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KS4 Cell Biology

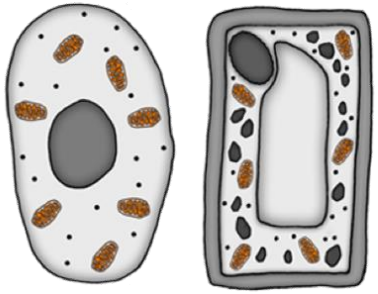
Task 1: Read the information on slides 2-13 and use it to answer the questions on the sheet. (40mins)

Task 2: Login to your Tassomai account and complete your daily goal of questions (15mins)

Cell structure part 1 - Eukaryotes and prokaryotes

All living things are **made** of **cells**, they are the **basic unit** of all **life.**

Eukaryotic cells



Have a cell membrane, cytoplasm and genetic material (DNA) enclosed in a nucleus.

Animal and plant cells are eukaryotic cells

Prokaryotic cells

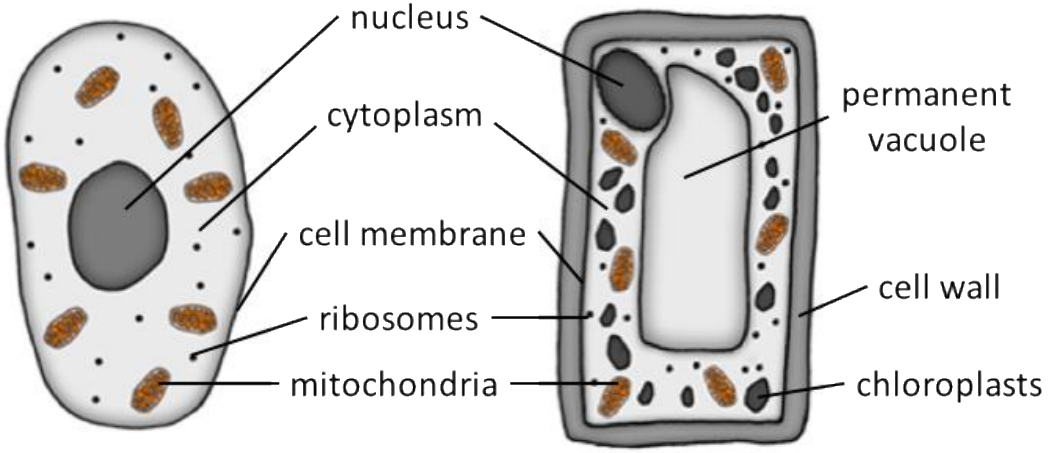
These are **smaller** than eukaryotic cells. The genetic material is not enclosed in a nucleus. The DNA is a single loop and there may be one or more rings of DNA called plasmids.

Bacterial cells are prokaryotic cells

Prefixes are used in science to make very small numbers more manageable. You need to learn the ones in the table and be able to convert to and from standard form.

Prefix	Multiple	Standard form
centi (cm)	1 cm = 0.01 m	$\times 10^{-2}$
milli (mm)	1 mm = 0.001 m	$\times 10^{-3}$
micro (µm)	1 µm = 0.000 001 m	$\times 10^{-6}$
nano (nm)	1 nm = 0.000 000 001 m	$\times 10^{-9}$

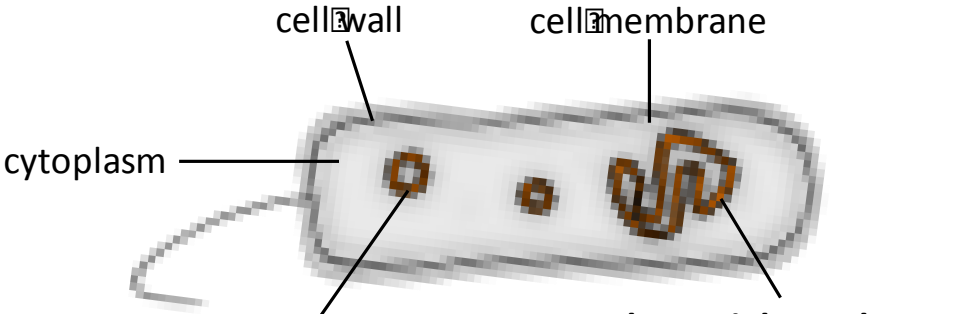
Cell structure part 1 - Animal, plant cells and bacterial cells



animal cell

plant cell

You will need to know the differences between plant, animal and bacterial cells.



bacterial cell

Bacterial cells are much smaller than plant and animal cells.

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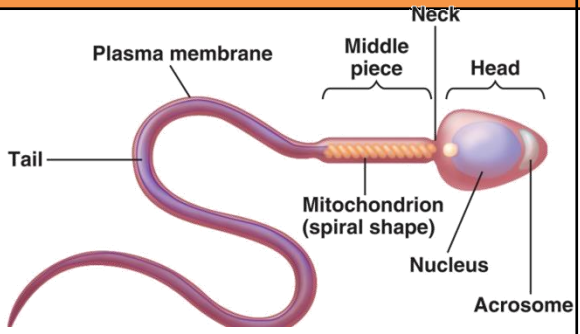
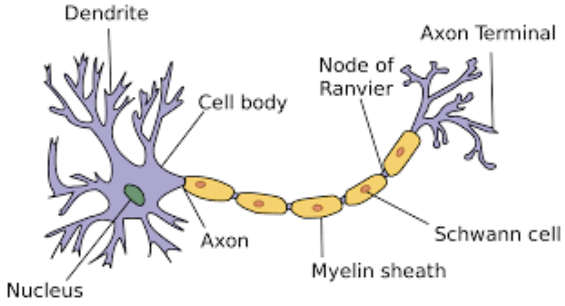
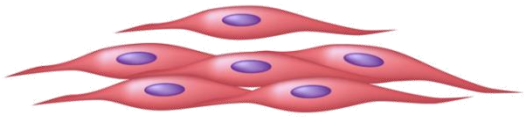
Cell structure part 1 - Animal, plant cells and bacterial cells

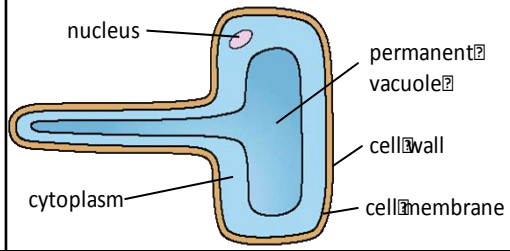
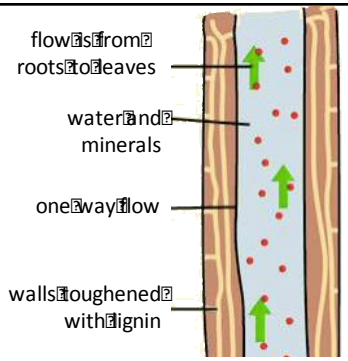
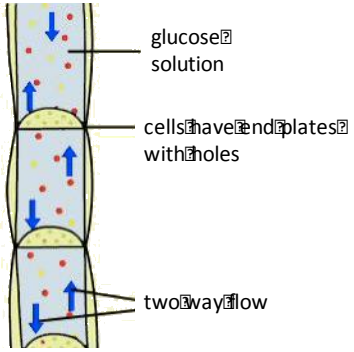
Cell part	Function	Animal	Plant	Bacteria
Nucleus	Contains genetic material, which controls the activities of the cell	✔	✔	
Cytoplasm	Most chemical processes take place here, controlled by enzymes	✔	✔	✔
Cell membrane	Controls the movement of substances into and out of the cell	✔	✔	✔
Mitochondria	Most energy is released by respiration here	✔	✔	
Ribosomes	Protein synthesis happens here	✔	✔	
Cell wall	Strengthens the cell – made of cellulose (not bacteria) (algal cells also have a cell wall)		✔	✔
Chloroplasts	Contain chlorophyll, absorbs light energy for photosynthesis		✔	
Permanent vacuole	Filled with cell sap to help keep the cell turgid		✔	
Bacterial DNA	Loop of DNA NOT found in a nucleus			✔
Plasmid (DNA)	Small ring of DNA often used as a vector in genetic modification			✔

Cell structure part 2 - Animal cell specialisation

The **structure** of different cells helps them to carry out a **particular function** within the organism. These cells are called **specialised cells**.

Name of animal cell	Diagram	Structure and function
Sperm		**Function is to fertilise an egg.** • Streamlined with a long tail to swim to the egg. • Acrosome in the head containing enzymes to digest the egg cell membrane. • Large number of mitochondria in the mid section to release energy for movement.
Nerve		**Function is to carry electrical signals.** • Long to carry signals long distances. • Branched connections to connect to other nerve cells and form a network around the body. • Insulating sheath to enhance transmission of electrical signals.
Muscle	 Smooth muscle cells	**Function is .** • Contain a large number of mitochondria to release energy from respiration for movement. • Long so that there is enough space to contract.

Cell structure part 2 - Plant cell specialisation

Name of plant cell	Diagram	Structure and function
Root hair		**Function is to absorb water and minerals from the soil.** • Hair like projections to increase the surface area. (Note that root hair cells have no chloroplasts this is because they do not need them as they are in the soil)
Xylem		**Function is to carry water and minerals in plants.** • Form hollow xylem tubes made of dead tissue. • Long cells with walls toughened by lignin. • Water and minerals flow from the roots towards the leaves only in one direction in a process called **TRANSPIRATION**.
Phloem		**Function is to carry glucose around the plant.** • Form phloem tubes made of living tissue. • Cells have end plates with holes in them. • Glucose in solution moves from the leaves to growth and storage tissues in a process called **TRANSLOCATION**.

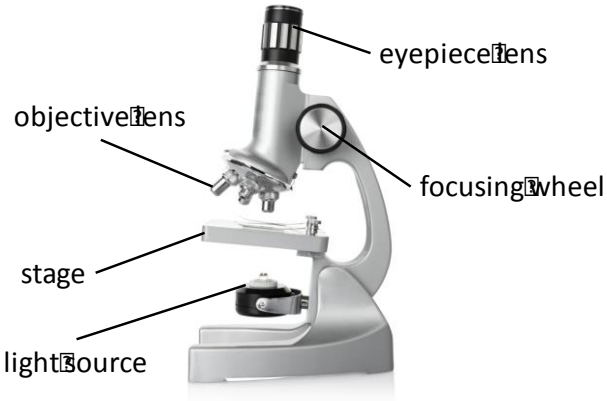
Cell structure part 2 - Cell differentiation

Cell **differentiation** occurs as organisms develop, the cell changes and becomes **specialised**. As the cell **differentiates,** it forms different sub-cellular structures, e.g. the tail on a sperm cell or the hairs on a root hair cell.

Most types of **ANIMAL** cells **differentiate** in the early stage of development.

Most types of **PLANT** cells can **differentiate throughout their life** cycle.

Cell structure - Microscopy



light microscope

First ones used in 1590's

electron microscope

First ones used in 1960's

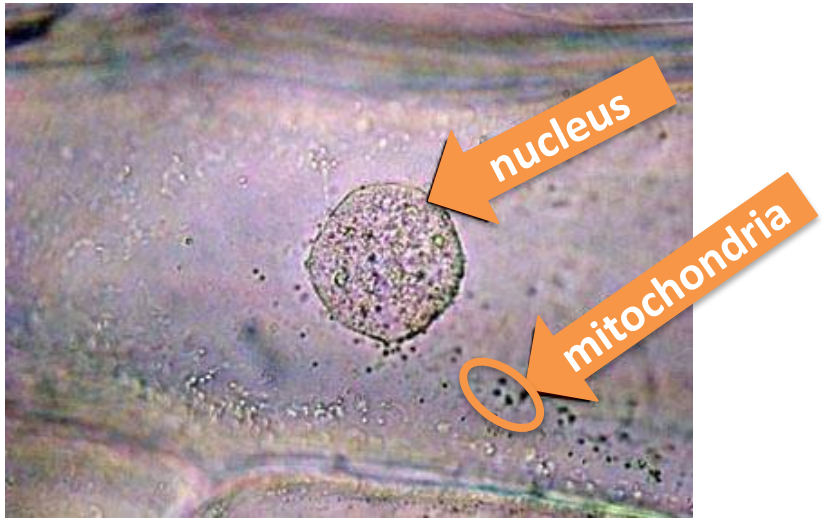
Feature	Light (optical) microscope	Electron microscope
Radiation used	Light rays	Electron beams
Max magnification	~ 1500 times	~ 2 000 000 times
Resolution	200nm	0.2nm
Size of microscope	Small and portable	Very large and not portable
Cost	~£100 for a school one	Several £100,000 to £1 million plus

Resolution: The **shortest distance** between **two objects** that can be seen clearly.

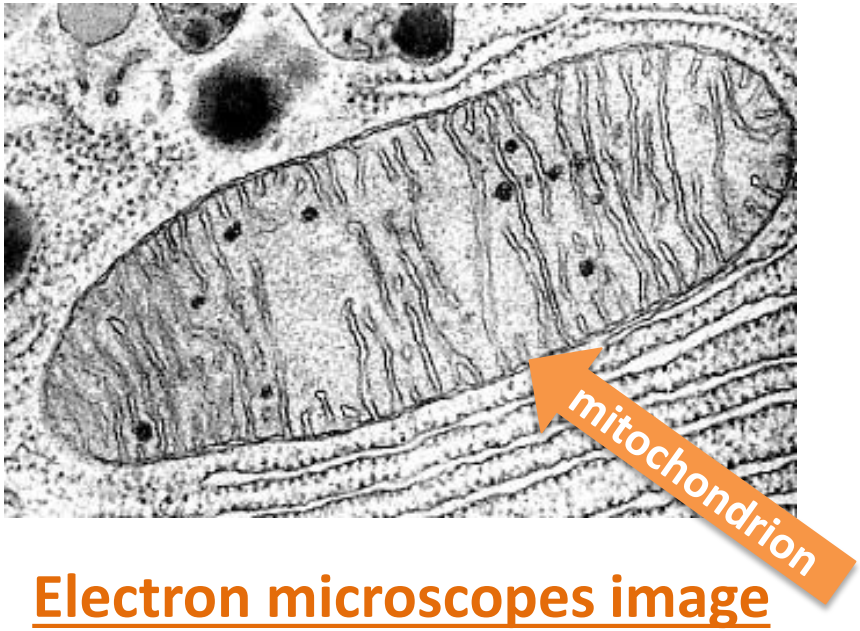
Video - Types of microscopes

Cell structure - Microscopy

Electron microscopes have a **higher** magnification and resolution than **light microscopes**. This means that scientists can see more sub- cellular structures (structures within the cells).



Light microscopes image can let us see **structures** like nuclei and mitochondria.



Electron microscopes image can let us see the **internal structures** of a chloroplast and mitochondrion.

Cell structure - Microscopy

You can **calculate** the magnification of an image by using the equation:

$$\text{magnification M} = \frac{\text{size of image I}}{\text{real size of the object A}}$$

MAGNIFICATION: the number of times bigger the image looks compared to the object
IMAGE: what is viewed through the microscope lenses
OBJECT: the **ACTUAL** specimen under the microscope

WORKED EXAMPLE 1:

A magnified animal cell structure has a diameter of 6 mm. ← IMAGE

The actual diameter of the structure is 0.15mm. ← OBJECT

Calculate how many times the structure has been magnified.

$$M = \frac{I}{A} \qquad M = \frac{6}{0.15} \qquad M = 40$$

You may need to to write your answers in **standard form.**

You may need to be able rearrange to change the **subject** of the equation.

Cell structure - Microscopy

$$\text{magnification } M = \frac{\text{size of image } I}{\text{real size of the object } A}$$

WORKED EXAMPLE 2:

The actual length of a cell structure is 30µm. ← OBJECT (A)

It is magnified 40 times. ← MAGNIFICATION (M)

Calculate the length of the magnified cell structure in mm.

Rearrange the equation to make I the subject

$$A \times M = \frac{I \times A}{A}$$

Multiply both sides by A

Cancel out the As

$$I = M \times A$$

Put I on the left of the equation

$$I = 40 \times 30$$

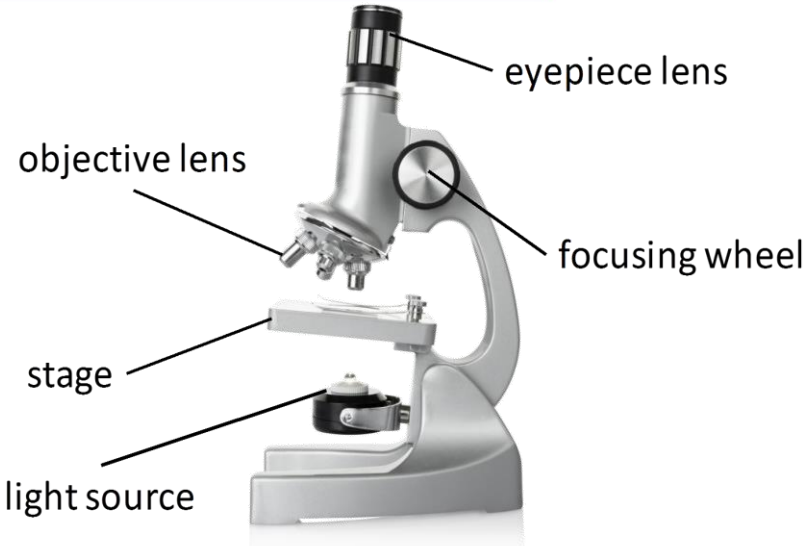
$$I = 1200\ \mu m$$

$$I = 1.2mm$$

To convert to mm you need to divide by 1000

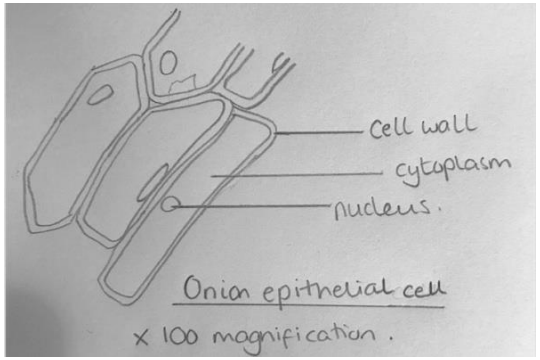
You may need to to write your answers in **standard form.**

Cell structure – Microscopy



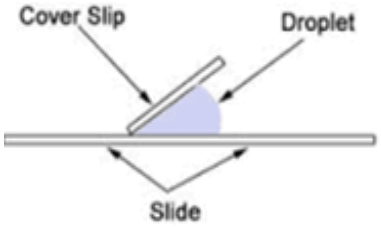
Drawing what you see

- **Clear line drawing – no shading**
- **Label main cell structures**
- **Add a title and the magnification.**



Making a wet mount slide e.g. onion cells

- Place a thin section of the **specimen** onto slide.
- Place a drop of water in the middle of the slide or stain the specimen.
- Gently lower cover slip onto the specimen without trapping air bubbles.

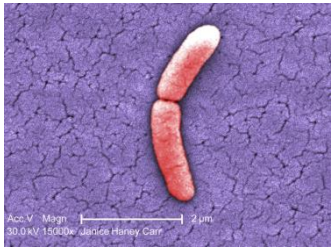


- Soak up any excess liquid with a paper towel.
- Switch on the light source and place your slide on the stage.
- Use the lowest objective lens and turn the focusing wheel to move the lens close to the slide.
- Slowly adjust the focusing wheel until you can see a clear image.
- Increase the magnification by changing the objective lens and re-focus.

See GCSE Practical Guide - Biology – Microscopy on Huddle - Microscopy Practical guide

Cell structure - Culturing microorganisms (biology only)

Bacteria multiply by binary fission (a cell division where two identical cells are formed). In the right conditions cells can divide as often as every 20 minutes.



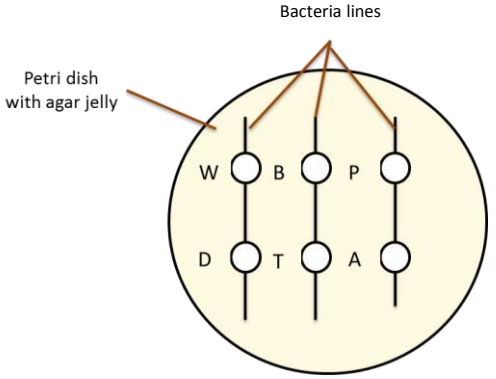
Bacteria can be grown in the lab

- A ***culture medium (agar)*** used containing an *energy* source (carbohydrate) and minerals.
- Petri dishes and agar must be **sterilised before use to kill microorganisms.**
- **Inoculating loops** used to transfer bacteria after being heated in a Bunsen flame.
- The lid of the Petri dish should be **sealed** with **tape to stop other microorganisms** getting in (must **not be fully sealed so oxygen** can get in)
- In school, Petri dishes are **incubated at 25°C to reduce risk** of growth of **pathogens** that might be **harmful to humans.**

Effectiveness of disinfectants and antibiotics on bacteria experiment

- Agar inoculated with **BACTERIA**.
- **Paper discs** containing **antiseptics** and **antibiotics** placed on **bacteria** and **left to grow.**

  Water disc used as a CONTROL.
- If **bacteria don't grow** around the disc then the chemical is **effective** at killing bacteria.
- **Area** where **bacteria don't grow** is called **ZONE OF INHIBITION**.



See GCSE Practical Guide - Practical guide - Microbiology

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QuestionIT!

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AnswerIT!

Cell structure – AnswerIT

1. Where is the genetic material in a prokaryotic cell?

In a bacterial DNA loop and there may be one or more plasmid rings.

2. Where is the genetic material in a eukaryotic cell?

The DNA is in chromosomes enclosed in a nucleus.

3. Copy and complete the table.

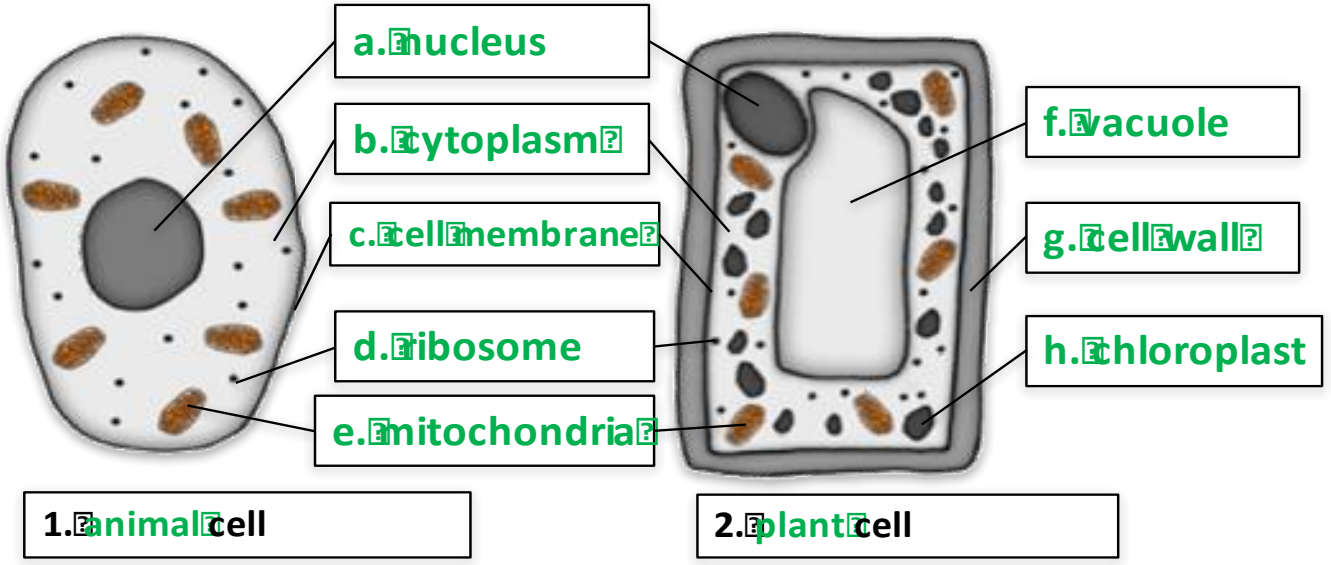
Prefix	Multiple	Standard form
centi (cm)	**1 cm = 0.01 m**	x 10^{-2}
milli (mm)	1 mm = 0.001 m	x 10^{-3}
micro (µm)	1 µm = 0.000 001 m	**x 10^{-6}**
nano (nm)	**1 nm = 0.000 000 001 m**	x 10^{-9}

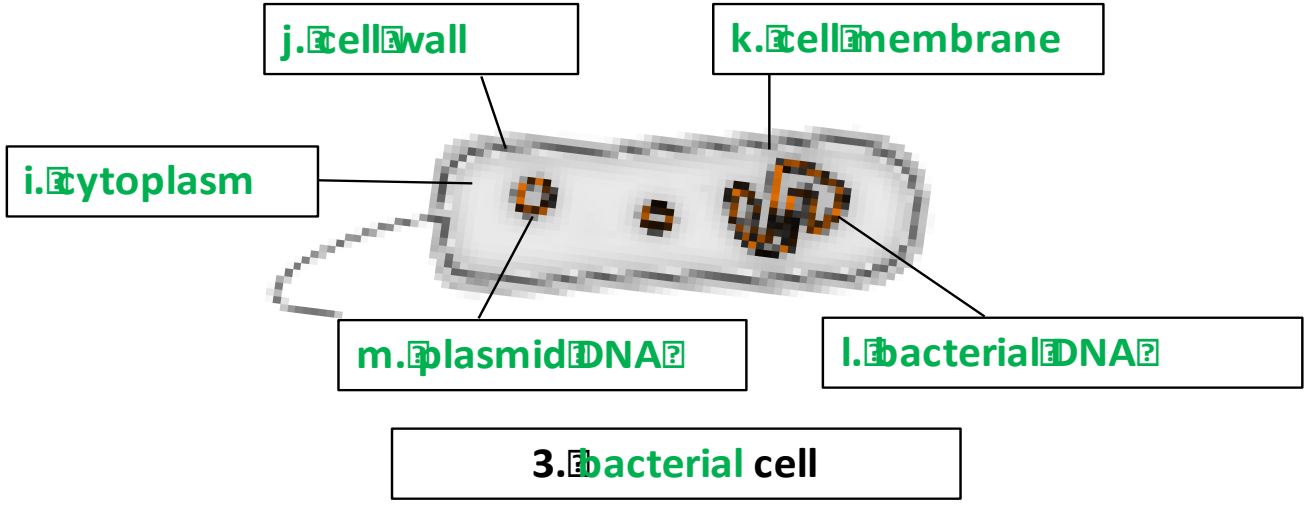
4. Why do scientists use prefixes?

To make very small numbers more manageable

Cell structure – AnswerIT

5. Name the structures **A to L** on the diagrams below and label cells 1, 2 and 3.





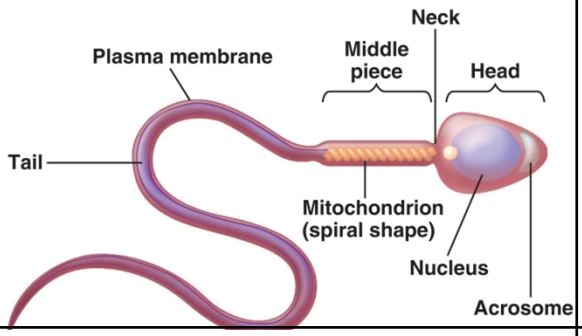
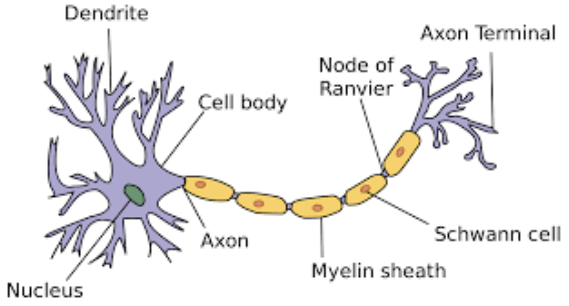
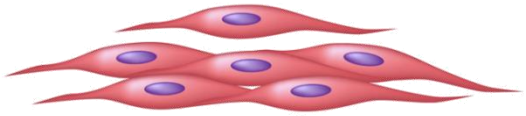
Cell structure – AnswerIT

6. Copy and complete the table and tick the correct column for each one.

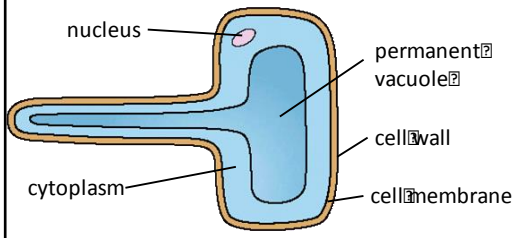
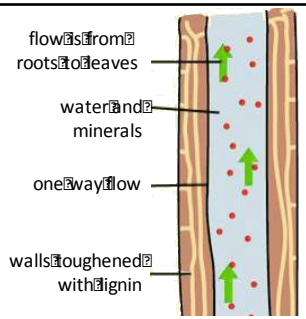
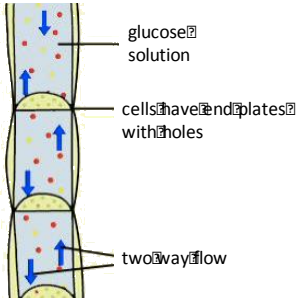
Cell part	Function	Animal	Plant	Bacteria
Nucleus	Contains genetic material, which controls the activities of the cell	✔	✔	
Cytoplasm	Most chemical processes take place here, controlled by enzymes	✔	✔	✔
Cell membrane	Controls the movement of substances into and out of the cell	✔	✔	✔
Mitochondria	Most energy is released by respiration here	✔	✔	
Ribosomes	Protein synthesis happens here	✔	✔	
Cell wall	Strengthens the cell – made of cellulose		✔	✔
Chloroplasts	Contain chlorophyll, absorbs light energy for photosynthesis		✔	
Permanent vacuole	Filled with cell sap to help keep the cell turgid		✔	
Bacterial DNA	Loop of DNA NOT found in a nucleus			✔
Plasmid (DNA)	Small ring of DNA often used as a vector in genetic modification			✔

Cell structure – AnswerIT

1. Name animal cells A, B and C and describe their structure and function.

Name of animal cell	Diagram	Structure and function
A. Sperm		**Function is to fertilise an egg.** • Streamlined with a long tail to swim to the egg. • Acrosome in the head containing enzymes to digest the egg cell membrane. • Large number of mitochondria in the mid section to release energy for movement.
B. Nerve		**Function is to carry electrical signals.** • Long to carry signals long distances. • Branched connections to connect to other nerve cells and form a network around the body. • Insulating sheath to enhance transmission of electrical signals.
C. Muscle	 Smooth muscle cells	**Function is to contract to allow movement.** • Contain a large number of mitochondria to release energy from respiration for movement. • Long so that there is enough space to contract.

2. Name plant cells A,B and C and describe their structure and function.

Name of plant cell	Diagram	Structure and function
A. Root hair		**Function is to absorb water and minerals from the soil.** • Hair like projections to increase the surface area. (Note that root hair cells have no chloroplasts this is because they do not need them as they are in the soil)
B. Xylem		**Function is to carry water and minerals in plants.** • Form hollow xylem tubes made of dead tissue. • Long cells with walls toughened by lignin. • Water and minerals flow from the roots towards the leaves only in one direction in a process called **TRANSPIRATION**.
C. Phloem		**Function is to carry glucose around the plant.** • Form phloem tubes made of living tissue. • Cells have end plates with holes in them. • Glucose in solution moves from the leaves to growth and storage tissues in a process called **TRANSLOCATION**.

3. What does cell differentiation mean?

When a cell changes to become specialised.

4. In what stage of an animal's life cycle do most cells differentiate?

In the early stages.

5. In mature animals when do cells still need to differentiate?

For repair and replacement of cells.

6. In what stage of their life cycle do plant cells differentiate?

They differentiate throughout their lifecycle.

Cell structure part 3 – QuestionIT

1. Define the term resolution.

The shortest distance between two objects that can be seen clearly.

2. Copy and complete the table below.

Feature	Light (optical) microscope	Electron microscope
Radiation used	**Light rays**	**Electron beams**
Max magnification	**~ 1500 times**	**~ 2 000 000 times**
Resolution	**200nm**	**0.2nm**
Size of microscope	**Small and portable**	**Very large and not portable**
Cost	**~£100 for a school one**	**Several £100,000 to £1 million plus**

3. What are the advantages of the electron microscope? **Electron microscopes have a higher magnification and resolution than light microscopes; scientists can see more sub-cellular structures.**

4. Name the smallest cell structures that can be seen by the light microscope?

Nuclei and mitochondria

5. What are the smallest cell structures that can be seen by the electron microscope? **Internal structures of mitochondria and chloroplasts.**

Cell structure part 3 – AnswerIT

6. Write down the magnification equation.

$$\text{magnification (M)} = \frac{\text{size of image (I)}}{\text{real size of the object (A)}}$$

7. Rearrange the equation to change the subject for the two other factors.

$$\text{size of image (I)} = \text{magnification (M)} \times \text{real size of the object (A)}$$

$$\text{real size of the object (A)} = \frac{\text{size of image (I)}}{\text{magnification (M)}}$$

8. A magnified cell structure has a diameter of 375µm.
The actual diameter of the structure is 2.5µm.
Calculate how many times the structure has been magnified.

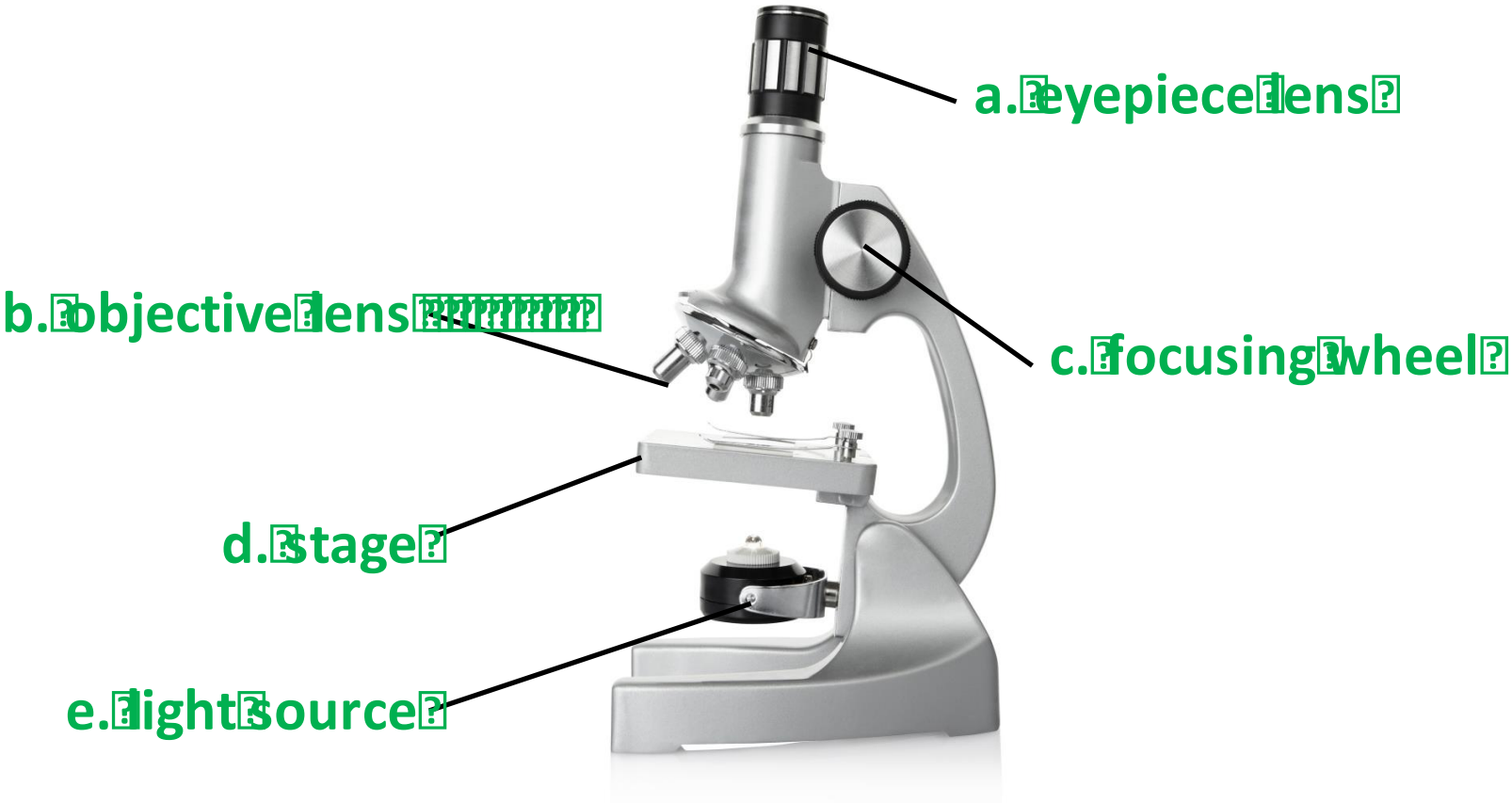
M = I/A M = 375/2.5 = 150 M = 150 times

9. The actual length of a cell structure is 3µm.
It is magnified 1,500 times.
Calculate the length of the magnified cell structure in mm.

I = M x A I = 1500 x 3 I = 4500 µm 4500 / 1000 = 4.5mm

Cell structure part 3 – QuestionIT

10. Name the parts of the light microscope in the diagram below.



Cell structure part 3 – QuestionIT

11. Describe how you would make an onion cell slide.

- **Place thin section of onion epidermis onto slide.**
- **Place a drop of iodine in the middle of the slide to stain the onion.**
- **Gently lower cover slip onto the onion without trapping air bubbles.**
- **Soak up any excess liquid with a paper towel.**

12. Describe how you would use the light microscope to view onion cells.

- **Switch on the light source and place your slide on the stage.**
- **Use the lowest objective lens and turn the focusing wheel to move the lens close to the slide.**
- **Slowly adjust the focusing wheel until you can see a clear image.**
- **Increase the magnification by changing the objective lens and re-focus.**