

# Cell Structure and Division — 1

All cells share some basic structural features, but there are plenty of differences you need to know about too. The structural differences between cell types are important for their particular functions and replication methods.

## 1 A student investigated mitosis in plant tissue.

### 1.1 A 1 cm length was cut from the tip of an onion root.

This tip was incubated in dilute hydrochloric acid for 5 minutes at 60 °C.

It was then rinsed well with cold water and left to dry.

Describe how the student could have prepared a microscope slide to view the cells in this root tip.

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(4 marks)

### 1.2 Give **two** safety precautions the student should have taken when preparing the slide.

1. ....

2. ....

(2 marks)

### 1.3 Explain why the student used the tip of the root for this investigation.

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(1 mark)

The student's observations are shown in **Table 1**.

**Table 1**

Type of cell	Number of cells
Dividing	240
Non-dividing	80

### 1.4 Explain how the student was able to distinguish between dividing cells and non-dividing cells.

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(1 mark)

### 1.5 Calculate the mitotic index of the root tip.

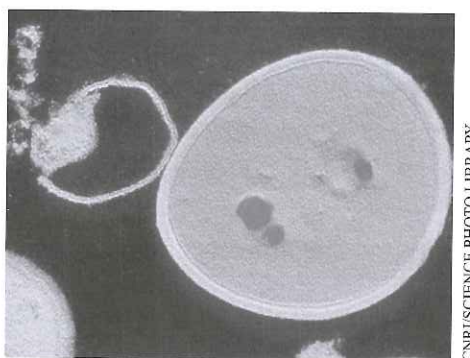
Mitotic index = .....

(2 marks)

- 2 Bacteria and viruses can cause disease when they infect humans.

*Staphylococcus aureus* can cause a range of illnesses in humans. The electron micrograph in **Figure 1** shows an intact *S. aureus* bacterium (right) and one undergoing lysis (left).

**Figure 1**



- 2.1 Give **one** reason why an electron microscope was used to view these cells rather than a light microscope.

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(2 marks)

- 2.2 Name the type of electron microscope that was used to produce the micrograph seen in **Figure 1**.  
Give a reason for your answer.

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(2 marks)

- 2.3 Give **two** ways in which you could distinguish between a prokaryotic cell and a eukaryotic cell in an electron micrograph.

1. ....
2. ....

(2 marks)

- 2.4 Penicillin is an antibiotic that can be used to treat infections of *Staphylococcus aureus*.  
The drugs cause cell lysis, as shown in **Figure 1**, by inhibiting cell wall synthesis.  
Explain why these drugs have no effect on human cells.

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(1 mark)

- 2.5 The infection of human cells with West Nile Virus (WNV) can involve the cell surface receptor,  $\alpha_v\beta_3$  integrin. Using your knowledge of the structure of viruses, suggest how a treatment that interferes with the function of  $\alpha_v\beta_3$  integrin in human cells could prevent WNV replication.

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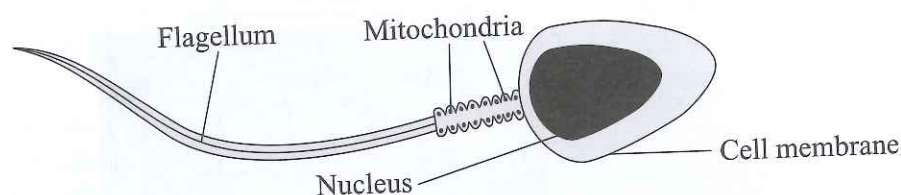
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(3 marks)

Sperm cells are specialised for their function of delivering genetic material to the egg.

**Figure 2** shows the structure of a sperm cell.

**Figure 2**



3.1 Using **Figure 2**, give **one** similarity and **one** difference between a sperm cell and a bacterium.

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(2 marks)

3.2 Suggest why the mitochondria are located close to the sperm cell's flagellum.

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(1 mark)

3.3 A scientist wanted to observe the mitochondria in a sample of sperm.  
Which type of microscope should the scientist use to study the internal structures of the mitochondria?  
Explain your answer.

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(2 marks)

3.4 DNA is related to the function of a sperm cell and a mitotic body cell.  
A mitotic body cell has many ribosomes, but a sperm cell does not.  
With reference to the functions of these cells, explain why there is this difference in organelles.

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(3 marks)



For questions on cell structure, you can be given a micrograph. It can be tricky to interpret these and to spot the different cell structures, but they are there. Trust me. To prepare yourself for the exam, make sure you learn what all the different cell structures look like.

Score

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## Cell Structure and Division — 2

- 1 A team of scientists studied the organelles in **two** types of cell (**A** and **B**) taken from the body tissues of a eukaryotic organism.

**Table 1** shows the volume, as a percentage of the total cell volume, of **three** organelles.

**Table 1**

Organelle	Percentage of total cell volume / %	
	Cell type A	Cell type B
Lysosomes	4	1
Rough endoplasmic reticulum	8	16
Nucleus	7	7

- 1.1 Cell types **A** and **B** are both specialised cells. Define the term 'specialised cell'.

(1 mark)

- 1.2 The relative volume of the nucleus is the same in both types of cell. Suggest why.

(1 mark)

- 1.3 The role of one of the two cell types is to ingest invading pathogens, and the other is to secrete enzymes. Use **Table 1** to determine which of these two roles is carried out by cell type **A** and which is carried out by cell type **B**. Explain your answers.

(4 marks)

- 1.4 Two other organelles that can be found in eukaryotes are mitochondria and chloroplasts. Contrast the structure and function of these organelles to give **two** differences.

1. ....
2. ....

(2 marks)

- 2 A student observed a sample of plant cells under a microscope.

2.1 Describe how to observe the cells in a prepared slide using a light microscope.

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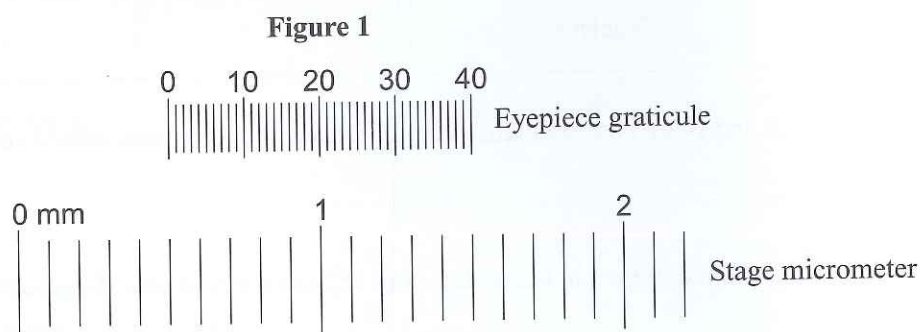
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(5 marks)

The student used an eyepiece graticule to calculate the size of some of the plant cells.

**Figure 1** shows the student's eyepiece graticule and stage micrometer.

The stage micrometer measures in millimetres.



2.2 Use **Figure 1** to calculate the size of **one** division on the student's eyepiece graticule, in micrometres.

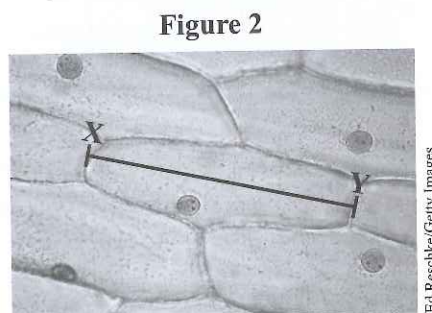
.....  $\mu\text{m}$   
(2 marks)

2.3 The student increased the magnification, so he needed to recalibrate the eyepiece graticule. Explain why the student needed to recalibrate the graticule.

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(1 mark)

Another student calculated the size of a cell from an image.

**Figure 2** shows the cell at  $\times 100$  magnification.



If you need to measure something in an exam, do it in millimetres. This'll make it easier to convert to micrometres ( $\text{mm} \times 1000$ ) or nanometres ( $\mu\text{m} \times 1000$ ).

2.4 Using **Figure 2**, calculate the real length of the cell (X to Y) in micrometres.

.....  $\mu\text{m}$   
(2 marks)

- 3 Abnormal mitochondria have been found in diseased heart tissue, suggesting a link between mitochondria and heart disease. Scientists investigated this by producing a strain of mice with abnormal mitochondria. The abnormal mice developed symptoms of heart disease after one year.

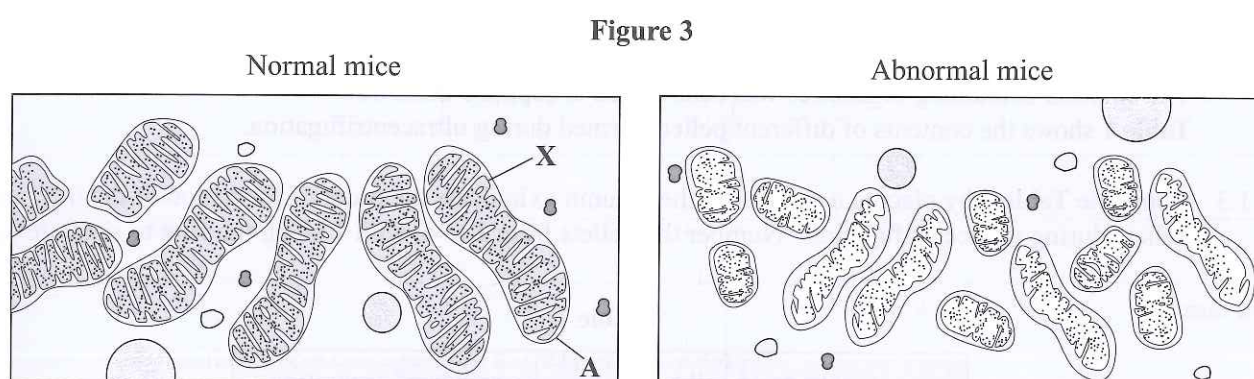
3.1 Describe the main function of mitochondria.

(1 mark)

3.2 Suggest why abnormal mitochondria might be problematic in heart tissue.

(2 marks)

Figure 3 shows mitochondria in normal mice and the abnormal mice.



3.3 Name the part of the mitochondrion labelled X in Figure 3.

(1 mark)

3.4 Describe **two** differences between the mitochondria found in the abnormal and normal mice. Suggest how each difference may impair the function of mitochondria in the abnormal mice.

1. ....

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2. ....

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(4 marks)

3.5 The mitochondrion labelled A in Figure 3 is about  $1.5\ \mu\text{m}$  in length. Calculate the magnification of the image.

(2 marks)



Maths always manages to worm its way in. You really need to make sure you learn some formulas, like the one for magnification (magnification = size of image  $\div$  size of real object). And make sure you *really* know them — you need to be confident rearranging them.

Score

28



# Cell Structure and Division — 3

- 1 A scientist was separating organelles from a sample of plant cells.

- 1.1 Describe how the scientist could separate the organelles from other plant cell components.

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(3 marks)

- 1.2 After separation, the solution containing organelles was kept in an ice bath. Explain why.

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(1 mark)

The solution containing organelles was centrifuged to separate them out.

**Table 1** shows the contents of different pellets formed during ultracentrifugation.

- 1.3 Complete **Table 1** by placing a number in the column to indicate the order of formation of the different pellets during ultracentrifugation. Number the pellets from 1 to 4, with 1 being the first to separate out.

**Table 1**

Contents of pellet	Sequence of separation
Mitochondria and chloroplasts	
Nuclei	
Ribosomes	
Endoplasmic reticulum	

(1 mark)

- 1.4 A student commented on the results and suggested that the sample of plant cells were from a root. Explain why the student is incorrect.

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(1 mark)

- 1.5 Nuclear pore complexes (NPCs) control the passage of substances in and out of the nucleus.

In the scientist's study, cells from mutant plants with reduced NPC function were also centrifuged. The cells from mutant plants produced a smaller pellet containing ribosomes, compared to cells from non-mutant plants. Explain why.

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(3 marks)

- 2 *Chlamydia trachomatis* is a bacteria that replicates within a host cell.

Once inside the host cell, *Chlamydia trachomatis* replicates normally. The replication of the bacteria causes the host cell to swell and eventually burst, releasing structures that can infect other cells.

- 2.1 Compare and contrast the replication of *C. trachomatis* with the replication of a virus.

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(3 marks)

*C. trachomatis* infections can be treated with azithromycin, a drug which inhibits ribosome function.

- 2.2 Explain the effect of this drug on bacterial growth.

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(2 marks)

- 2.3 Explain why azithromycin can't be used to treat viral infections.

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(1 mark)

A scientist compared the relative DNA content of a bacterial cell to its daughter cells, after the parent cell had divided to produce **two** daughter cells. The scientist's results are shown in **Table 2**.

**Table 2**

Cell	DNA content relative to the parent cell
Daughter cell A	1.4
Daughter cell B	0.8

- 2.4 Explain the results shown in **Table 2**.

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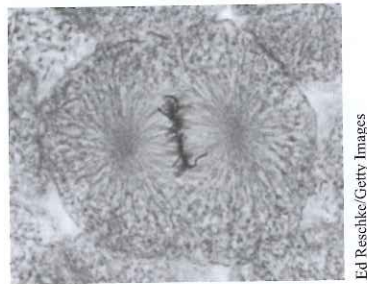
(2 marks)



- 3 A scientist was studying the stages of the cell cycle.

The scientist used a microscope to observe some cells undergoing mitosis.  
**Figure 1** shows an image of **one** of these cells.

**Figure 1**



Ed Reschke/Getty Images

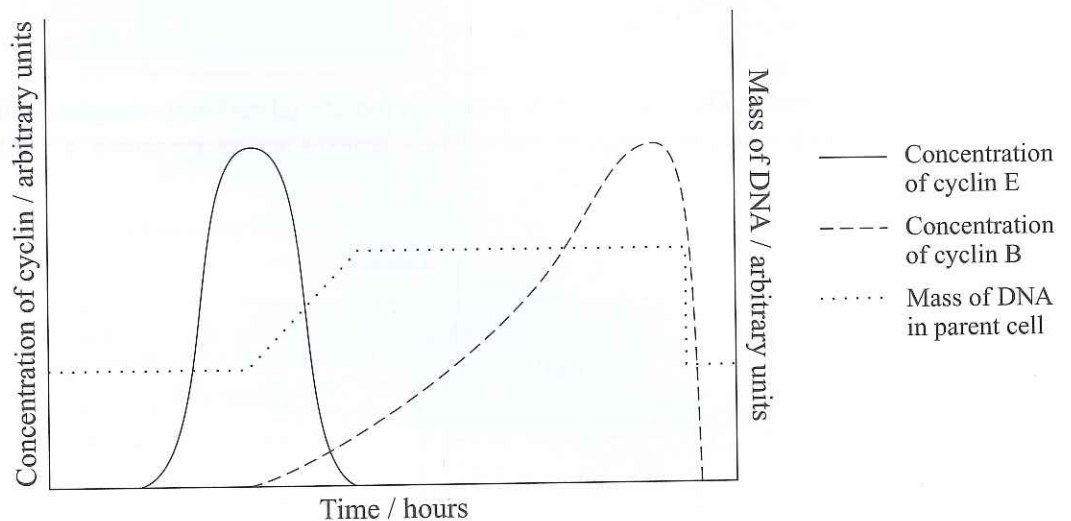
- 3.1 Name the stage of mitosis shown in **Figure 1** and explain your answer.

(2 marks)

Cyclins are proteins that play an important role in the cell cycle.

A scientist recorded the concentration of **two** cyclins (**E** and **B**) during part of the cell cycle shown in **Figure 2**. He also recorded the mass of DNA present in the parent cell during this period (also shown in **Figure 2**).

**Figure 2**



- 3.2 Using the results shown in **Figure 2**, suggest the functions of cyclins **E** and **B** in the cell cycle.

(4 marks)

**4** Chemotherapy is a type of drug treatment against cancer.

- 4.1 Chemotherapy can prevent the production of enzymes needed for DNA synthesis. Using your knowledge of the cell cycle, explain why this prevents cancerous cells from dividing.

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(1 mark)

- 4.2 A hair follicle is a sac at the root of a hair. Cells in the hair follicle divide frequently, causing hair growth. Suggest why non-cancerous cells in the hair follicle are more affected by chemotherapy than other non-cancerous body cells.

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(2 marks)

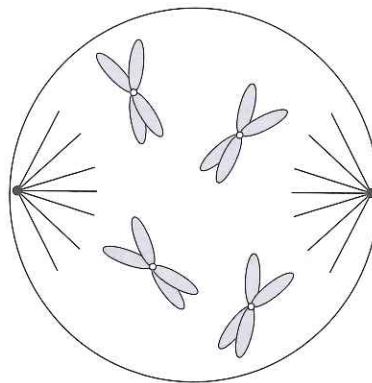
- 4.3 A scientist took a sample of cancerous cells from a patient and calculated a mitotic index of 0.9. The scientist observed a total number of 200 cells in the sample. Calculate how many of the cells in this sample were undergoing mitosis at that time. Show your working.

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(2 marks)

Aurora kinases are important molecules for the formation of spindle fibres during mitosis. Recent evidence suggests that an inhibitor of these molecules can be used to treat cancer. The inhibitor causes shortened spindle fibres to form during prophase, as shown in **Figure 3**.

**Figure 3**



- 4.4 Using **Figure 3**, explain why these drugs could potentially be used as a method of treating cancer.

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(3 marks)



Exam questions on the cell cycle often describe a way that the normal cycle is altered and ask you to explain what effect (if any) this has. As long as you know what usually happens during the different stages of the cell cycle, you should be able to work out what happens if something changes. It's important to be clued up about what happens during interphase and mitosis.

Score

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