Methods of Studying Cells: AQA A Level Biology Exam Questions by Top

18 questions · 46 marks · about 60 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · AS Paper 1 · June 2022 · Q03.3 · 1 mark

0 3 . 3 The resolution of an image obtained using an electron microscope is higher than the resolution of an image obtained using an optical microscope.

Explain why.

[1 mark]

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Question 2 · A level Paper 1 · June 2017 · Q10.1 · 6 marks

1 0 . 1 Contrast how an optical microscope and a transmission electron microscope work **and** contrast the limitations of their use when studying cells.

[6 marks]

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0 4 . 2 **Table 3** shows the resolution of three types of microscope.

Table 3

Microscope	Resolution / µm
Optical	0.25
Scanning electron (SEM)	0.02
Transmission electron (TEM)	0.0002

Table 4 shows information about yeast cells and mitochondria.

Table 4

	Mean diameter / µm
Yeast cells	3.0
Mitochondria	0.22

Identify the correct microscope to use in each of the following investigations.

Use your knowledge of microscopes and information in **Table 3** and **Table 4**.

Give **two** reasons for each choice of microscope.

[4 marks]

Investigation 1 – to study the living cells in a yeast culture that contains both living cells and dead cells. The living cells remain colourless and the dead cells are stained blue when a dye is added.

Type of microscope _____

Reason 1 _____

_____

_____

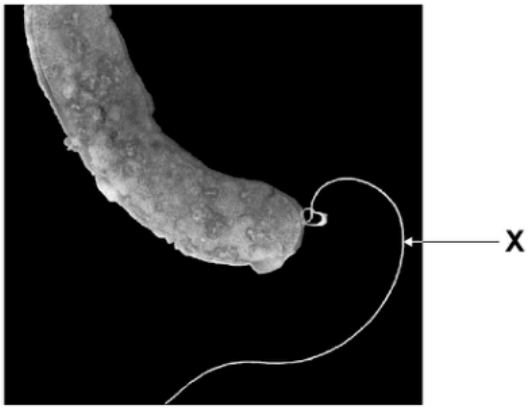
Reason 2 _____

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Question 4 · information from earlier in the question

0 3 . 1 **Figure 2** is an image of a bacterium obtained using a scanning electron microscope.

Figure 2



Name the structure labelled **X**.

[1 mark]

Question 4 · AS Paper 1 · June 2022 · Q03.2 · 2 marks

0 3 . 2 **Figure 2** is different from an image of this bacterium obtained using a transmission electron microscope.

Describe and explain **one** difference between these images.

[2 marks]

Description _____

_____

Explanation _____

_____

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Question 5 · information from earlier in the question

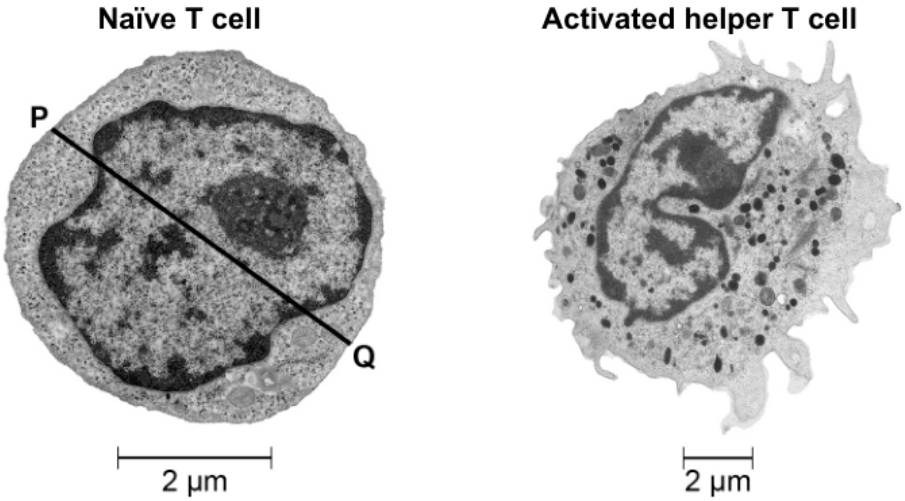
0 4 Scientists investigated the activation of T lymphocytes.

The scientists studied two types of cell:

- naïve T cells, which are T cells that have not yet been in contact with a foreign antigen
- activated helper T cells, which are T cells that have been activated by a foreign antigen.

Figure 5 shows electron microscope images of the two types of cell.

Figure 5



The activated helper T cell has a volume of 463 μm^3

Question 5 · AS Paper 1 · June 2023 · Q04.2 · 2 marks

0 4 . 2 State **one** feature that shows the images in **Figure 5** were taken with an electron microscope and **not** an optical microscope.

Explain your answer.

[2 marks]

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Figure 3 is a transmission electron micrograph of a plant cell.

Figure 3



0 4 . 2 Suggest why a nucleus is **not** visible in **Figure 3**.

[1 mark]

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Question 7 · A level Paper 1 · June 2023 · Q06.2 · 3 marks

The classification system used in the early 20th century grouped different species of bacteria according to the position and shape of flagella on bacterial cells and by the number of flagella per cell. These were observed using an optical microscope.
Each species of bacterium has a characteristic cell shape and arrangement of flagella.
These characteristics may be shared with other species within a genus.
Flagella are fragile, difficult to stain and may extend from the cell at any angle.

0 6 . 2 Consider the accuracy and limitations of the early classification of bacteria using the arrangement of flagella.

[3 marks]

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Question 8 · AS Paper 2 · June 2024 · Q03.1 · 4 marks

0 3 . 1 Describe how you would use cell fractionation and ultracentrifugation to obtain a sample of mitochondria from muscle tissue.

[4 marks]

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Question 9 · AS Paper 1 · June 2019 · Q05.6 · 3 marks

0 5 . 6 A biologist separated cell components to investigate organelle activity. She prepared a suspension of the organelles in a solution that prevented damage to the organelles.

Describe **three** properties of this solution and explain how each property prevented damage to the organelles.

[3 marks]

Property 1 _____

Explanation

_____

_____

_____

_____

Property 2 _____

Explanation

_____

_____

_____

_____

Property 3 _____

Explanation

_____

_____

_____

_____

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0 4 A student isolated chloroplasts from spinach leaves into a solution to form a chloroplast suspension. He used the chloroplast suspension and DCPIP solution to investigate the light-dependent reaction of photosynthesis. DCPIP solution is blue when oxidised and colourless when reduced.

The student set up three test tubes as follows:

- **Tube 1** – 1 cm^3 of solution without chloroplasts and 9 cm^3 of DCPIP solution in light.
- **Tube 2** – 1 cm^3 of chloroplast suspension and 9 cm^3 of DCPIP solution in darkness.
- **Tube 3** – 1 cm^3 of chloroplast suspension and 9 cm^3 of DCPIP solution in light.

The student recorded the colour of the DCPIP in each of the tubes at the start and after the tubes had been left at 20 °C for 30 minutes.

His results are shown in **Table 1**.

Table 1

Tube	Colour of DCPIP in tube	
	At start	After 30 minutes
1	blue	blue
2	blue	blue
3	blue	colourless

0 4 . 1 The solution that the student used to produce the chloroplast suspension had the same water potential as the chloroplasts.

Explain why it was important that these water potentials were the same.

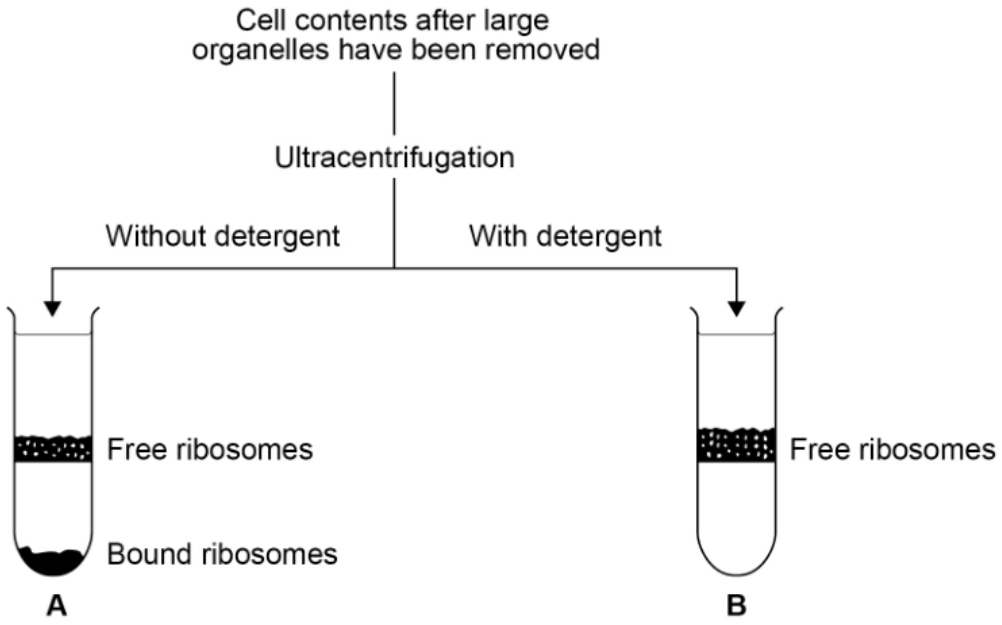
[2 marks]

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Scientists investigated ribosomal RNA in liver cells.

Figure 10 shows the method they used to isolate the ribosomes from the liver cells. The detergent dissolves lipids.

Figure 10



0 7 . 2 The scientists broke open the cells to produce a suspension of cell contents.

Describe how the scientists would remove large organelles from this suspension of cell contents.

[2 marks]

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Question 12 · A level Paper 1 · June 2022 · Q07.3 · 3 marks

0 7 . 3 Explain the position of the bands of ribosomes in tubes **A** and **B** in **Figure 10**.

[3 marks]

A _____

_____

_____

_____

B _____

_____

_____

_____

Question 13 · information from earlier in the question

0 5 Scientists investigated the role of a protein called CENP-W in mitosis. Their method involved cell fractionation and ultracentrifugation.

Question 13 · A level Paper 3 · June 2018 · Q05.2 · 2 marks

0 5 . 2 Explain how ultracentrifugation separates CENP-W from other molecules.

[2 marks]

_____

_____

_____

_____

_____

_____

_____

_____

_____

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Question 14 · A level Paper 1 · June 2024 · Q03.2 · 2 marks

0 3 . 2 A scientist prepared alveolar tissue to view using an optical microscope. The scientist cut very thin slices of the alveolar tissue.

Explain why the scientist used very thin slices of alveolar tissue with the optical microscope.

[2 marks]

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Question 15 · AS Paper 2 · June 2017 · Q06.1 · 3 marks

0 6 Stomata are found mainly on the underside of leaves of dicotyledonous plants.
A student painted a layer of nail varnish on the lower epidermis of a leaf.
She peeled off the dry layer of nail varnish and placed it on a microscope slide.
The student was able to see the impressions of the stomata on the varnish using an optical microscope.
She then determined the mean diameter of the stomata.

0 6 . 1 Describe how the student could use an eyepiece graticule to determine the mean diameter of stomata.

[3 marks]

[Extra space]

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Question 16 · AS Paper 1 · June 2022 · Q03.4 · 2 marks

0 3 . 4 A student determined the size of a cell structure from a photograph obtained using a microscope.

He used a ruler and a calculator and gave the answer in μm

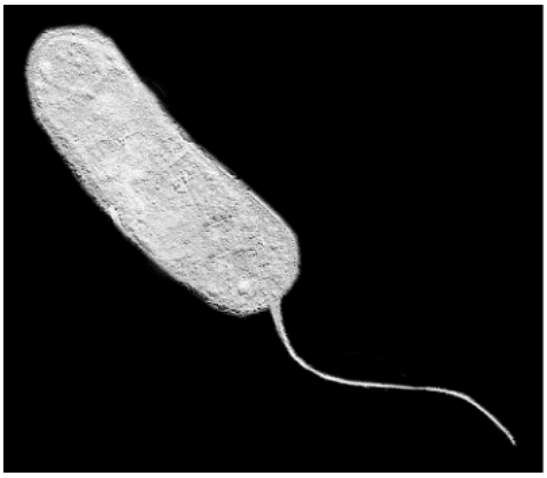
Describe how the student determined the size of the structure.

[2 marks]

Question 17 · A level Paper 1 · June 2023 · Q06.4 · 2 marks

0 6 . 4 **Figure 6** shows an image from an optical microscope of a single bacterial cell.

Figure 6



This bacterial cell is 2.3 μm long (excluding the flagellum).

Calculate the magnification of this image.

Show your working.

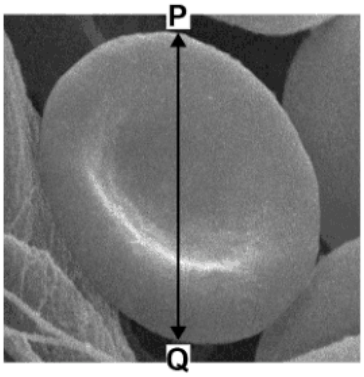
[2 marks]

Magnification × _____

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0 2 . 1 **Figure 2** shows an image of a red blood cell at a magnification of × 5500

Figure 2



Calculate the actual diameter in μm of the red blood cell between points **P** and **Q**.

Show your working.

[2 marks]

Answer _____ μm

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Mark schemes

Question 1 · AS Paper 1 · June 2022 · Q03.3 · 1 mark

03.3	Shorter wavelength between electrons **OR** Longer wavelength in light (rays);	1 (AO1)	Accept 'of electrons' **OR** 'of electron beam' for 'between electrons' Reject Electron microscope has a shorter wavelength Reject Light microscope has a longer wavelength

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Question 2 · A level Paper 1 · June 2017 · Q10.1 · 6 marks

10.1	1. TEM use electrons **and** optical use light; 2. TEM allows a greater resolution; 3. (So with TEM) smaller organelles/named cell structure can be observed **OR** greater detail in organelles/named cell structure can be observed; 4. TEM view only dead/dehydrated specimens **and** optical (can) view live specimens; 5. TEM does not show colour **and** optical (can); 6. TEM requires thinner specimens; 7. TEM requires a more complex/time consuming preparation; 8. TEM focuses using magnets and optical uses (glass) lenses;

6 max	3. 'clearer' is not equivalent to 'detail' 4. Accept 'Only optical can view live specimens' 5. Accept 'Only optical can show colour' 7. Accept 'TEM requires a more difficult preparation' Ignore references to artefacts

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04.2	(Optical/light microscope – no mark) 1. Detects living (cells/organisms/sample/ specimen); 2. Detects colour/stain/dye; 3. Resolution is enough/0.25 µm (to view cells); (Scanning electron microscope/SEM – no mark) 4. Resolution is high(er)/enough/0.02 µm (to view mitochondria); 5. Detects three dimensions/surface structures;	4 max (2 x AO2, 2 x AO3)

Accept converse eg electron microscopes do not detect colour

Max 2 marks from 1. 2. and 3.

1. 2. and 3. optical/light must be the named microscope

If 4 and 5 not achieved accept for 1 mark, TEM/electron microscope to see internal structures
OR
TEM/electron microscope has high(est)/enough/ 0.0002 µm resolution

5. Accept 3-D for 'three dimensions'

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Question 4 · AS Paper 1 · June 2022 · Q03.2 · 2 marks

03.2	1. 3D with SEM, but 2D with TEM **OR** (Only) surface visible with SEM, but internal structures visible with TEM; 2. (Because) electrons deflected/bounce off (using SEM) **OR** Electrons transmitted/pass through (using TEM);	2 (2 x AO1)

2. Accept Resolution is lower (with SEM)

Question 5 · AS Paper 1 · June 2023 · Q04.2 · 2 marks

04.2	1. Nuclear membrane /nucleolus /vesicles/ lysosomes/ribosomes distinct/visible; 2. EM has greater resolution;	2 (1 x AO1, 1 x AO2)	1. Accept invaginations of membrane distinct/visible 1. Reject nucleus 1. Reject mitochondrion 2. assume 'it' refers to electron microscope

Question 6 · AS Paper 1 · November 2020 · Q04.2 · 1 mark

04.2	A section/slice (so nucleus in another part of cell) **OR** (Nucleus) not stained;	1

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06.2	1. Can not identify/distinguish species; 2. (Optical) microscope resolution is low; 3. Flagella (are fragile so) broken/damaged/missing **OR** Artefacts misinterpreted/mistaken for flagella; 4. (Flagella) difficult to stain **so** not visible; 5. (Flagella) at an angle **so** not visible; 6. Not all bacteria have flagella;

3 max (3 x AO3)	2. Ignore magnification 4. Ignore difficult to stain unqualified 5. Accept 'out of plane' for 'at an angle'

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03.1	1. Use cold, buffered solution with same water potential; 2. Homogenise tissue and (then) filter; 3. Centrifuge at low speed and remove supernatant **OR** Centrifuge at low speed to remove/separate nuclei; 4. Centrifuge supernatant at higher speed (and pellet containing mitochondria is mixed with new supernatant);	4 (4 x AO1)

1. Accept isotonic for same water potential.

2. Accept blend OR grind for homogenise.

3. and 4. Accept solution for supernatant.

3. Accept heavier/denser organelles

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Question 9 · AS Paper 1 · June 2019 · Q05.6 · 3 marks

05.6	1. (Ice) cold to prevent/reduce enzyme activity; 2. Buffered to prevent denaturing of enzyme/protein; 3. Same water potential/Ψ to prevent lysis/bursting (of organelle);	3	For 1, 2 and 3 reject context of cell 2. Accept description of buffer. 2. Accept: prevent change of tertiary structure. 3. Accept: isotonic for same water potential. 3. Reject: references to turgor or plasmolysis or crenation.
TOTAL		**11**	

Question 10 · A level Paper 2 · June 2017 · Q04.1 · 2 marks

04.1	1. <u>Osmosis</u> does not occur; 2. Chloroplast/organelle does not burst/lyse/shrivel/shrink;	2	1. Accept: osmosis would occur if water potentials were not the same. 1 and 2, Accept: correct reference to osmotic lysis for **2 marks**. 2. Accept: chloroplast would burst/lyse/shrivel/shrink if water potentials were not the same. 2. Reject: '<u>cell</u> bursts/shrivels' 2. Ignore: damage to chloroplasts on its own is not enough for a mark. 2. Reject: becomes turgid/flaccid.

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07.2	1. Use centrifuge/centrifugation at slow/low/increasing (sequence of) speed(s); 2. Large/dense organelles (removed) in (first/early) pellet **OR** Less dense organelles (removed) in supernatant **OR** Small organelles (removed) in supernatant;

2 (1 x AO2, 1 x AO3)	Ignore homogenate OR filtering Ignore cold, isotonic, buffered 2. Accept descriptions of supernatant and pellet, eg liquid and sediment/bottom of tube 2. Accept light for small 2. Accept ribosomes for small organelles 2. Accept more dense OR heavy for large 2 Accept named large organelle in pellet, eg mitochondria

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07.3	(Tube **A**) 1. (Ribosomes bound to) rough endoplasmic reticulum; 2. (Are) denser/heavier **so** move further; (Tube **B**) 3. (Only free ribosomes because) membrane/phospholipids/endoplasmic reticulum dissolved (by detergent);	3 (3 x AO2)

Award marks across A and B

1. and 3 Do not credit ER/rER the first time used if endoplasmic reticulum not given

2. Accept, free ribosomes are lighter so form a band higher in tube OR do not move as far

2. For 'heavier/lighter' accept 'denser/less dense'.

2. Accept settle lower OR are lower down OR at bottom OR in pellet, for move further

3. Accept broken down for dissolved

3. Ignore damaged for dissolved

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Question 13 · A level Paper 3 · June 2018 · Q05.2 · 2 marks

05.2	1. Spin (liquid / supernatant) at (very) high speed / high g; 2. Molecules / CENP-W separates depending on (molecular) mass / size / density;	2	1. Need context of high, **not** just 'faster', 'higher' in context of use of bench centrifuge 1. Accept high centrifugal force Award 1 max if ref. to organelle separation 2. Accept weight

Question 14 · A level Paper 1 · June 2024 · Q03.2 · 2 marks

03.2	1. (Create a) single/few layer(s) of cells/tissue; 2. (So) light can pass through;	2 (2 x AO1)	1. Accept to avoid overlapping cells

Question 15 · AS Paper 2 · June 2017 · Q06.1 · 3 marks

06.1	1. Measure (each stoma) using eyepiece graticule; 2. Calibrate eyepiece graticule against stage micrometer / ruler / graph paper; 3. Take a number of measurements (to calculate a mean);	3	2. Accept micrometer slide 3. Idea of enough readings for a reliable mean (min. 5)

Question 16 · AS Paper 1 · June 2022 · Q03.4 · 2 marks

03.4	Mark in pairs: 1 **and** 2 **OR** 3 **and** 4 1. Measure (length of structure) **and** divide by magnification; 2. Correct conversion from measured length to µm, either × 10 000 from cm **OR** × 1000 from mm; 3. Measure (length of structure) **and** divide by (image) length of scale bar; 4. Multiply by actual length of scale bar;	2 (2 x AO1)	1. Accept correct equation making reference to a measurement

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Question 17 · A level Paper 1 · June 2023 · Q06.4 · 2 marks

06.4	Correct answer of 19 565 (from measurement of 45mm) **OR** 20 000 (from measurement of 46mm) **OR** 20 435 (from measurement of 47mm) = **2 marks**;; Accept for **1 mark**, evidence of 45 000 OR 46 000 OR 47 000 (correct image size in µm) **OR** ÷ 2.3 (correct use of equation);

2 (2 x AO2)	Accept answers that round correctly to those shown Accept division by 2.3 x 10^{-3} OR 0.0023

Question 18 · AS Paper 2 · June 2024 · Q02.1 · 2 marks

02.1	Correct answer within range of 7 to 7.5 = **2 marks**;; Incorrect but shows division by 5500 = **1 mark** **OR** Answer shows correct number but incorrect decimal place eg 70 / 727 / 0.72 = **1 mark**;	2 (2 x AO2)

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