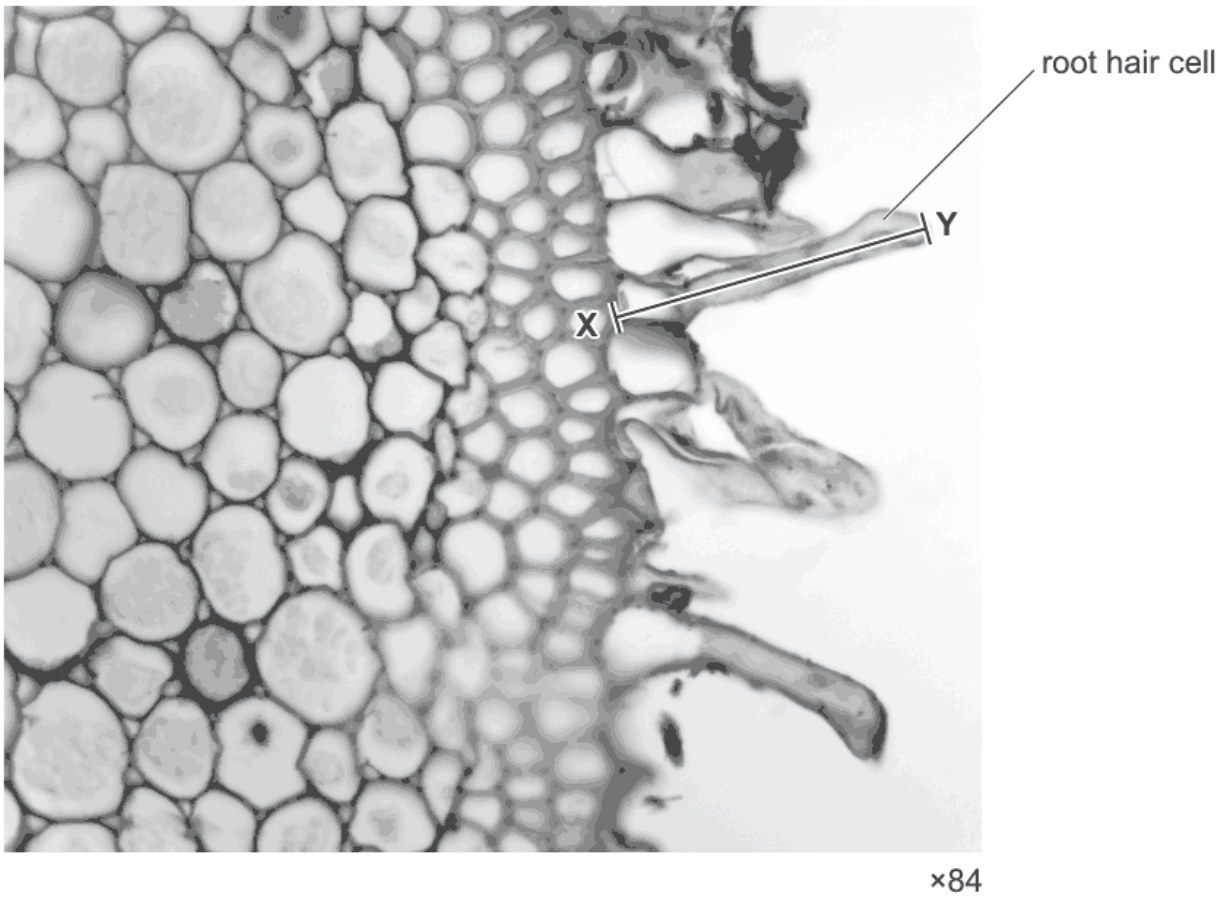


Fig. 1.1

Question 1 · Paper 2 · February/March 2025 (22) · Q1(b) · 1 mark

(b) Calculate the **actual** length, in micrometres (μm), of the root hair cell labelled in Fig. 1.1. Use the **image** length of the root hair cell along line **X–Y** in your calculation.

actual length = ... μm [1]

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(c) Malaria is caused by species from the genus *Plasmodium*.

Ring cells are one stage in the complex life cycle of *Plasmodium* that are found within red blood cells. Fig. 2.1 is a scanning electron micrograph showing two ring cells, surrounded by the membrane of a red blood cell, which has just lysed (burst).

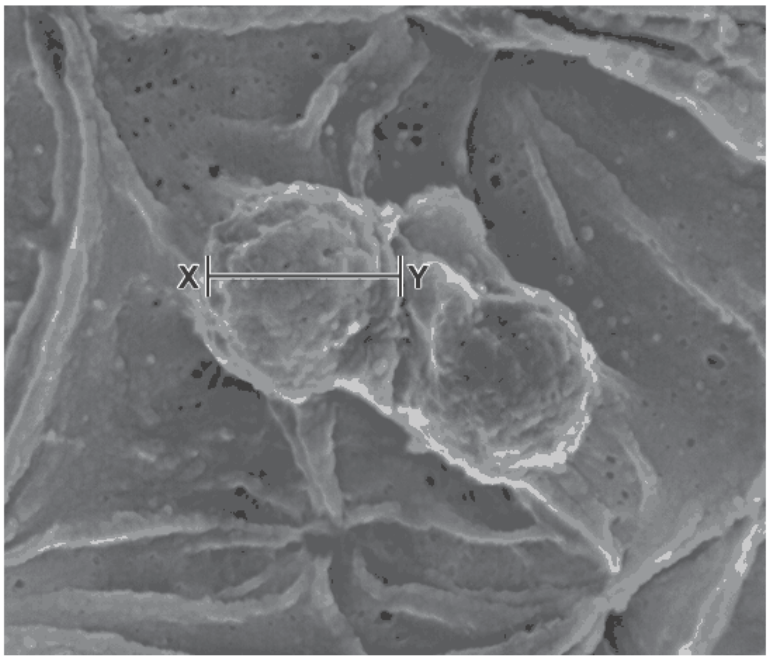


Fig. 2.1

(i) The actual diameter of the ring cell along the length **X–Y** is 2 μm.

Calculate the magnification of the image shown in Fig. 2.1.

Give your answer to 3 significant figures.

magnification = × ..... [2]

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(b) Fig. 1.2 is a transmission electron micrograph of human kidney cells infected with Zika viruses.

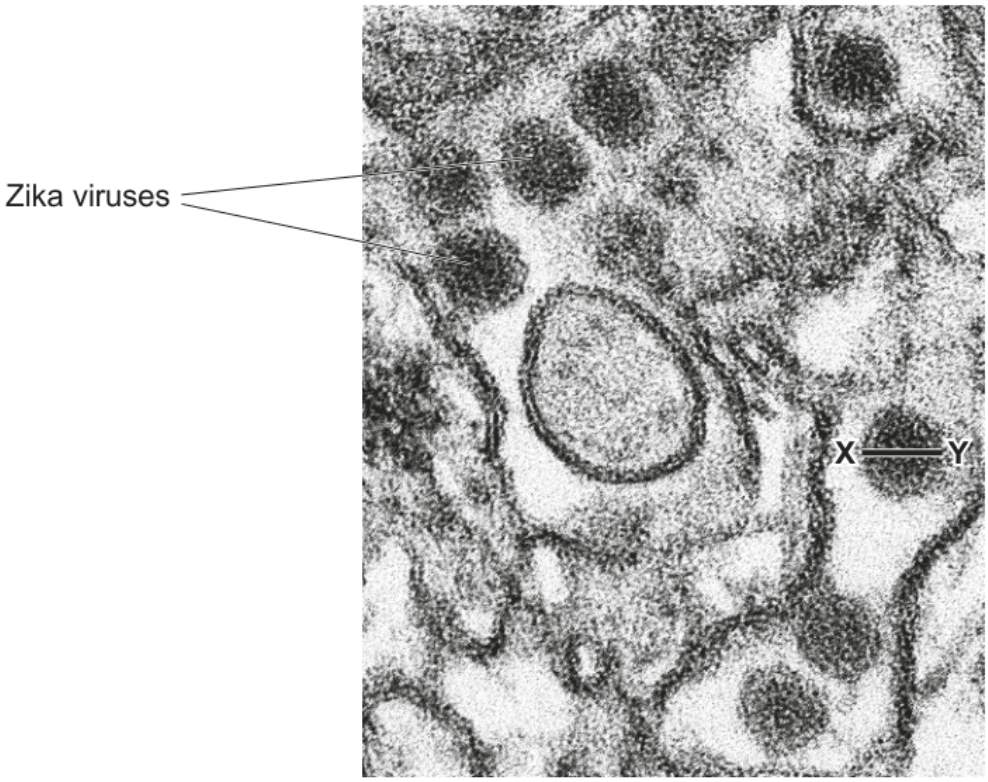


Fig. 1.2

(i) Calculate the actual diameter of a Zika virus using the line **X**–**Y** in Fig. 1.2.

Show your working.

Give your answer in nanometres (nm).

diameter = ... nm [2]

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Question 4 · information from earlier in the question

1 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**.

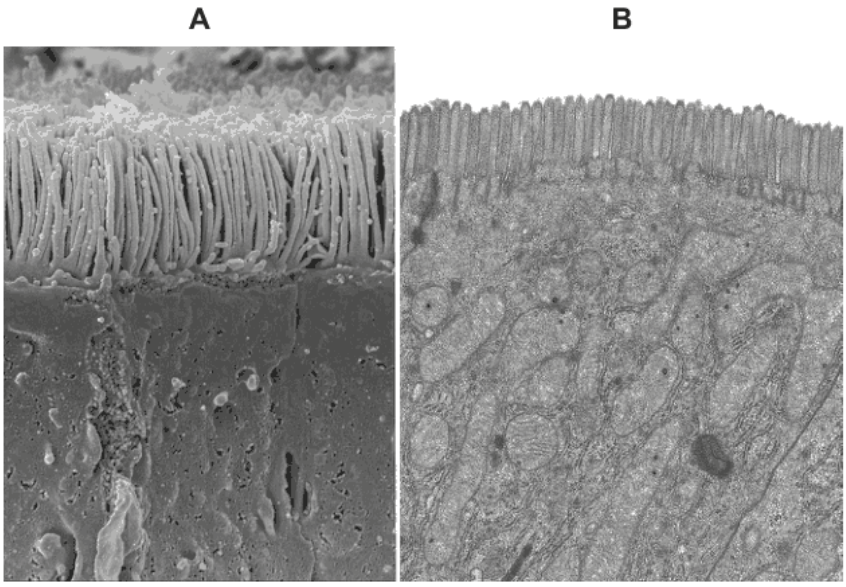


Fig. 1.1

Question 4 · Paper 2 · May/June 2022 (22) · Q1(b) · 2 marks

(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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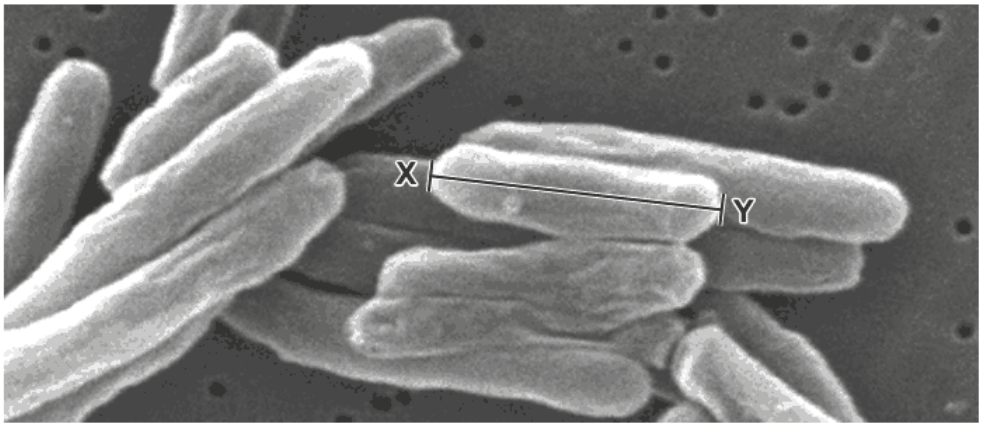
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(b) Fig. 4.1 is a scanning electron micrograph of bacteria that cause TB.



magnification ×21 000

Fig. 4.1

Calculate the actual length of the bacterial cell shown in Fig. 4.1, along the line **X–Y**.

Write the formula you will use in the box.

Give your answer in micrometres (μm) to two significant figures.

formula

actual length = ... μm
[2]

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

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

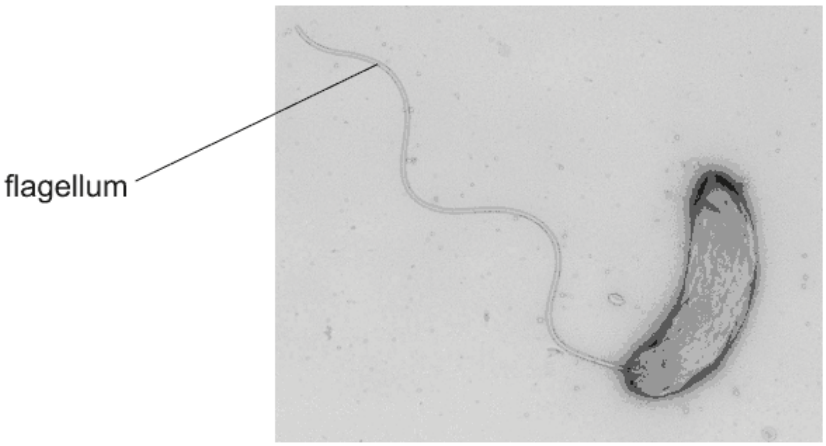


Fig. 5.1

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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Question 7 · information from earlier in the question

1 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.

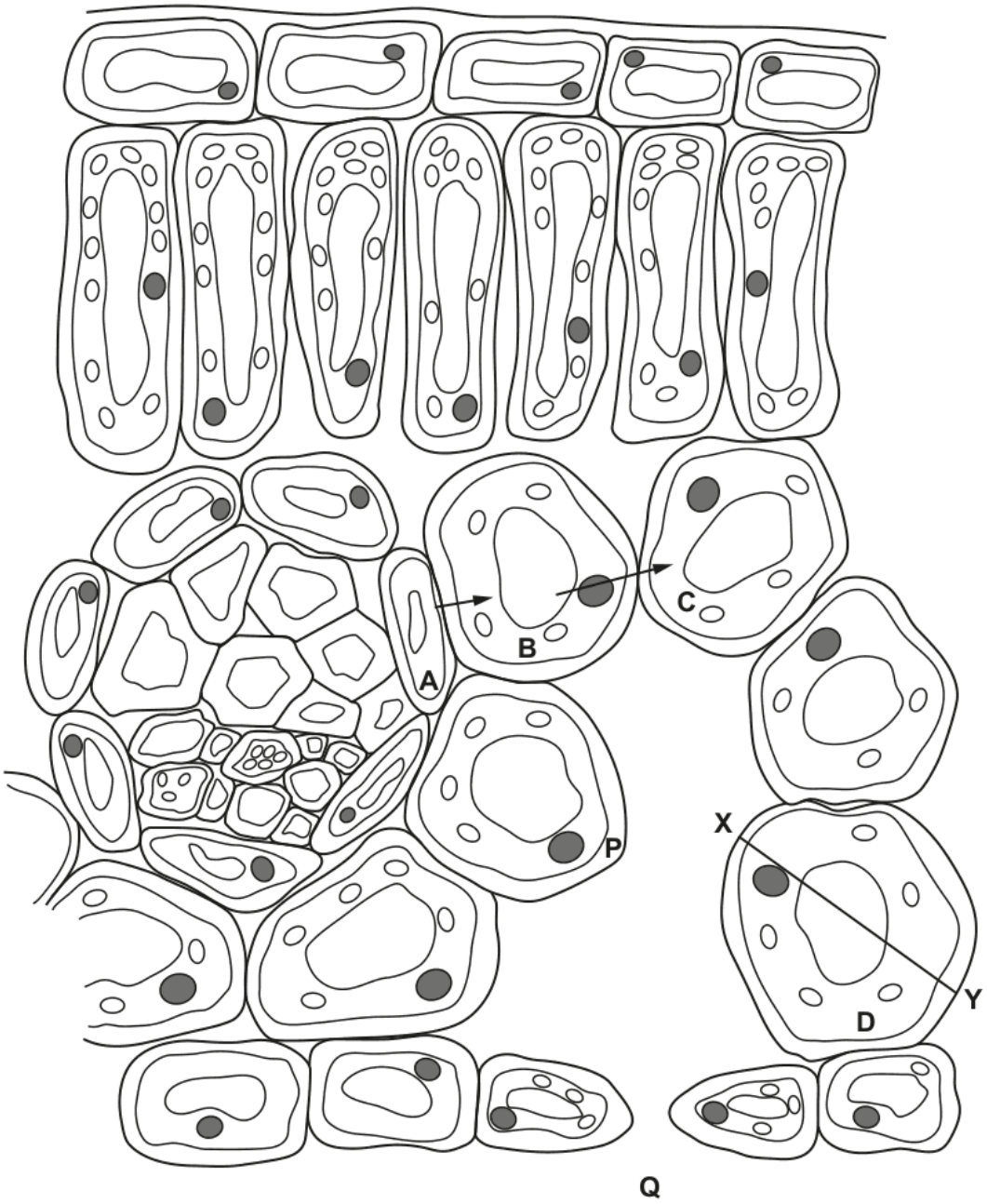


Fig. 1.1

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Question 7 · Paper 2 · October/November 2020 (22) · Q1(c) · 3 marks

(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]

Question 8 · information from earlier in the question

6 Fig. 6.1 is a transmission electron micrograph of a plant parenchyma cell.

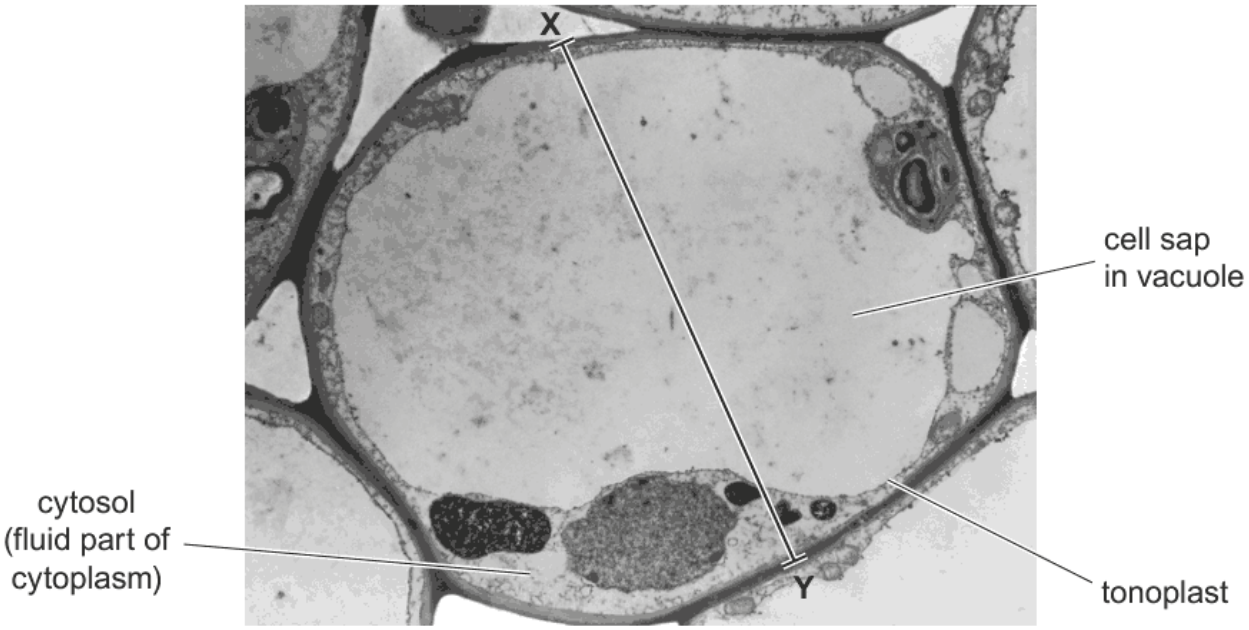


Fig. 6.1

(b) The image shown in Fig. 6.1 is at a higher magnification than can be obtained using a typical light microscope.

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Question 8 · Paper 2 · February/March 2020 (22) · Q6(b)(ii) · 2 marks

(ii) The actual diameter of the parenchyma cell in Fig. 6.1 along the line **X—Y** is 35 μm.

Calculate the magnification of the image.

magnification = × .....

[2]

Question 9 · information from earlier in the question

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

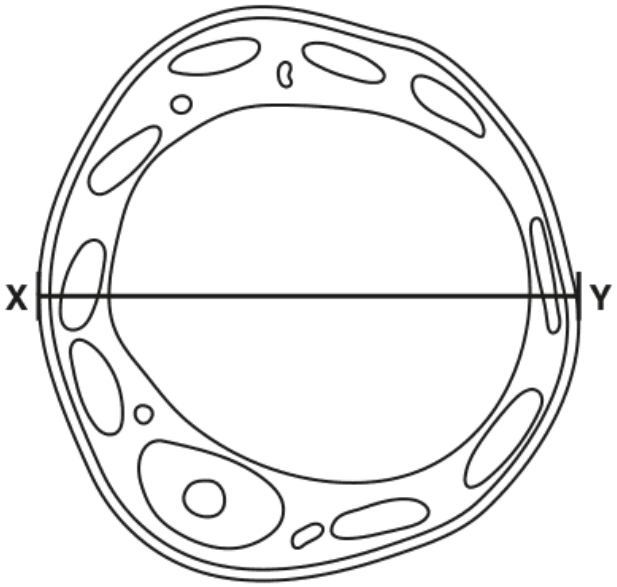


Fig. 1.1

Question 9 · Paper 2 · May/June 2018 (22) · Q1(b) · 2 marks

(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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Question 10 · information from earlier in the question

Fig. 3.1 is a transmission electron micrograph showing the developing *Plasmodium* cells inside a protective structure known as an oocyst. In this stage of the life cycle the oocysts are found in the mosquito gut. When mature, the *Plasmodium* cells are released and travel to the salivary glands of the mosquito.

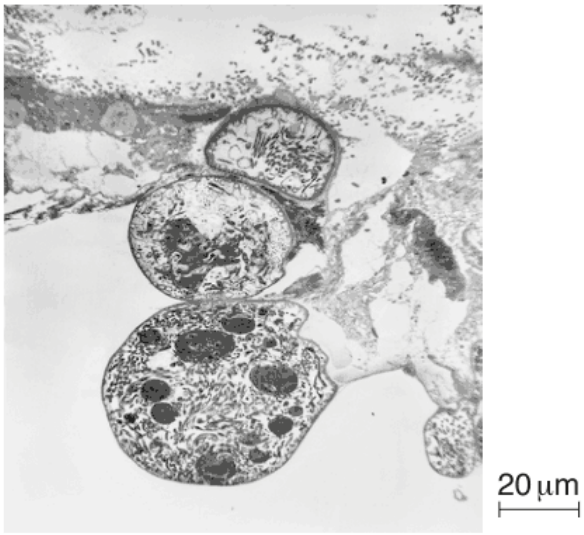


Fig. 3.1

Question 10 · Paper 2 · May/June 2017 (22) · Q3(d) · 3 marks

(d) Use the scale bar to calculate the magnification of the image shown in Fig. 3.1.

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

formula

magnification × .....[3]

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Question 11 · Paper 2 · May/June 2024 (22) · Q1(b)(i) · 1 mark

(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.

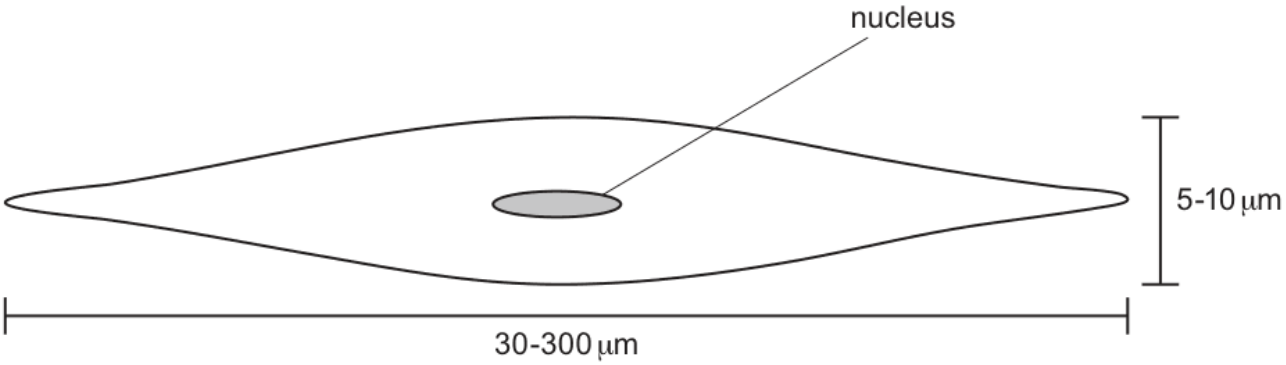


Fig. 1.1

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.

Question 12 · Paper 2 · May/June 2024 (22) · Q1(b)(ii) · 1 mark

(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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Question 13 · information from earlier in the question

1 Fig. 1.1 is a photomicrograph of a transverse section through the stem of creeping buttercup, *Ranunculus repens*.

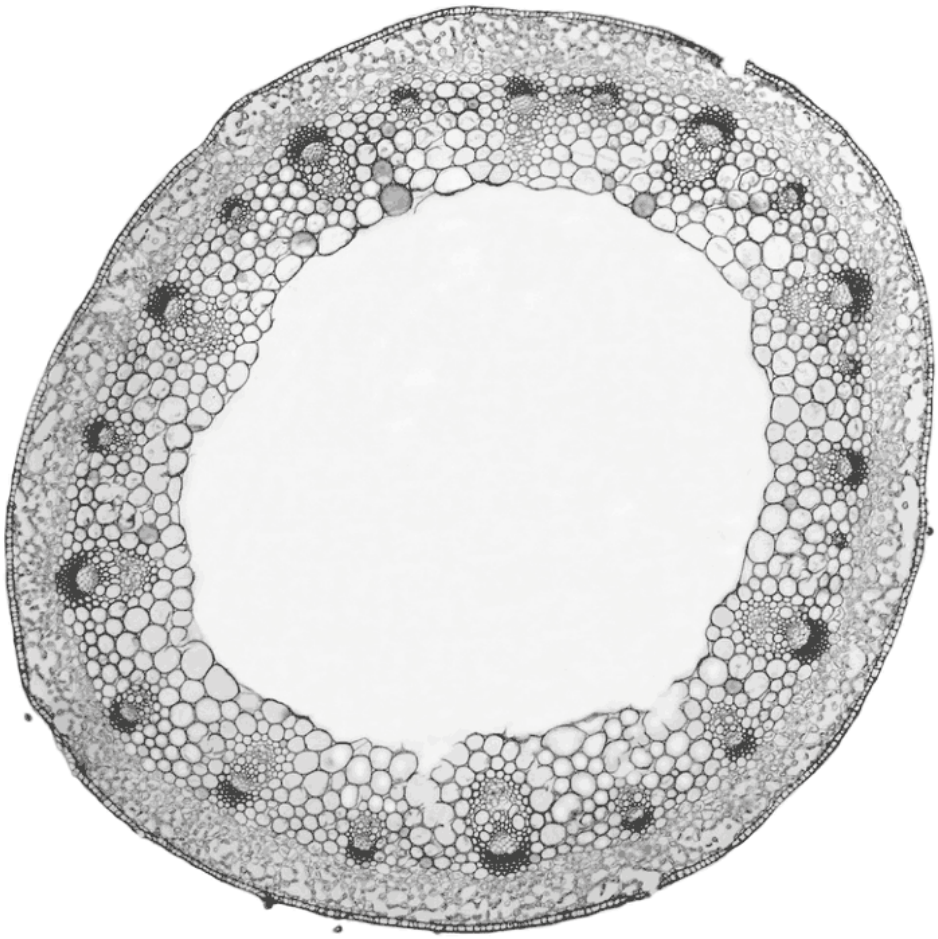


Fig. 1.1

(c) A good quality plan diagram of Fig. 1.1 will show only the tissues in the stem in their correct location and in the correct proportions.

Question 13 · Paper 2 · October/November 2019 (22) · Q1(c)(ii) · 1 mark

(ii) State the piece of equipment that can be used in the light microscope to work out the correct proportions of the tissues.

Question 14 · information from earlier in the question

(d) A virus named *Pandoravirus salinus* was discovered in 2013 by French scientists.

The virus was so large that the scientists initially thought that *P. salinus* was a bacterium.

P. salinus was confirmed to be a virus after further research.

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Question 14 · Paper 2 · February/March 2019 (22) · Q6(d)(ii) · 1 mark

(ii) The dimensions of viruses are usually stated in nanometres (nm).

As *P. salinus* is so big, it has been described as 1 μm long and 0.5 μm wide.

Convert the **width** of *P. salinus* to nanometres.

width = ... nm [1]

Question 15 · Paper 2 · February/March 2025 (22) · Q1(a) · 1 mark

1 *Smilax china* is a herbaceous plant.

Fig. 1.1 shows part of a transverse section of a root of *S. china* with root hair cells visible.

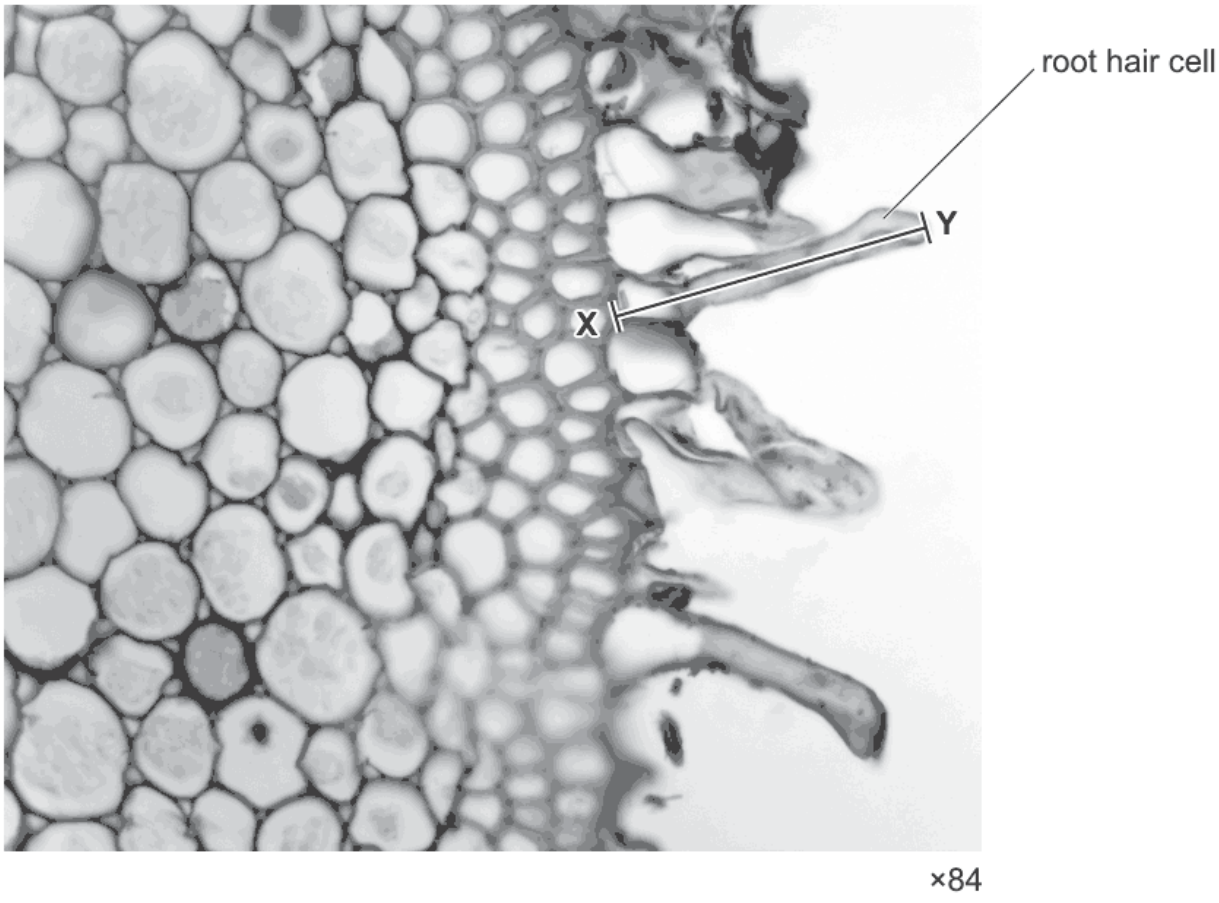


Fig. 1.1

(a) Name the type of microscope that has been used to obtain the image in Fig. 1.1.

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Question 16 · Paper 2 · February/March 2024 (22) · Q5(a)(i) · 1 mark

5 The pathogen that causes cholera is a prokaryote.

(a) Fig. 5.1 shows an electron micrograph of the pathogen that causes cholera.

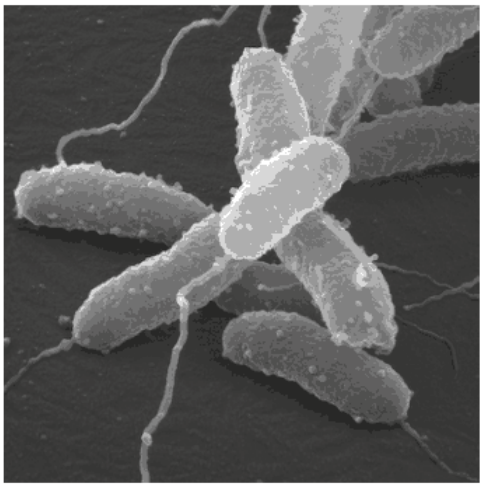


Fig. 5.1

(i) Name the type of electron microscope used to produce the image shown in Fig. 5.1.

Question 17 · Paper 2 · February/March 2018 (22) · Q1(a) · 1 mark

Answer **all** the questions.

1 Fig. 1.1 is an electron micrograph of part of a eukaryotic cell.

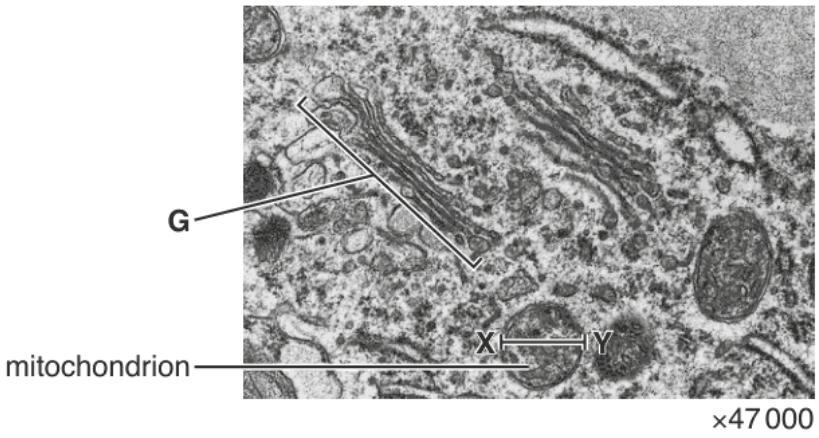


Fig. 1.1

(a) State how it is possible to deduce that Fig. 1.1 is a transmission electron micrograph and **not** a scanning electron micrograph.

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Question 18 · information from earlier in the question

6 Fig. 6.1 is a transmission electron micrograph of a plant parenchyma cell.

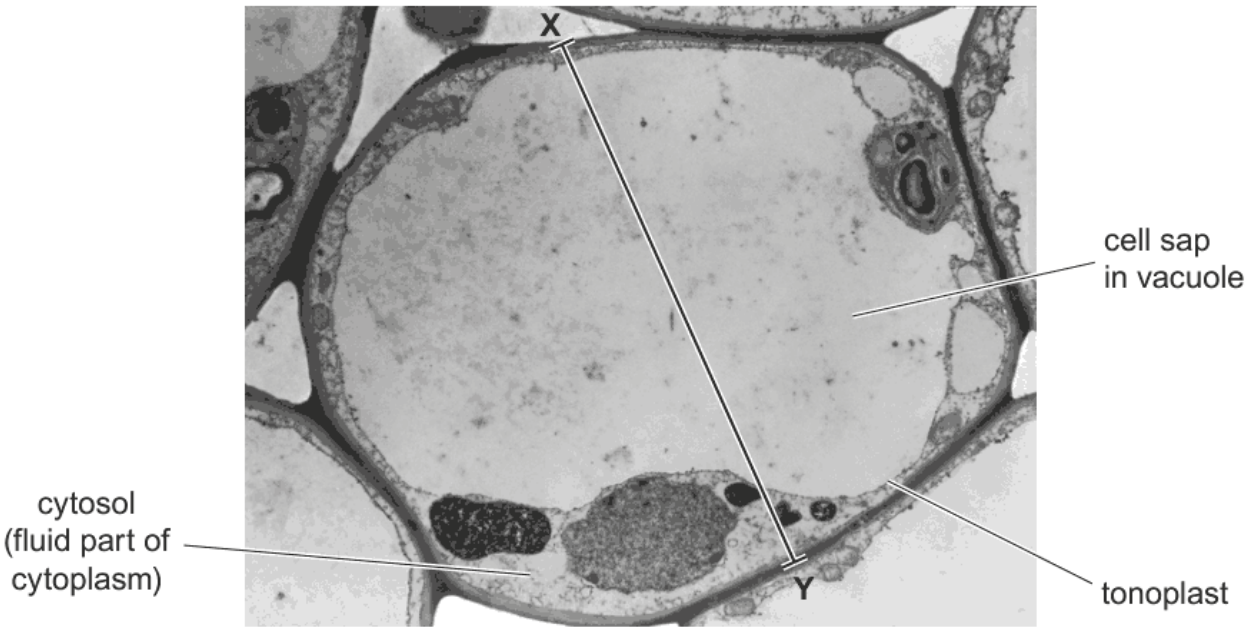


Fig. 6.1

Question 18 · Paper 2 · February/March 2020 (22) · Q6(b)(i) · 1 mark

(b) The image shown in Fig. 6.1 is at a higher magnification than can be obtained using a typical light microscope.

(i) Explain what is meant by the term *magnification*.

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Question 19 · information from earlier in the question

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

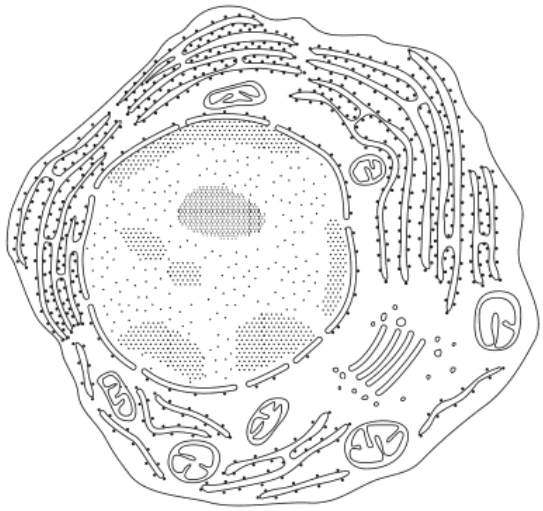


Fig. 4.1

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

Question 19 · Paper 2 · October/November 2020 (22) · Q4(a)(ii) · 2 marks

(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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Question 20 · Paper 2 · October/November 2022 (21) · Q1(b) · 3 marks

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

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3 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.

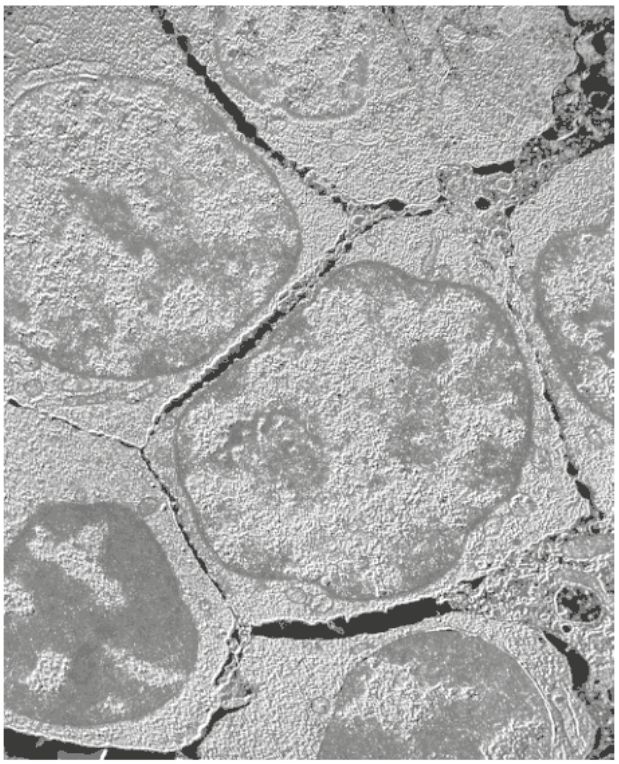


Fig. 3.1

(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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Fig. 3.1 is a transmission electron micrograph showing the developing *Plasmodium* cells inside a protective structure known as an oocyst. In this stage of the life cycle the oocysts are found in the mosquito gut. When mature, the *Plasmodium* cells are released and travel to the salivary glands of the mosquito.

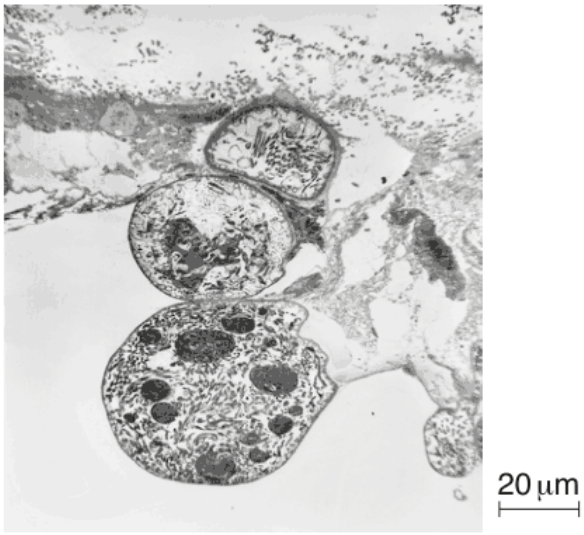


Fig. 3.1

(c) The magnification used in Fig. 3.1 can also be obtained using a light microscope.

Suggest why an electron microscope was used to obtain this image instead of a light microscope.

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Mark schemes

Question 1 · Paper 2 · February/March 2025 (22) · Q1(b) · 1 mark

1(b)	460 / 464 (μm) ; **A** 450–480	**1**

Question 2 · Paper 2 · October/November 2025 (24) · Q2(c)(i) · 2 marks

2(c)(i)	*magnification* (x) 12 000 ;; *for line X-Y measuring 24 mm* **A** *calculated values for line X-Y measured between 23 to 25 mm* *for one mark:* • *correct calculation for 23.5 or 24.5 but not to 3 sig. figs = 1 mark* • *incorrect answer e.g. conversion factor incorrect, but* – *shows correct measurement for image* – *uses correct formula for calculation* – *answer to 3 sig. figs* • *measurement 22 mm or 26 mm* – *correct answer for their measurement* – *uses correct formula for calculation* – *answer to 3 sig. figs*	**2**

Question 3 · Paper 2 · May/June 2024 (23) · Q1(b)(i) · 2 marks

1(b)(i)	50 (nm) ; **A** 50 / 52.5 / 55 / 57.5 / 60 nm working showing use of correct formula, A = I / M ; *length* **X**–**Y** */ ÷ magnification*	**2**

Question 4 · Paper 2 · May/June 2022 (22) · Q1(b) · 2 marks

1(b)	*any **two** from: max 1 if stating to measure one of the sides of the figure* (for each image) measure a number of microvilli and calculate a mean ; same units for actual and measured images / example given ; e.g. *if microvillus measurement is in mm* convert, microvillus measured length to μm / actual length to mm **R** if extra detail given is incorrect e.g. <u>divide</u> by 1000 for mm to μm divide, microvillus / image, length by, actual length / AW / 1(μm) ; **A** *idea that* value for, microvillus / image, length is the magnification	**2**

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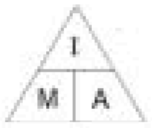
Question 5 · Paper 2 · February/March 2022 (22) · Q4(b) · 2 marks

4(b)	length X–Y (in mm) × 1000 ÷ 21 000 ; 1.7–1.8 (μm) (to 2 significant figures) ;	**2**

Question 6 · Paper 2 · May/June 2022 (21) · Q5(b) · 2 marks

5(b)	*any **two** from* *information needed* **1** magnification of, image / (electron) micrograph / Fig. 5.1 ; **A** scale bar **I** magnification of (electron) microscope **2** length of flagellum (in, image / Fig. 5.1) ; **I** width / diameter / size **3** *formula* actual length of flagellum = measured length of flagellum divided by magnification ; **A** A= I / M **or** magnification triangle	**2**

Question 7 · Paper 2 · October/November 2020 (22) · Q1(c) · 3 marks

1(c)	**1** correct formula ; (magnification) = image length ÷ actual length ; **A** rearranged formula **A** magnification triangle  **2** correct working ; **3** correct answer for magnification ; **R** if units given (×) 1440 (36 mm) / 1460 (36.5 mm) /1480 (37 mm) / 1500 (37.5 mm) 1520 (38 mm) / 1540 (38.5 mm) / 1560 (39 mm) ; *if answer given to 2 sig. figs, look for the correct answer at the end of working **or** allow if stated by answer that this is to 2 sig. figs.* *allow ecf for incorrect conversions used in working or incorrect measured value of X–Y*	**3**

Question 8 · Paper 2 · February/March 2020 (22) · Q6(b)(ii) · 2 marks

6(b)(ii)	(×) 2000 ; ; *if incorrect:* one mark for correct working 70 000 / 35 **or** one mark for correct measurement **and** division by 35 e.g. 70 mm / 35 7 cm / 35	**2**

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Question 9 · Paper 2 · May/June 2018 (22) · Q1(b) · 2 marks

1(b)	ref. to conversion of measured (**X**-**Y**) line to μm / AW ; e.g. line is measured in, mm and then multiplied by 1000 / cm and then multiplied by 10 000 evidence that, 60 (±1 mm) is multiplied by 1000 / 6 cm is multiplied by 10 000 measured diameter is 60 000 μm (and) divide by, magnification / 2000 ;	**2**

Question 10 · Paper 2 · May/June 2017 (22) · Q3(d) · 3 marks

3(d)	(magnification =) $\frac{\text{image / scale bar (length)}}{\text{actual / object (length)}}$; **A** triangle / letters only (x) 500 ;; *using 10 mm as measured length* **A** calculated values for measured length of 9 mm or 11 mm *allow one mark if correct answer given with units* *allow one mark if incorrect answer and* *correct measurement and correct working* *correct measurement and formula but incorrect conversion* *measurement ±2 mm and correct working*	**3**

Question 11 · Paper 2 · May/June 2024 (22) · Q1(b)(i) · 1 mark

1(b)(i)	stage micrometer / stage micrometer scale ;	**1**

Question 12 · Paper 2 · May/June 2024 (22) · Q1(b)(ii) · 1 mark

1(b)(ii)	yes, qualified ; e.g. 0.2 mm = 200 μm 0.2 mm / smallest student can see, is less than 0.25 mm 250 μm = 0.25 mm 250 μm / cell length, is longer than 200 μm the cell is 50 μm longer (than 0.2 mm) the cell is 0.05 mm longer (than 0.2 mm) *allow if converted to standard form* (2×10^{-4} v 2.5×10^{-4} m) *must have units* *must include numerical values*	**1**

Question 13 · Paper 2 · October/November 2019 (22) · Q1(c)(ii) · 1 mark

1(c)(ii)	eyepiece graticule ; **I** stage micrometre	**1**

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Question 14 · Paper 2 · February/March 2019 (22) · Q6(d)(ii) · 1 mark

6(d)(ii)	500 (nm) ;	1

Question 15 · Paper 2 · February/March 2025 (22) · Q1(a) · 1 mark

1(a)	light / optical (microscope) ;	1

Question 16 · Paper 2 · February/March 2024 (22) · Q5(a)(i) · 1 mark

5(a)(i)	scanning (electron microscope) ;	1

Question 17 · Paper 2 · February/March 2018 (22) · Q1(a) · 1 mark

1(a)	*assume in context of transmission electron micrograph unless otherwise stated* *any **one** from:* *idea that* can see internal structures ; cannot see surface contours / AW ; **A** not 3-D appearance AVP ; e.g. ref. to small(er) depth of field ;	1

Question 18 · Paper 2 · February/March 2020 (22) · Q6(b)(i) · 1 mark

6(b)(i)	number of times an image is larger than, actual / real, size ; **A** image size ÷ actual size **R** increase in size of specimen or object	1

Question 19 · Paper 2 · October/November 2020 (22) · Q4(a)(ii) · 2 marks

4(a)(ii)	*any **two** from:* resolution / resolving power, is, low / lower / poor / AW / 200 nm / 0.2 µm ; (**A** range 100–300 nm) **A** electron microscope has a higher resolution further detail ; e.g. ribosomes / ER, smaller than 200 nm can only see cell structures greater than (limit of) resolution cannot see structures smaller than 200 nm cell structures too small for the resolution (*needs ref. to resolution)* cell structures, too small to / do not, interfere with light waves ; AW	2

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Question 20 · Paper 2 · October/November 2022 (21) · Q1(b) · 3 marks

1(b)	*any **three** from:* higher magnification (without loss of detail) ; higher resolution / ability to see object that are close together as separate objects ; *ref. to* resolution of (up to) 0.5 nm compared to, 200 nm / 0.2 µm (light microscope) ; **A** ranges, e.g. 0.5–30 nm and 100–300 nm ability to see organelles such as, SER / ribosomes / other named organelle ; AVP ; e.g. very thin sections, qualified, e.g. for greater internal detail	**3**

Question 21 · Paper 2 · October/November 2019 (22) · Q3(a) · 2 marks

3(a)	*any two from:* **1** higher / better, resolution **A** higher resolving power **I** clearer resolution **or** greater ability to distinguish between two points / AW ; *ignore wavelength values if stated as wavelength but **R** if stated as resolution values* **2** *ref. to* resolution values ; e.g. able to see points closer together than 200 nm (range 100–300 nm) can see, points up to 0.5 nm (0.0005 µm) apart (range 0.2–1.0 nm) can see structures larger than 0.5 nm **3** thinner sections can be obtained ; **A** idea that complete image will be in better focus **4** able to see, ribosomes / membranes / detail within organelles ;	**2**

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Question 22 · Paper 2 · May/June 2017 (22) · Q3(c) · 2 marks

3(c)	*look for ora*	**max 2**
	1 higher / better / AW, resolution / resolving power ;	
	2 0.5 nm (**A** 0.2–1 nm) compared to, 200 nm 0.2 μm (**A** range 100–300 nm) **or** electrons have shorter wavelength ; **R** electron microscope has a shorter wavelength **or** *idea that* cell structures too small to interfere with light waves ora	
	3 better able to distinguish between two points ; **A** as a definition if mp 1 achieved	
	4 (can see) more detail ; *treat 'clearer' as neutral*	
	5 able to make thinner sections / able to see inside (oocyst) ;	
	6 can continue to obtain higher magnifications and see more detail ;	

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