1.9 Cell Structure and Microscopy: 1-hour Pack

AQA 8464 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A student measures cell sizes from a printout of a light microscope image. The scale bar on the printout is labelled 50 micrometres and measures 5.0 mm. The student measures one cell as 8.0 mm on the printout. Calculate the actual size of the cell in micrometres. Show substitution and give the final answer with units.

(a) Set up the ratio to convert the measured image length to actual size. **(1)**

(b) Calculate the actual size and give the answer with units. **(2)**

.....

(Total for Question 1 is 3 marks)

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2 This question is about structures found in cells.

(a) Which cell structure controls which substances enter and leave a cell? **(1)**

- ☐ A) Cytoplasm
- ☐ B) Cell membrane
- ☐ C) Nucleus
- ☐ D) Ribosome

(b) State the function of the nucleus. **(1)**

.....

(c) State the function of the cytoplasm. **(1)**

.....

(d) State the function of the mitochondria. **(1)**

.....

(e) State the function of the ribosomes. **(1)**

.....

(Total for Question 2 is 5 marks)

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3 A chloroplast is measured on a micrograph (a photograph taken through a microscope).

(a) In the micrograph, the chloroplast has a length of 12 mm. The micrograph was produced at a total magnification of x2400. Calculate the actual length of the chloroplast, in micrometres (µm). **(2)**

.....

(b) Give your answer to part (a) in standard form, in metres (m). **(1)**

.....

(Total for Question 3 is 3 marks)

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4 Write each of the following lengths in standard form, in metres (m).

(a) 0.02 mm **(1)**

.....

(b) 15 µm **(1)**

.....

(c) 750 nm **(1)**

.....

(d) 4 nm **(1)**

.....

(Total for Question 4 is 4 marks)

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5 A typical animal cell has a diameter of about 20 micrometres (μm). A mitochondrion inside the cell has a diameter of about 1 micrometre (μm).

(a) Calculate how many times greater the diameter of the cell is than the diameter of the mitochondrion. **(2)**

.....

(Total for Question 5 is 2 marks)

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6 Plant cells contain some structures that are not found in animal cells.

(a) Plant cells (but not animal cells) have a cell wall. State what the cell wall is made of, and describe its function. **(2)**

(b) State the function of the chloroplasts found in plant cells. **(2)**

(c) State the function of the permanent vacuole found in plant cells. **(2)**

(Total for Question 6 is 6 marks)

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7 Cells become specialised (differentiated) to carry out a particular function.

(a) Describe one way a sperm cell is adapted for its function, and explain how this adaptation helps the cell. **(2)**

(b) Describe one way a root hair cell is adapted for its function, and explain how this adaptation helps the cell. **(2)**

(c) Describe one way a red blood cell is adapted for its function, and explain how this adaptation helps the cell. **(2)**

(d) Describe one way a ciliated epithelial cell is adapted for its function, and explain how this adaptation helps the cell. **(2)**

(Total for Question 7 is 8 marks)

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8 A student compares two staining methods to make cell walls more visible. Method A produces clear cell walls but also causes some shrinkage of cells. Method B preserves cell shape but gives lower contrast. Evaluate which method is better for measuring cell dimensions and suggest which would be better when studying cell wall thickness. In your answer consider accuracy and artefacts and give a justified conclusion.

(Total for Question 8 is 6 marks)

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9 Explain how differences between a light microscope and a transmission electron microscope (TEM) affect the choice of microscope for viewing detailed internal structure of organelles. In your answer discuss magnification, resolution and sample preparation.

(Total for Question 9 is 6 marks)

10 Higher tier only. The resolution of a light microscope is approximately 200 nanometres (2×10^{-7} m). The resolution of a transmission electron microscope (TEM) is approximately 0.2 nanometres (2×10^{-10} m).

(a) Calculate how many times better (smaller) the resolution of the TEM is compared with the resolution of the light microscope. **(2)**

(b) Suggest one advantage, other than resolution, that a light microscope has over a transmission electron microscope for viewing onion cells. **(1)**

(Total for Question 10 is 3 marks)

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Mark scheme · 1.9 Cell Structure and Microscopy: 1-hour Pack

Question 1

(a) states magnification or scale: 5.0 mm on image corresponds to 50 micrometres actual, so conversion factor is 50 micrometres / 5.0 mm **M1**

(a) Answer: Scale: 5.0 mm = 50 micrometres, so 1.0 mm = 10 micrometres; actual size = 8.0 mm x 10 micrometres/mm

(b) performs multiplication: 8.0 x 10 **M1**

(b) gives 80 micrometres cao **A1**

(b) Answer: 80 micrometres

Question 2

(a) B (cell membrane) **B1**

(a) Answer: B (cell membrane)

(b) contains the genetic material (DNA) and controls the activities of the cell, oe **B1**

(b) Answer: Contains the genetic material and controls the cell's activities.

(c) gel-like substance in which most of the cell's chemical/metabolic reactions take place, oe **B1**

(c) Answer: The gel-like substance in which most chemical reactions of the cell take place.

(d) site of aerobic respiration, which releases/transfers energy for the cell, oe **B1**

(d) Answer: Site of aerobic respiration, releasing energy for the cell.

(e) site of protein synthesis, oe **B1**

(e) Answer: Site of protein synthesis.

Question 3

(a) converts 12 mm to 12000 µm, then actual size = image size / magnification, oe **M1**

(a) 5 µm cao **A1**

(a) Answer: 5 µm

(b) 5 x 10^{-6} m, ft from their (a) answer converted correctly to standard form **B1**

(b) Answer: 5 x 10^{-6} m

Question 4

(a) 2 x 10^{-5} m cao **B1**

(a) Answer: 2 x 10^{-5} m

(b) 1.5 x 10^{-5} m cao **B1**

(b) Answer: 1.5 x 10^{-5} m

(c) 7.5 x 10^{-7} m cao **B1**

(c) Answer: 7.5 x 10^{-7} m

(d) 4 x 10^{-9} m cao **B1**

(d) Answer: 4 x 10^{-9} m

Question 5

(a) 20 / 1, oe **M1**

(a) 20 (times) cao **A1**

(a) Answer: 20 times

Question 6

(a) made of cellulose **B1**

(a) provides strength/structural support to the cell, and prevents the cell bursting, oe **B1**

(a) Answer: Made of cellulose; provides strength and support and stops the cell bursting.

(b) absorb light energy, using the chlorophyll they contain, oe **B1**

(b) used to produce glucose/sugars by photosynthesis, oe **B1**

(b) Answer: Absorb light energy (using chlorophyll) and use it to produce glucose by photosynthesis.

(c) contains cell sap (a solution of sugars and salts), oe **B1**

(c) helps to keep the cell turgid/rigid, providing support to the plant, oe **B1**

(c) Answer: Contains cell sap; keeps the cell turgid, helping to support the plant.

Question 7

(a) adaptation, e.g. has a long tail (flagellum) / has many mitochondria in the mid-piece / has an acrosome containing enzymes **B1**

(a) linked explanation, e.g. the tail allows the cell to swim towards the egg cell; OR many mitochondria release energy (by respiration) for the tail to move; OR acrosome enzymes help digest the outer coat surrounding the egg, allowing the sperm to reach the egg cell membrane, oe **B1**

(a) Answer: E.g. a long tail (flagellum) allows the sperm cell to swim towards the egg cell. Alternatively, many mitochondria release energy for movement, or acrosome enzymes help digest the outer coat surrounding the egg.

(b) adaptation: has a long, hair-like extension (the root hair) **B1**

(b) explanation: this increases the surface area of the cell, increasing the rate of absorption of water and mineral ions from the soil, oe **B1**

(b) Answer: Long hair-like extension, which increases surface area for absorbing water and mineral ions.

(c) adaptation, e.g. biconcave disc shape / no nucleus / contains haemoglobin **B1**

(c) explanation, e.g. biconcave shape increases surface area for the diffusion of oxygen; OR having no nucleus leaves more space to carry haemoglobin/oxygen, oe **B1**

(c) Answer: E.g. biconcave disc shape, which increases surface area for the diffusion of oxygen.

(d) adaptation: has cilia (tiny hair-like structures) on its surface **B1**

(d) explanation: the cilia beat/move to waft mucus (and trapped particles/pathogens) away from the lungs, oe **B1**

(d) Answer: Has cilia on its surface, which waft mucus and trapped particles away from the lungs.

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Question 8

Level 3 A balanced evaluation comparing accuracy and artefacts of both methods, stating which method is better for measuring dimensions and which for wall thickness, and giving a justified conclusion. **5-6**

Level 2 Some comparison with at least one justification and one consideration of artefacts or accuracy. **3-4**

Level 1 Simple judgement with limited justification or only one method discussed. **1-2**

Indicative content:

- Method A increases contrast making cell walls easier to see so may increase measurement precision but causes shrinkage which reduces accuracy of true dimensions
- Method B preserves shape so gives more accurate dimensions but lower contrast may reduce ability to see wall boundaries precisely
- For measuring cell dimensions Method B is probably better because it reduces systematic shrinkage artefact; however if contrast is too poor measurements may be imprecise so combining with mild contrast enhancement could be best
- For studying cell wall thickness Method A may be better because the high contrast makes thin walls visible, but corrections for shrinkage should be considered or use calibration against known standards
- Overall justified conclusion could state a preference depending on priority: choose B for true size measurements, choose A for visualising thin walls, or perform both and compare

Question 9

Level 3 A clear, detailed explanation linking magnification, resolution and preparation to the choice of TEM for detailed internal structure; uses comparative statements and gives consequences for observed detail. **5-6**

Level 2 A partial explanation including at least two relevant points (for example resolution and magnification) with some link to viewing organelles. **3-4**

Level 1 Simple statements about one or two differences without clear linking to microscope choice. **1-2**

Indicative content:

- TEM has much higher resolution than light microscope because electrons have much shorter wavelength, so TEM can show internal organelle detail that light microscopes cannot
- TEM can have much higher useful magnification (hundreds of thousands x) compared with light microscope (typically up to about 1500x), allowing smaller structures to be seen
- Sample preparation for TEM requires thin slicing, fixing and staining with heavy metals and must be done in vacuum; this can create artefacts and is time consuming
- Light microscopes require simpler preparation (wet mount, staining) and can view living cells, whereas TEM requires dead, fixed samples
- Consequence: choose TEM to investigate fine internal structure of organelles; choose light microscope for general cell organisation and living processes

Question 10

(a) 200 / 0.2, oe (or (2×10^{-7}) / (2×10^{-10})) **M1**

(a) 1000 (times) cao **A1**

(a) Answer: 1000 times

(b) any one of: can view living samples (electron microscopes need samples in a vacuum) / cheaper to buy and run / simpler and quicker sample preparation / portable, oe **B1**

(b) Answer: E.g. it can be used to view living cells, since electron microscopes require the sample to be in a vacuum.

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