Cambridge (CIE) IGCSE Biology

Your notes

Cell Structure & Size of Specimens

Contents

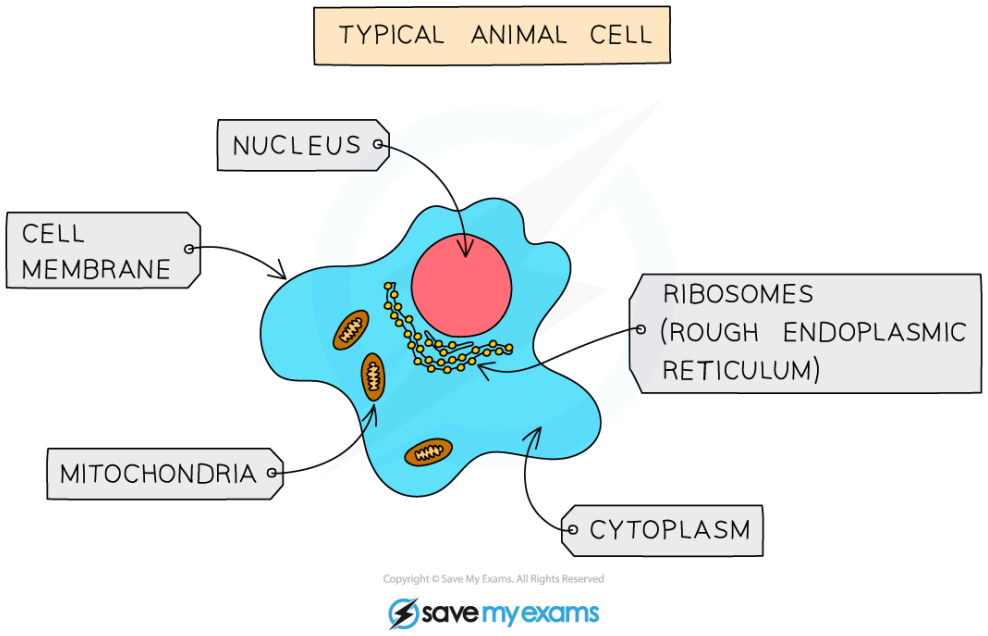
Your notes

Animal & plant cells

Animal cell structure

- **The main features of animal cells:**
  - They contain a **nucleus** with a **distinct membrane**
  - **Cells do not** have **cellulose cell walls**
  - Their cells **do not** contain **chloroplasts** (so they **are unable** to carry out **photosynthesis**)
  - They contain carbohydrates stored as **glycogen**

Animal cell diagram



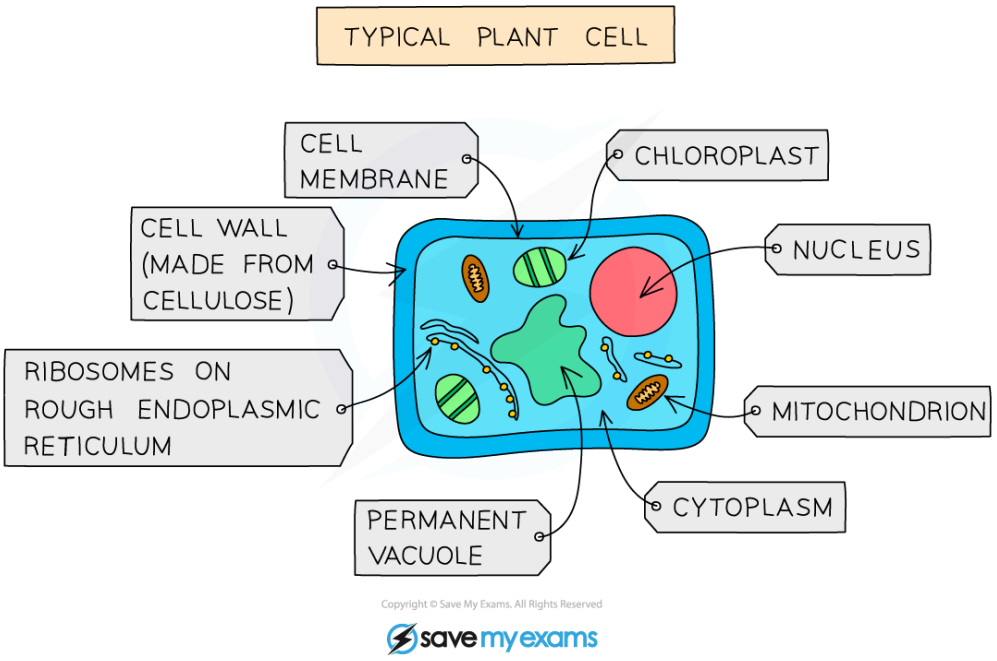
A typical animal cell

Plant cell structure

- **The main features of plant cells:**
  - They contain a **nucleus** with a **distinct membrane**
  - Cells have **cell walls** made out of **cellulose**
  - They contain **chloroplasts** (so they can carry out **photosynthesis**)
  - Carbohydrates are stored as **starch** or **sucrose**

Plant cell diagram

Your notes

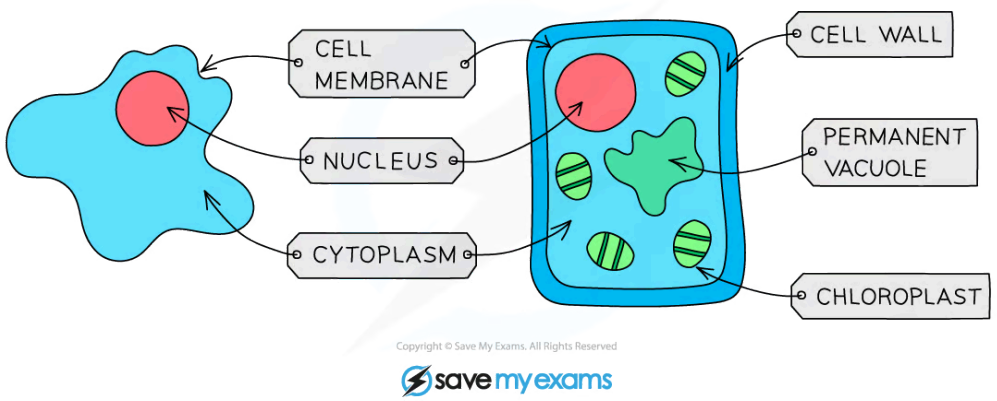


A typical plant cell

Plant and animal cell structure and function

Structure	Function
Nucleus	▪ Contains the DNA (genetic material) which controls the activities of the cell
Cytoplasm	▪ A gel like substance composed of water and **dissolved solutes** ▪ Supports the internal structures of the cell ▪ Site of many **chemical reactions** (including anaerobic respiration)
Cell membrane	▪ Holds the cell together separating the inside of the cell from the outside ▪ Controls which substances **enter or leave** the cell
Ribosomes	▪ Found in the cytoplasm ▪ The site of **protein synthesis**
Mitochondria	▪ The site of **aerobic respiration**

Cell structure diagram



An animal and plant cell as seen under a light microscope

Your notes

Plant cell structure and function

Structure	Function
Cell wall	▪ Made of **cellulose** (a polymer of glucose) ▪ Gives the cell extra **support**, defining its shape
Chloroplast	▪ Contains the green **chlorophyll** pigment that absorbs light energy for **photosynthesis**
Permanent vacuole	▪ Contains **cell sap**: a solution of sugar and salt ▪ Used for storage of certain materials ▪ Helps to **support** the shape of the cell

Bacteria cells

Bacteria cell structure

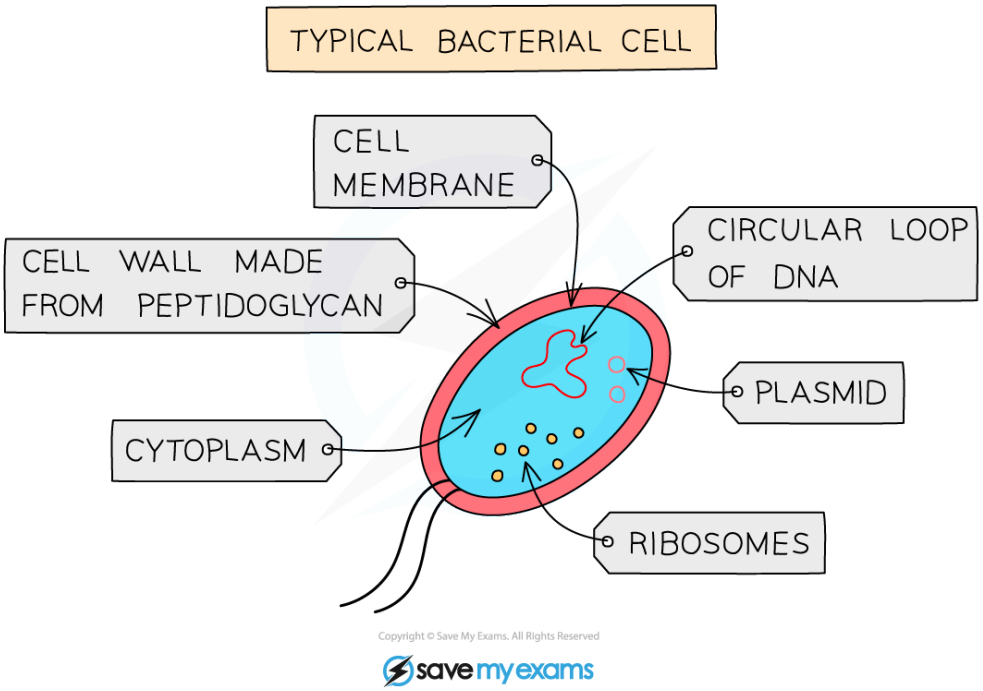
- Bacteria, which have a wide variety of shapes and sizes, all share the following biological characteristics:
  - They are **microscopic single-celled organisms**
  - Possess a **cell wall** (made of **peptidoglycan**, not cellulose), **cell membrane**, **cytoplasm** and **ribosomes**
  - **Lack a nucleus** but contain a **circular chromosome of DNA that floats in the cytoplasm**

- **Plasmids** are sometimes present - these are **small rings of DNA** (also floating in the cytoplasm) that contain **extra genes** to those found in the chromosomal DNA
- They **lack mitochondria, chloroplasts and other membrane-bound organelles** found in animal and plant cells

- Some bacteria also have a **flagellum** (singular) or **several flagella** (plural). These are **long, thin, whip-like tails** attached to bacteria that allow them to **move**
- Examples of bacteria include:
  - **Lactobacillus** (a rod-shaped bacterium used in the production of yoghurt from milk)
  - **Pneumococcus** (a spherical bacterium that acts as the pathogen causing pneumonia)

Your notes

Bacteria cell diagram



A typical bacterial cell

Identifying cell structures & function

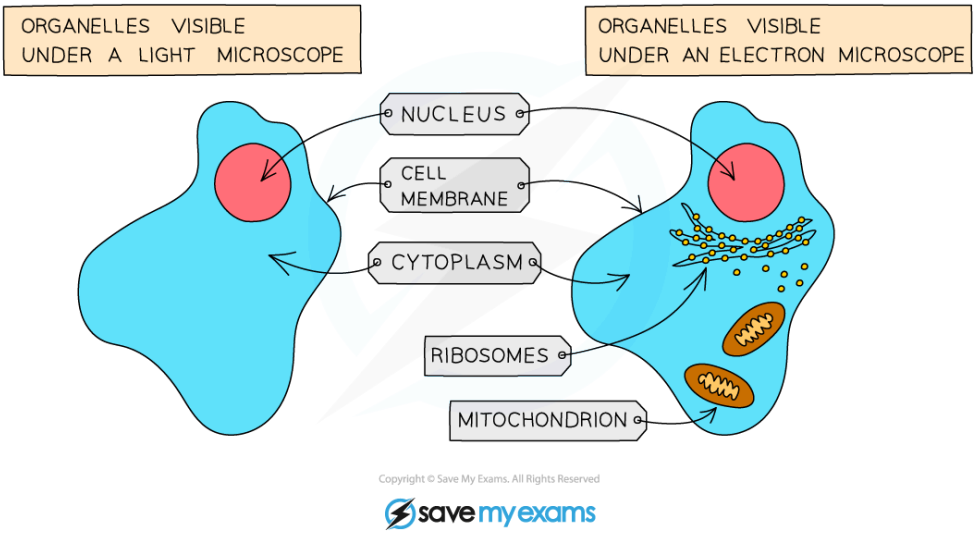
- Within the cytoplasm, the following organelles are visible in almost all cells except prokaryotes when looking at higher magnification (ie using an electron microscope):
  - **Mitochondria** (singular: mitochondrion) are organelles found throughout the cytoplasm
  - **Ribosomes** are tiny structures that can be free within the cytoplasm or attached to a system of membranes within the cell known as **Endoplasmic Reticulum**
  - Endoplasmic reticulum studded with ribosomes looks **rough** under the microscope; this gives rise to its name of **Rough Endoplasmic Reticulum** (often shortened to

R.E.R.)

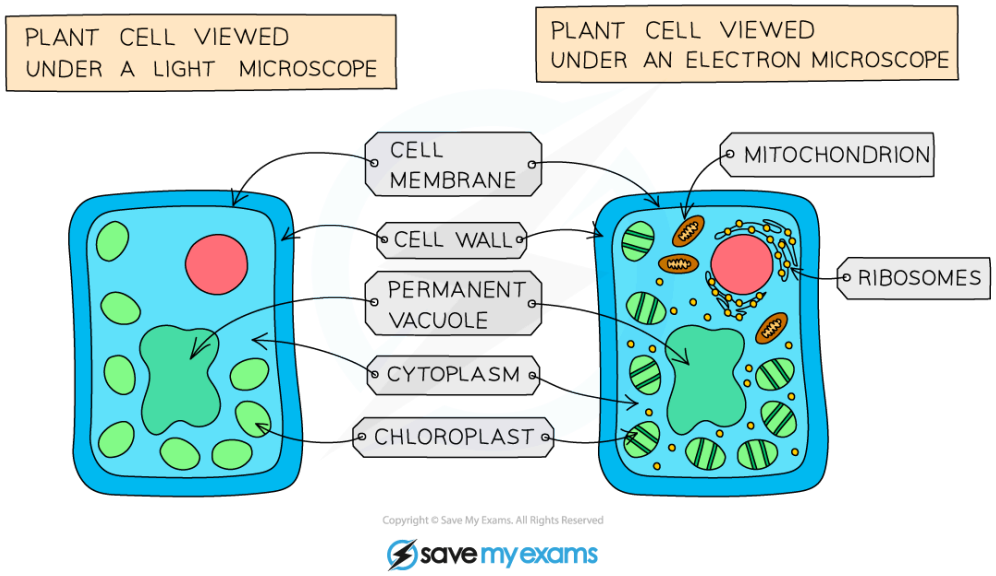
- **Vesicles** can also be seen using a higher magnification - these are small circular structures found moving throughout the cytoplasm

Your notes

Identifying cell structures under a microscope



Structures in an animal cell visible under a light microscope and an electron microscope



Structures in a plant cell visible under a light microscope and an electron microscope

Your notes

Producing New Cells

- The cells in your body need to be able to divide to help your body **grow** and **repair** itself
- Cells grow and divide over and over again
- New cells are produced by the **division of existing cells**

Specialised Cells

Specialised cells in animals

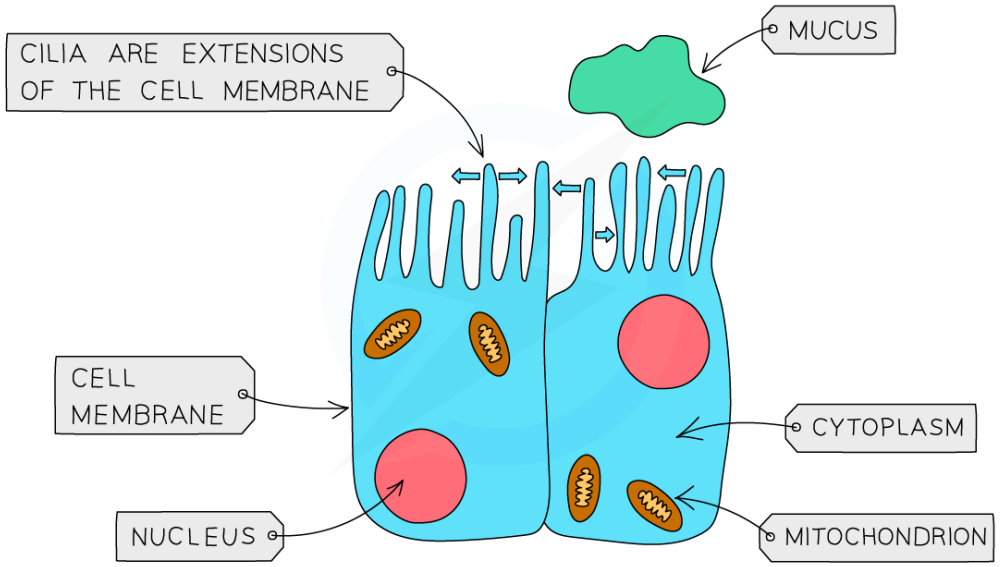
- Specialised cells are those which have **developed certain characteristics** in order to **perform particular functions**. These differences are controlled by genes in the nucleus
- Cells specialise by undergoing **differentiation**: this is a process by which cells develop the structure and characteristics needed to be able to carry out their functions

Specialised Cells in Animals Table

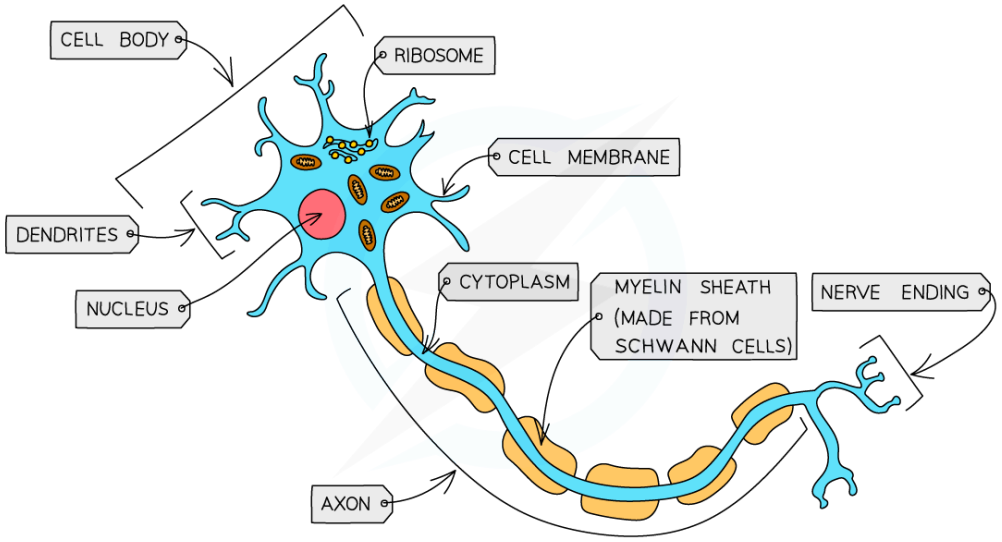
CELL	FUNCTION	ADAPTATIONS
CILIATED CELL	MOVEMENT OF MUCUS IN THE TRACHEA AND BRONCHI	– EXTENSIONS OF THE CYTOPLASM AT THE SURFACE OF THE CELL FORM HAIR–LIKE STRUCTURES CALLED **CILIA** WHICH **BEAT TO MOVE MUCUS** AND TRAPPED PARTICLES UP TO THE THROAT
NERVE CELL	CONDUCTION OF IMPULSES	– **LONG** SO THAT NERVES CAN RUN TO AND FROM **DIFFERENT PARTS OF THE BODY** TO THE CENTRAL NERVOUS SYSTEM – THE CELL HAS **EXTENSIONS AND BRANCHES**, SO THAT IT CAN **COMMUNICATE** WITH OTHER NERVE CELLS, MUSCLES AND GLANDS – THE AXON (EXTENSION OF CYTOPLASM AWAY FROM THE CELL BODY) IS COVERED WITH A **FATTY SHEATH**, WHICH **INSULATES** THE NERVE CELL AND **SPEEDS UP** THE NERVE IMPULSE
RED BLOOD CELL	TRANSPORT OF OXYGEN	– **BICONCAVE DISC** SHAPE **INCREASES SURFACE AREA** FOR MORE EFFICIENT DIFFUSION OF OXYGEN – CONTAINS **HAEMOGLOBIN** WHICH **JOINS WITH OXYGEN** TO TRANSPORT IT – CONTAINS **NO NUCLEUS** TO **INCREASE AMOUNT OF SPACE** AVAILABLE FOR HAEMOGLOBIN INSIDE CELL
SPERM CELL	REPRODUCTION	– THE HEAD CONTAINS THE GENETIC MATERIAL FOR FERTILISATION IN A **HAPLOID NUCLEUS** (CONTAINING HALF THE NORMAL NUMBER OF CHROMOSOMES) – THE **ACROSOME** IN THE HEAD CONTAINS **DIGESTIVE ENZYMES** SO THAT A SPERM CAN PENETRATE AN EGG – THE MID–PIECE IS PACKED WITH **MITOCHONDRIA** TO RELEASE **ENERGY** NEEDED TO SWIM AND FERTILISE THE EGG – THE **TAIL** ENABLES THE SPERM TO **SWIM**
EGG CELL (OVUM)	REPRODUCTION	– CONTAINS A **LOT OF CYTOPLASM** WHICH HAS **NUTRIENTS** FOR THE GROWTH OF THE EARLY EMBRYO – **HAPLOID NUCLEUS** CONTAINS THE GENETIC MATERIAL FOR FERTILISATION – CELL MEMBRANE **CHANGES AFTER FERTILISATION** BY A SINGLE SPERM SO THAT **NO MORE SPERM** CAN ENTER

Your notes

Diagrams of specialised cells in animals:

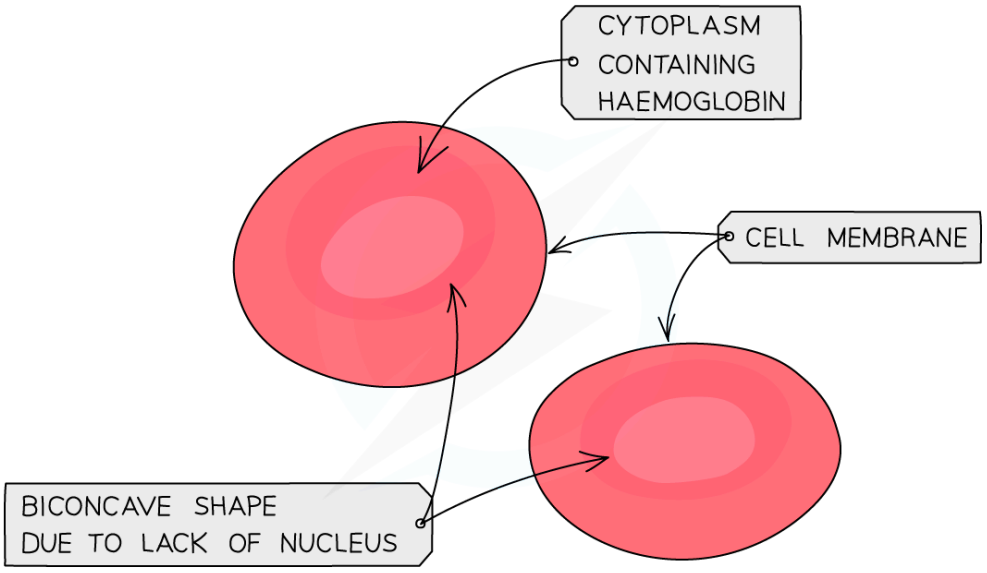


Ciliated cell

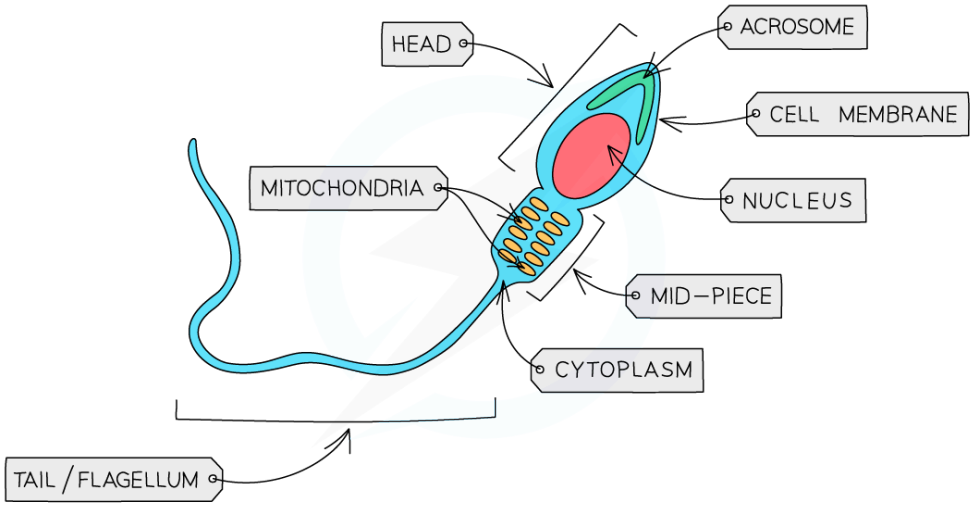


Nerve cell

Your notes

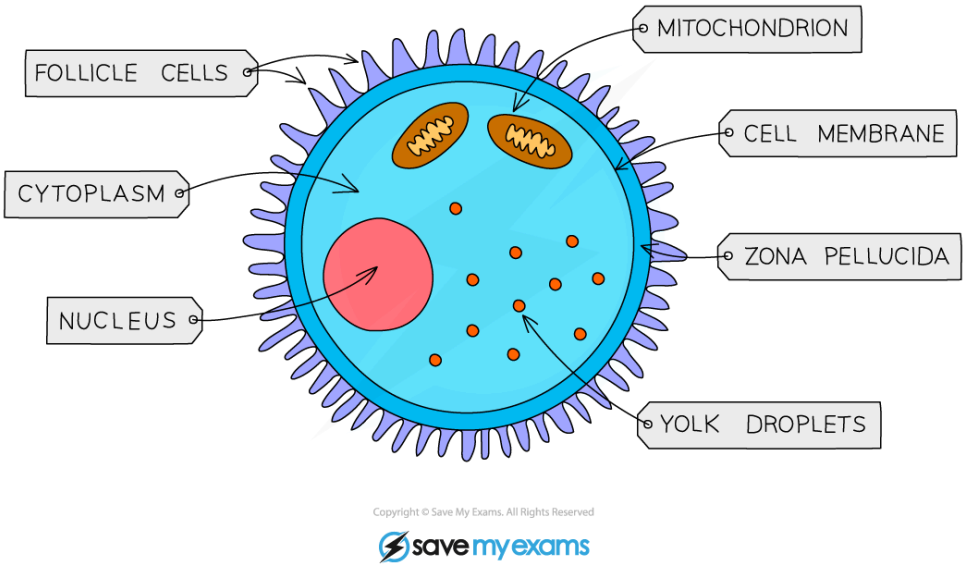


Red blood cells



Sperm cell

Your notes



Egg cell

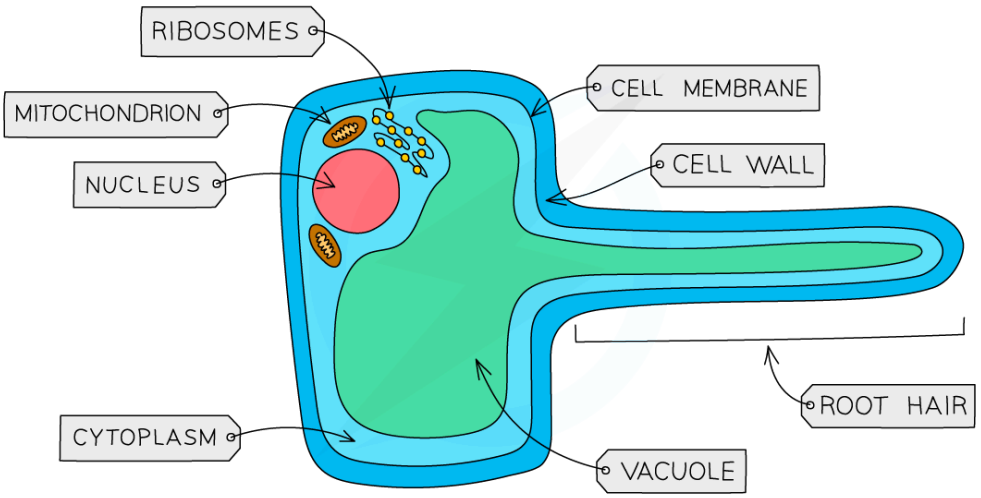
Your notes

Examples of specialised cells in plants:

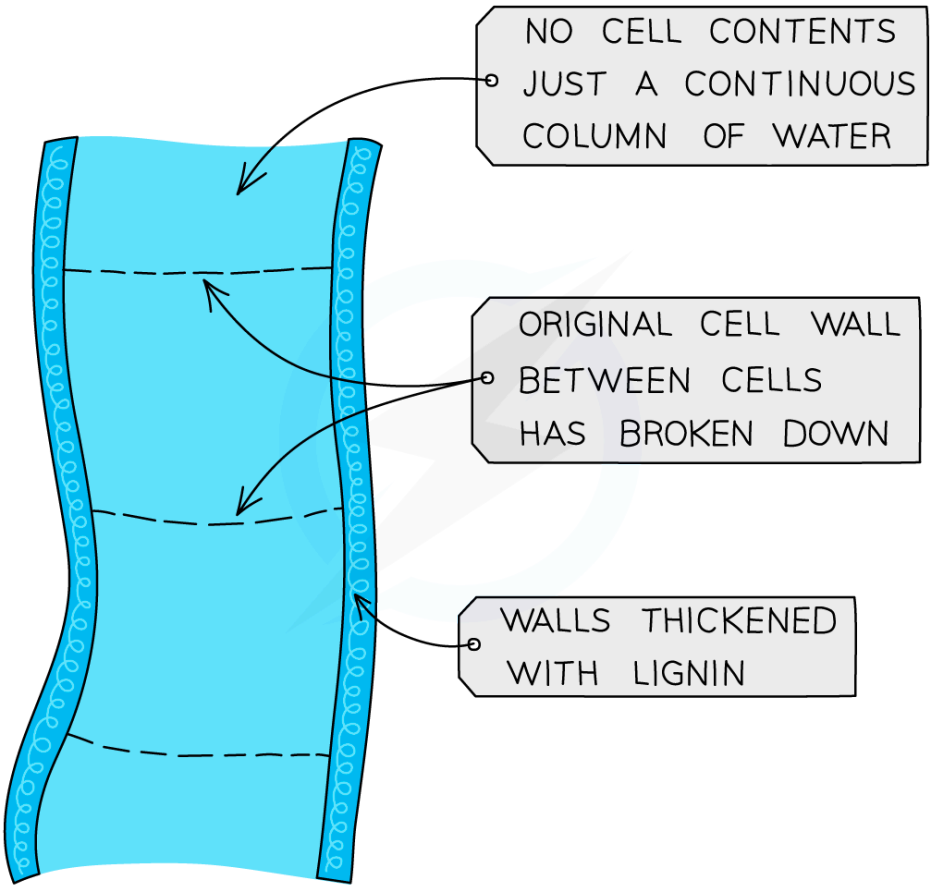
ROOT HAIR CELL	ABSORPTION OF WATER AND MINERAL IONS FROM SOIL	– **ROOT HAIR** INCREASES **SURFACE AREA** OF CELL TO ENSURE **MAXIMUM ABSORPTION** OF WATER AND MINERAL IONS – WALLS ARE **THIN** TO ENSURE WATER MOVES THROUGH **QUICKLY** – NO CHLOROPLASTS PRESENT
XYLEM VESSEL	CONDUCTION OF WATER THROUGH THE PLANT; SUPPORT OF THE PLANT	– **NO TOP AND BOTTOM WALLS** BETWEEN XYLEM VESSELS, SO THERE IS A **CONTINUOUS COLUMN OF WATER** RUNNING THROUGH THEM – CELLS ARE **DEAD** WITHOUT ORGANELLES OR CYTOPLASM TO ALLOW **FREE PASSAGE OF WATER** – THEIR WALLS BECOME **THICKENED** WITH A SUBSTANCE CALLED **LIGNIN** WHICH MEANS THEY ARE ABLE TO HELP **SUPPORT** THE PLANT
PALISADE MESOPHYLL CELL	PHOTOSYNTHESIS	– **COLUMN SHAPED** TO MAXIMIZE ABSORPTION OF SUNLIGHT AND **FIT AS MANY IN A LAYER** UNDER THE UPPER EPIDERMIS OF THE LEAF AS POSSIBLE – CONTAINS **MANY CHLOROPLASTS** FOR MAXIMUM **PHOTOSYNTHESIS**

Your notes

Diagrams of specialised cells in plants:

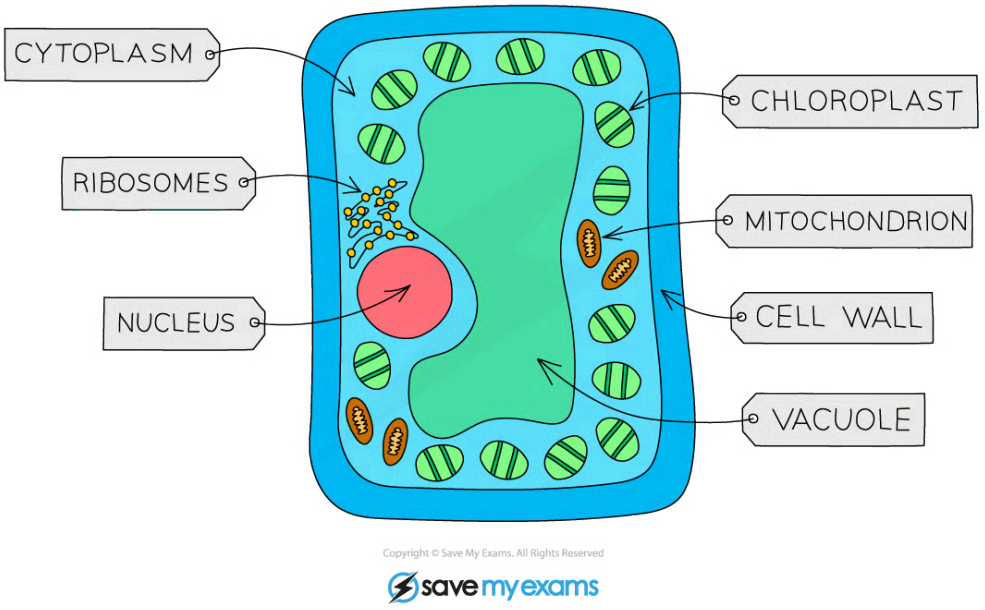


Root hair cell



Xylem structure

Your notes

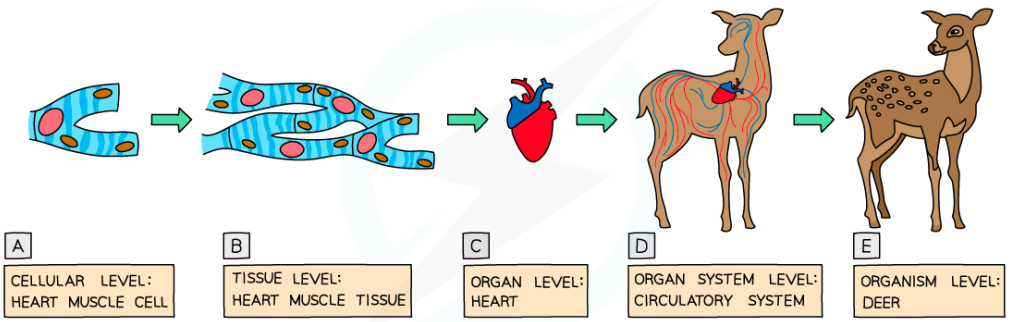


Palisade mesophyll cell

Your notes

Levels of Organisation in an Organism

LEVEL	DESCRIPTION
CELLS	BASIC FUNCTIONAL AND STRUCTURAL UNITS IN A LIVING ORGANISM
TISSUES	GROUPS OF CELLS OF SIMILAR STRUCTURE WORKING TOGETHER TO PERFORM THE SAME FUNCTION
ORGANS	MADE FROM DIFFERENT TISSUES WORKING TOGETHER TO PERFORM SPECIFIC FUNCTIONS
ORGAN SYSTEMS	GROUPS OF ORGANS WITH RELATED FUNCTIONS, WORKING TOGETHER TO PERFORM BODY FUNCTIONS



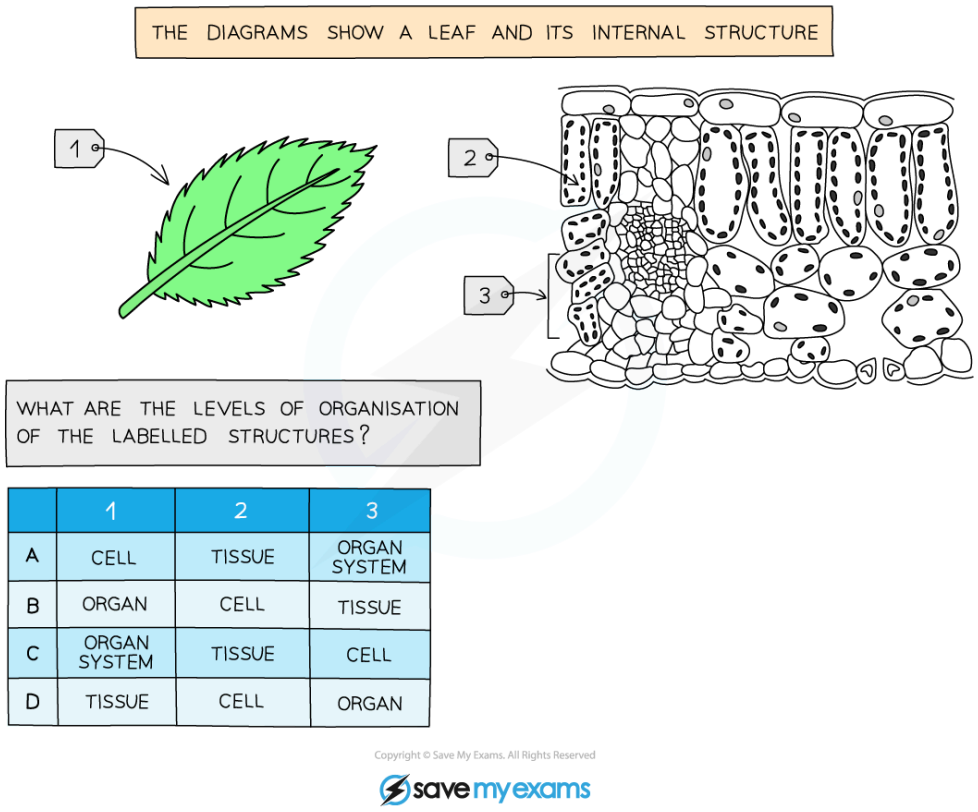
Levels of organisation

Your notes

ORGAN SYSTEM	ORGANS	TISSUE EXAMPLES
SHOOT SYSTEM	LEAF, STEM, FLOWER, FRUIT	– EPIDERMIS MESOPHYLL – XYLEM – PHLOEM
ROOT SYSTEM	ROOT, TUBER	– XYLEM – PHLOEM – GROUND TISSUE
DIGESTIVE SYSTEM	OESOPHAGUS, STOMACH, SMALL INTESTINE, LARGE INTESTINE	– MUSCLE – CONNECTIVE – NERVE – EPITHELIAL
CIRCULATORY SYSTEM	HEART, VEINS, ARTERIES	– MUSCLE – CONNECTIVE – NERVE – EPITHELIAL
IMMUNE SYSTEM	THYMUS, SPLEEN	– BONE MARROW
RESPIRATORY SYSTEM	TRACHEA, BRONCHI, LUNGS	– CONNECTIVE – MUSCLE – EPITHELIAL
EXCRETORY SYSTEM	LIVER, KIDNEY, SKIN, LUNGS	– MUSCLE – CONNECTIVE – EPITHELIAL – NERVE
NERVOUS SYSTEM	BRAIN, SPINAL CORD	– NERVE
REPRODUCTIVE SYSTEM	OVARY, CERVIX, UTERUS, VAGINA, TESTES, PENIS	– MUSCLE – CONNECTIVE – NERVOUS – ERECTILE

Your notes

- Your syllabus states that you should be able to identify the different levels of organisation in drawings, diagrams and images of familiar material
- An example of this is shown in the exam question below:



	1	2	3
A	CELL	TISSUE	ORGAN SYSTEM
B	ORGAN	CELL	TISSUE
C	ORGAN SYSTEM	TISSUE	CELL
D	TISSUE	CELL	ORGAN

Typical levels of organisation question

Examiner Tips and Tricks

Most incorrect answers here come from not being able to identify a tissue, so it's worth making sure you understand and remember that **tissues are always made up of only one type of cell**.

Your notes

Your notes

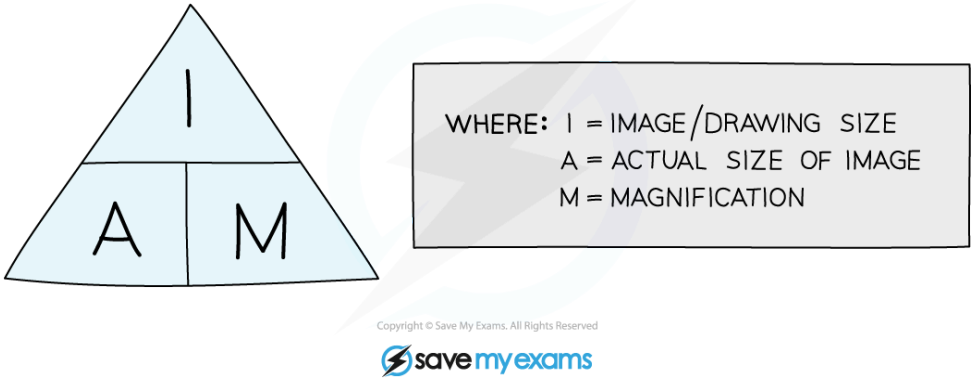
Magnification Formula

Calculating magnification and specimen size using millimetres as units

- Magnification is calculated using the following equation:

Magnification = Image size ÷ Actual size

- A better way to remember the equation is using an equation triangle:



Magnification equation

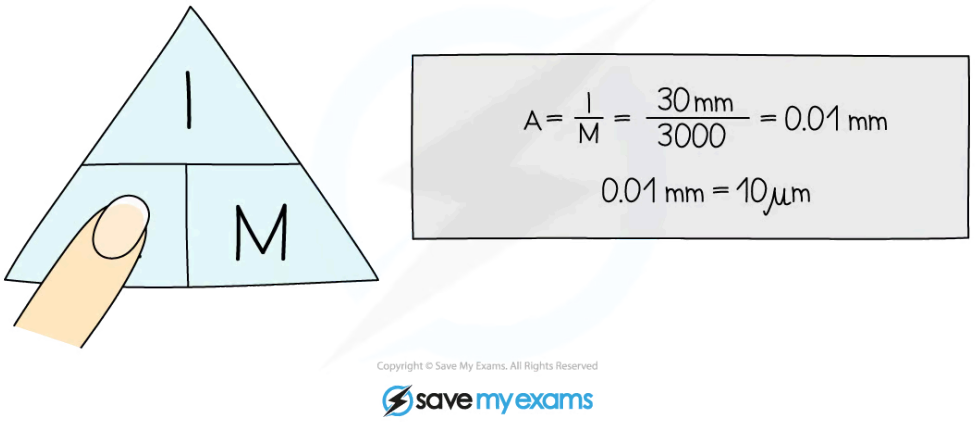
- Rearranging the equation to find things other than the magnification becomes easy when you remember the triangle - whatever you are trying to find, place your finger over it and whatever is left is what you do, so:
  - Magnification = image size / actual size
  - Actual size = image size / magnification
  - Image size = magnification x actual size

Remember magnification does not have any units and is just written as 'x 10' or 'x 5000'

Worked Example

An image of an animal cell is 30 mm in size and it has been magnified by a factor of x 3000. What is the actual size of the cell?

To find the actual size of the cell:



Worked example using the magnification equation

Your notes

Examiner Tips and Tricks

This skill most frequently comes up in paper 5 and 6 (although it also comes up in the multiple choice and occasionally the theory paper) and you will definitely have to **calculate either magnification, drawing size or actual size** in a least one paper. To ensure you do not lose marks:

1. Always **look at the units** that have been given in the question - if you are asked to measure something, most often you will be expected to measure it in millimetres NOT in centimetres - double check the question to see!
2. **Learn the equation triangle for magnification** and write it on the page straight away
3. Don't forget that **magnification has NO UNITS** - students often lose a mark because they put one in

Your notes

Converting Between Units: Extended

Extended Tier Only

Using millimetres and micrometres as units

- The table below shows how millimetres are related to two other measures of length
- What this basically means is that 1mm = 1000μm and 1cm = 10,000μm
- This usually comes up in questions where you have two different units and you need to ensure that you convert them both into the same unit before proceeding with the calculation
- For example:

UNIT	LENGTH IN mm
1 CENTIMETRE (cm)	10 mm
1 MILLIMETRE (mm)	1 mm
1 MICROMETRE (μm)	0.001 mm

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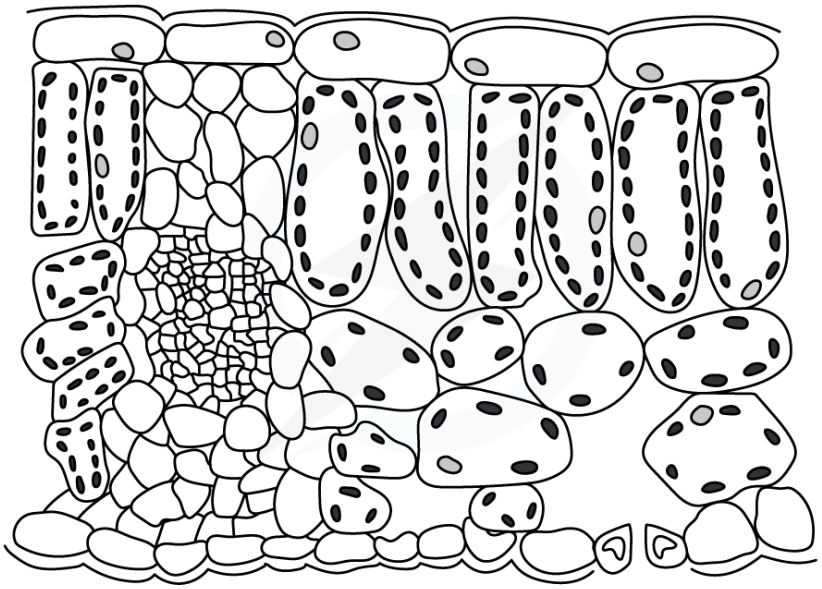
THE ACTUAL THICKNESS OF THE LEAF BELOW IS 2000μm, BUT THE IMAGE SIZE OF THE LEAF IN THE DIAGRAM IS 50mm



WHAT IS THE MAGNIFICATION OF THE DIAGRAM?

A x0.025 B x25 C x100 D x100 000

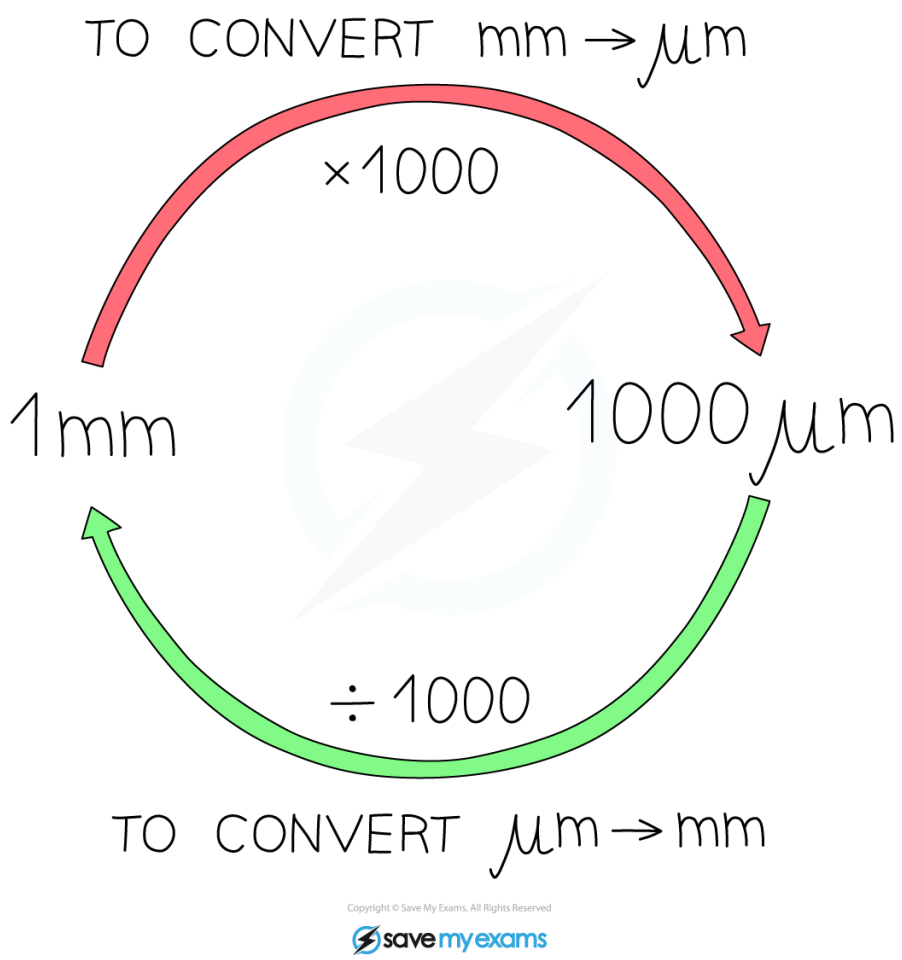
save my exams

Example extended magnification question

- Remember 1mm = 1000μm
- 2000 / 1000 = 2 so the actual thickness of the leaf is 2mm and the drawing thickness is 50mm
- Magnification = image size / actual size = 50 / 2 = 25
- So the magnification is x 25 (NO UNITS)

Examiner Tips and Tricks

If you are given a question with two different units in it, make sure you convert them to the same unit before doing your calculation.If you don't, there is a good chance that your answer will be the same as one of the incorrect options in a multiple choice question so you may think you got it right when, in fact, you haven't!The following diagram may help with unit conversion between mm and μm:



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