Cambridge IGCSE · Biology 0610 · Notes

Organisation of the organism

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What you need to know

This topic is about cells: what is inside them, how they differ, how they are specialised, and how they build up into whole organisms. It also covers working out real sizes from magnified drawings. The part marked **Extended only** is tested on Papers 2 and 4 only. By the end of it you should be able to:

Cell structure

1. **Describe and compare a plant cell and an animal cell**, using these structures: cell wall, cell membrane, nucleus, cytoplasm, chloroplasts, ribosomes, mitochondria and vacuoles.
2. **Describe a bacterial cell**, using these structures: cell wall, cell membrane, cytoplasm, ribosomes, circular DNA and plasmids.
3. **Identify all of these structures** on diagrams and photographs (images) of plant, animal and bacterial cells.
4. **Describe what each of these structures does** in plant, animal and bacterial cells.
5. **State that new cells come only from existing cells dividing.**
6. **State that specialised cells have particular jobs**, for these six: ciliated cells (move mucus in the trachea and bronchi), root hair cells (absorption), palisade mesophyll cells (photosynthesis), neurones (carry electrical impulses), red blood cells (carry oxygen), and sperm and egg cells (reproduction).
7. **Describe what cell, tissue, organ, organ system and organism mean**, with examples.

Size of specimens

8. **State and use the formula** magnification = image size ÷ actual size.
9. **Calculate magnification and size** of biological specimens in millimetres (mm).
10. **Extended only:** convert measurements between millimetres (mm) and micrometres (μm).

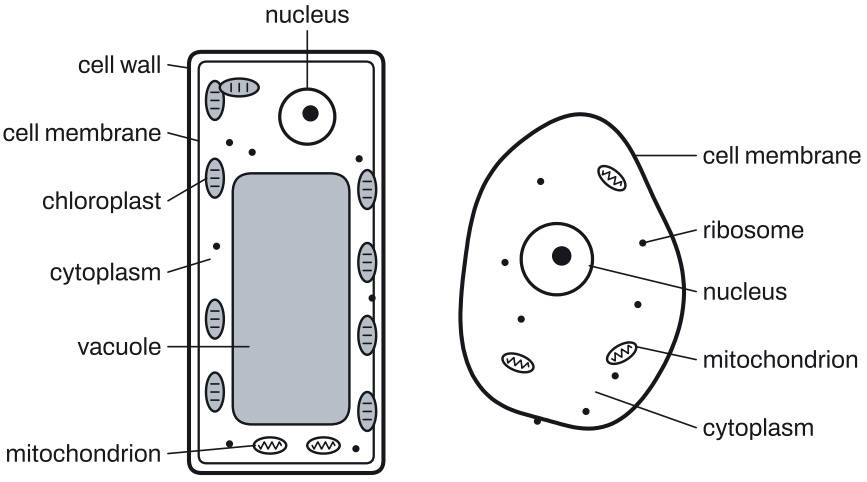
Understand it

Cells: the building blocks

Every living thing is made of one or more **cells**. A cell is the smallest unit that can carry out the processes of life. New cells are made only when an **existing cell divides** into two; cells never appear from nothing. That is how a single fertilised egg grows into a body of trillions of cells, and how damaged skin is replaced.

Plant cells and animal cells

Both kinds of cell share a basic kit. Plant cells have three extra structures. The diagram shows a **palisade mesophyll cell** from a leaf next to a typical animal cell.



plant cell (palisade mesophyll) animal cell

Structure	What it does	Plant cell	Animal cell
Cell membrane	controls what enters and leaves the cell	yes	yes
Cytoplasm	jelly-like liquid that holds the other structures; most of the cell's chemical reactions happen here	yes	yes
Nucleus	contains the genetic material (chromosomes, made of DNA); controls the cell's activities	yes	yes
Ribosomes	tiny structures in the cytoplasm where **proteins are made** (protein synthesis)	yes	yes
Mitochondria (one: mitochondrion)	where **aerobic respiration** happens, which **releases energy** for the cell	yes	yes
Cell wall	made of **cellulose**; strong and rigid, so it supports the cell, keeps its shape and stops it bursting when it takes in water	yes	**no**
Chloroplasts	contain the green pigment **chlorophyll**, which absorbs light; the site of **photosynthesis**, where glucose is made	yes (green parts only)	**no**
Large permanent vacuole	filled with **cell sap** (water with dissolved sugars and salts); pushes the cytoplasm against the wall, keeping the cell firm and supporting the plant	yes	**no** (only small, temporary vacuoles)

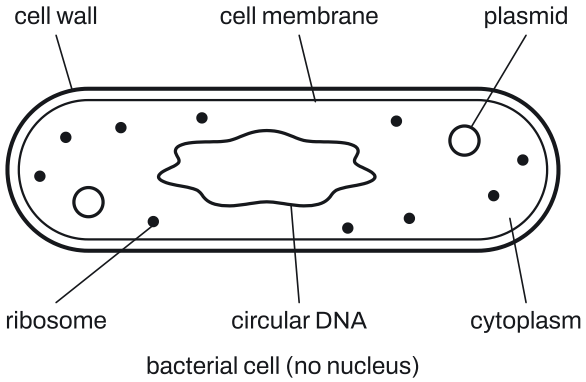
So the three structures found in plant cells but **not** in animal cells are the **cell wall**, **chloroplasts** and the **large permanent vacuole**.

A few details that exams test:

- The **cell wall is outside the cell membrane**. A plant cell has both; the wall is not a replacement for the membrane.
- **Chloroplasts sit in the cytoplasm**, usually near the edge of the cell, pushed there by the vacuole.
- **Not every plant cell has chloroplasts.** Root cells, including root hair cells, are underground where there is no light, so they have none. They still have a cell wall and a large vacuole, so they are still plant cells.
- Where two animal cells touch, there are **two cell membranes** side by side, one from each cell. Animal cells have no wall between them.
- **Mitochondria release energy**; they do not "make" or "produce" energy. Cells that use a lot of energy, such as muscle cells, sperm cells and root hair cells (which take in ions using energy), have **many mitochondria**.
- **Red blood cells** are unusual: when mature they have **no nucleus** (and no mitochondria), leaving more room for haemoglobin.

Bacterial cells

Bacteria are single cells that are much smaller and simpler than plant or animal cells. They are **prokaryotes**: they have **no nucleus**.



bacterial cell (no nucleus)

Structure	What it does
Cell wall	supports the cell and stops it bursting (it is **not** made of cellulose)
Cell membrane	controls what enters and leaves the cell
Cytoplasm	where the cell's reactions happen, including respiration
Ribosomes	make proteins
Circular DNA	one large loop of DNA, loose in the cytoplasm, carrying the cell's genes; it controls the cell
Plasmids	small extra **rings of DNA** carrying a few genes

Comparing all three cell types:

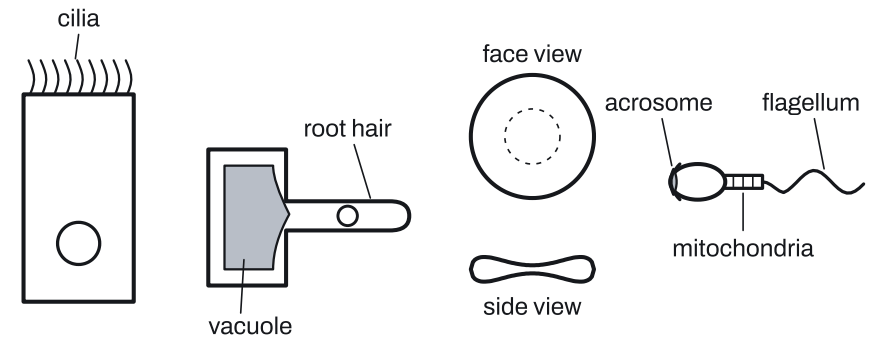
Structure	Plant	Animal	Bacterium
Cell membrane	yes	yes	yes
Cytoplasm	yes	yes	yes
Ribosomes	yes	yes	yes
Cell wall	yes (cellulose)	no	yes (not cellulose)
Nucleus	yes	yes	**no** (circular DNA instead)
Mitochondria	yes	yes	no
Chloroplasts	yes	no	no
Large permanent vacuole	yes	no	no
Plasmids	no	no	**yes**

The first three rows (**cell membrane, cytoplasm, ribosomes**) are found in **every** cell too: in a nucleus in plants and animals, loose as a circular loop (plus plasmids) in bacteria.

Specialised cells

In a many-celled organism, most cells are **specialised**: their shape and contents suit one particular job. You need these six:

Cell	Job	How it is suited to the job
Ciliated cell	**moves mucus** in the trachea and bronchi	tiny hairs (**cilia**) on its surface beat together to sweep mucus, with trapped dust and bacteria, up and away from the lungs
Root hair cell	**absorbs water and mineral ions** from the soil	a long, thin extension (the **root hair**) gives a **large surface area** for absorption; no chloroplasts, as there is no light underground
Palisade mesophyll cell	**photosynthesis**	packed with **many chloroplasts**; tall, column-shaped cells in a layer near the top of the leaf, where the light is
Neurone (nerve cell)	**carries electrical impulses**	very long, thin fibres that carry impulses over long distances, with branched endings that connect to many other cells
Red blood cell	**transports oxygen**	full of **haemoglobin**, which carries oxygen; **no nucleus**, leaving more room for haemoglobin; a disc that is thinner in the middle, giving a large surface area
Sperm cell and egg cell (gametes)	**reproduction**	sperm: a **flagellum** (tail) to swim, **many mitochondria** to release energy for swimming, and an **acrosome** at the tip of the head holding **enzymes** to digest a way into the egg; egg: a large cell with an **energy store** in its cytoplasm and a **jelly coat** that changes after one sperm enters



ciliated cell
moves mucus

root hair cell
absorbs water, ions

red blood cell
carries oxygen

sperm cell
reproduction

Levels of organisation

Cells are organised into bigger and bigger units, from the smallest to the largest:

Level	Meaning	Examples
Cell	the basic unit of a living thing	neurone, red blood cell, root hair cell, sperm
Tissue	a group of **similar cells** working together to do **one job**	muscle tissue, palisade mesophyll, epidermis, xylem, phloem
Organ	a structure made of **several different tissues** working together for a job	heart, brain, liver, kidney, stomach, pancreas, eye, **leaf**, root
Organ system	a group of **organs** working together for a job	circulatory system (heart and blood vessels), digestive system (oesophagus, stomach, intestines), nervous system
Organism	a whole living thing, made of organ systems working together	a human, a tree, a dog

A **leaf** is an **organ**: it contains several tissues (epidermis, palisade mesophyll, spongy mesophyll, xylem and phloem) working together for photosynthesis. The **heart** is an organ for the same reason: muscle, nerve and other tissues work together to pump blood. Structures **inside** a cell, such as chloroplasts, nuclei and mitochondria, are smaller than a cell, so they are none of these levels.

Magnification

Cells are far too small to see with the naked eye, so we look at them with a **light microscope**, or at magnified photographs (photomicrographs) and drawings. **Magnification** says how many times bigger the image is than the real thing:

$$\text{magnification} = \frac{\text{image size}}{\text{actual size}}$$

- **Image size** is how long the object is in the drawing or photo; you measure it with a ruler, in **mm**.

- **Actual size** is how long the real object is.
- Magnification has **no units**. Write it with a times sign, for example $\times 400$.

Rearranging gives the other two versions:

$$\text{actual size} = \frac{\text{image size}}{\text{magnification}} \qquad \text{image size} = \text{actual size} \times \text{magnification}$$

A triangle helps you remember: **I** on top, **A** and **M** below. Cover the one you want: $I = A \times M$, $A = I \div M$, $M = I \div A$.

For example, a drawing of an insect is 40 mm long and the insect is 8 mm long: magnification $= 40 \div 8 = \times 5$. A cell whose image is 60 mm long at $\times 400$ has an actual length of $60 \div 400 = 0.15$ mm.

Image size and actual size must be in the **same units** before you divide. Measure with a ruler in mm, not cm.

Millimetres and micrometres (Extended only)

Extended only: cells are so small that their size is usually given in **micrometres** (μm). One micrometre is a thousandth of a millimetre:

$$1 \text{ mm} = 1000 \ \mu\text{m}$$

- **mm → μm: multiply by 1000.** 0.15 mm $= 150$ μm; 0.025 mm $= 25$ μm.
- **μm → mm: divide by 1000.** 85 μm $= 0.085$ mm.

Extended only: in a calculation, convert **first** so both sizes are in the same unit. For a 30 mm image of a cell that is really 15 μm across: 30 mm $= 30\,000$ μm, so magnification $= 30\,000 \div 15 = \times 2000$. For a 12 mm image at $\times 3000$: 12 mm $= 12\,000$ μm, so the actual size is $12\,000 \div 3000 = 4$ μm.

Key facts and formulas

There is no formula list in the IGCSE Biology exam. Everything below must be learnt.

Formula	Status
magnification $= \frac{\text{image size}}{\text{actual size}}$	Learn it
actual size $= \frac{\text{image size}}{\text{magnification}}$; image size $=$ actual size $\times$ magnification	Learn it
Magnification has no units; write it as $\times 400$	Learn it
1 cm $= 10$ mm (cm → mm: $\times 10$)	Learn it
Extended: 1 mm $= 1000$ μm (mm → μm: $\times 1000$; μm → mm: $\div 1000$)	Learn it

Formula	Status
Plant cells only: cell wall (cellulose), chloroplasts, large permanent vacuole	Learn it
In every cell: cell membrane, cytoplasm, ribosomes	Learn it
Bacteria: no nucleus; circular DNA and plasmids; cell wall not made of cellulose	Learn it
Nucleus: genetic material, controls the cell · mitochondria: aerobic respiration, release energy · ribosomes: make proteins · membrane: controls what enters and leaves · wall: support, stops bursting · chloroplasts: photosynthesis · vacuole: cell sap, keeps cell firm	Learn it
Cell → tissue → organ → organ system → organism	Learn it
Tissue = group of similar cells with one function; organ = several tissues working together	Learn it
New cells are produced only by the division of existing cells	Learn it

How to do it

In the questions we have tagged for this topic (205 questions, 2021–2025, on Papers 1–4), the types came up this often. 20 of the 205 questions mix types, so the counts add up to more than 205.

Question type	Questions
Compare cell types: which structures plant, animal and bacterial cells have	57
Magnification calculation (actual size, image size or magnification)	50
Levels of organisation (cell, tissue, organ, organ system, organism)	30
Specialised cells: identify, state the function, explain the adaptation	28
Identify or label a cell structure on a diagram or photomicrograph	28
State the function of a cell structure	28
Recall the magnification formula or the information needed	11
Convert units of cell size between mm and µm (Extended)	9

Most are one-mark multiple choice on Papers 1 and 2. On Papers 3 and 4 the topic usually comes as a labelled cell diagram with several short parts.

1. Compare cell types: which structures plant, animal and bacterial cells have (57 questions)

1. **Recall the comparison table** in "Understand it". Plant-only: cell wall, chloroplasts, large permanent vacuole. Everywhere: cell membrane, cytoplasm, ribosomes. Bacteria-only: circular DNA (no nucleus) and plasmids.
2. **Tick grids** ("Which row shows the structures in ...?"): go through each column one at a time and cross out every row with a wrong entry.
3. **Written "state one structure in plant cells but not animal cells"**: cell wall, chloroplast or large (permanent) vacuole.

Variations you will meet:

- **Unusual cells.** Check what that particular cell has, not what "a plant cell" has. A root hair cell has **no chloroplasts**; a guard cell does. A red blood cell has **no nucleus**. A sperm cell has a membrane, cytoplasm, nucleus and mitochondria, but no wall or chloroplasts.
- **Single-celled organisms with a nucleus** (such as *Spirogyra*, *Euglena* or *Chlamydomonas*): if the drawing shows a cell wall, chloroplasts and a large vacuole, it shares all the plant-cell features.
- **"Which features show it is a plant cell?"**: the **cell wall** and **chloroplasts** are the safest answers. Say "**large permanent** vacuole", not just "vacuole", because animal cells can have small ones.
- **"Found in the cells of all living organisms"**: cell membrane, cytoplasm and ribosomes. Not a nucleus (bacteria have none), not a wall (animals have none), not chloroplasts.
- **Bacteria compared with plant or animal cells**: bacteria have no nucleus, no mitochondria and no chloroplasts; they have circular DNA and plasmids. Plant cells and bacteria **both** have a cell wall; animal cells and bacteria do not share a wall.
- **"What is at X?"** between two animal cells that touch: **two cell membranes**, one from each cell.
- **"Which processes can this cell carry out?"**: chloroplasts → photosynthesis; mitochondria → aerobic respiration; ribosomes → protein synthesis.

2. Magnification calculation (actual size, image size or magnification) (50 questions)

1. **Write the formula** and decide which quantity you want.
2. **Put both sizes in the same units.** On Core papers they are usually both in mm. On Extended papers one may be in µm: convert first (see type 8).
3. **Substitute and calculate.** Magnification = image ÷ actual; actual = image ÷ magnification; image = actual × magnification.
4. **Check it makes sense**: the image should be bigger than the real thing when the magnification is more than 1. Give the answer with units (not for magnification).

For example, a drawing of a leaf is 84 mm long and the real leaf is 28 mm long: magnification $= 84 \div 28 = \times 3$.

Variations you will meet:

- **A size given in cm.** Change cm to mm first: 1 cm $=$ 10 mm, so multiply by 10. A drawing 6 cm long of a seed that is really 2 mm long: 6 cm $=$ 60 mm, so magnification $=$ $60 \div 2 = \times 30$. **Extended only:** a 3.6 cm image of a cell 12 µm across: 3.6 cm $=$ 36 mm $=$ $36\,000$ µm, so magnification $=$ $36\,000 \div 12 = \times 3000$.
- **A scale bar** on the image ("the line represents 20 µm"). Measure the bar in mm, then either use it like a ruler (actual size $=$ image length $\div$ bar length $\times$ bar value), or find the magnification from the bar: magnification $=$ bar length $\div$ bar value. For a 10 mm bar labelled 20 µm: $10\,000 \div 20 = \times 500$.
- **A ruler printed next to the drawing**: read the image length off it in mm, then divide by the magnification.
- **Ranking specimens by actual size**: work out each actual size, then compare. For P (40 mm at $\times 200$), Q (30 mm at $\times 50$) and R (24 mm at $\times 400$), the actual sizes are 0.2 mm, 0.6 mm and 0.06 mm, so Q is the longest and R the shortest. The biggest image is not always the biggest specimen.
- **"Which calculation gives the actual size?"**: pick image size $\div$ magnification, with the unit conversion in the right place.
- **Answers in standard form**: 6 mm at $\times 200$ gives 0.03 mm $=$ 30 µm $=$ 3.0×10^{1} µm. Convert carefully, then match the power of ten.
- The wrong answers are usually the division turned upside down, or a factor of 10 or 1000 out. Check your units if your answer matches none of the options.

3. Levels of organisation (cell, tissue, organ, organ system, organism) (30 questions)

1. **Ask what the structure is made of.** One cell → cell. Many **similar** cells doing one job → tissue. **Several different tissues** → organ. **Several organs** → organ system. A whole living thing → organism.
2. **Use the examples table** in "Understand it"; learn that a **leaf** and the **pancreas** are organs, and **palisade mesophyll** and **epidermis** are tissues.

Variations you will meet:

- **"Explain why a leaf (or the heart) is an organ"** (2 marks): it is made of **several different tissues** that **work together** to carry out a particular **function** (photosynthesis, pumping blood).
- **"Explain why this layer is a tissue"**: it is a group of **similar cells** with the **same function**.
- **Order from simplest to most complex**: red blood cell → blood (tissue) → heart (organ) → circulatory system (organ system). A cell structure such as a nucleus or chloroplast comes before "cell"; a DNA molecule is smaller still.
- **"Which organs belong to the same system?"**: oesophagus, stomach and small intestine (digestive); heart and blood vessels (circulatory); trachea, bronchi and lungs (gas exchange).
- **Tick tables** with examples such as circulatory system, epidermis, pancreas, tree, sperm: organ system, tissue, organ, organism, cell.

4. Specialised cells: identify, state the function, explain the adaptation (28 questions)

1. **Identify the cell from its drawing**: hairs on the surface → ciliated cell; long outgrowth into the soil → root hair cell; column packed with chloroplasts → palisade mesophyll cell; long fibre with branched ends → neurone; disc with no nucleus → red blood cell; head and tail → sperm; large round cell with a jelly coat →

egg.

2. **State the function** in the syllabus words from the table: move mucus, absorb water and mineral ions, photosynthesis, conduct electrical impulses, transport oxygen, reproduction.
3. **Explain an adaptation** as **feature + how it helps**: "a long root hair gives a large surface area, so more water and ions are absorbed".

Variations you will meet:

- **Match clues to cells**: "contains an acrosome" → sperm; "contains haemoglobin" → red blood cell; "found in plants" → root hair and palisade cells; "found in the nervous system" → neurone.
- **Where ciliated cells are found**: lining the **trachea and bronchi** (the airways), not the blood or the gut. They move mucus; goblet cells make it.
- **Sperm and egg features** in a tick table: acrosome enzymes and flagellum → sperm; energy store and jelly coat → egg.
- **Numbers of organelles.** A palisade cell has **many chloroplasts** because it photosynthesises; a root hair cell has **none** because no light reaches it. A cell with **many mitochondria** does a lot of **aerobic respiration**, releasing energy, for example for active uptake of ions (root hair), swimming (sperm) or contraction (heart muscle).

5. Identify or label a cell structure on a diagram or photomicrograph (28 questions)

1. **Start from the outside**: the outer thick line of a plant or bacterial cell is the **cell wall**; the thin line just inside it is the **cell membrane**. An animal cell's outer line is the **membrane**.
2. **Then the obvious parts**: the large round body is the **nucleus**; the large clear space in a plant cell is the **vacuole**; the small oval green bodies with internal lines are **chloroplasts**; small ovals with a folded inner line are **mitochondria**; tiny dots are **ribosomes**; everything else inside the membrane is **cytoplasm**.
3. **In bacteria**: the large tangled loop is the **circular DNA**; the small separate rings are **plasmids**.

Variations you will meet:

- **"Write the letter"** of a structure: read the question for its job ("the structure that controls the cell's activities" → nucleus).
- **"Draw an X (or M) to show where …"**: chromosomes are in the **nucleus**; mitochondria and ribosomes are in the **cytoplasm**.
- **Where things are**: chloroplasts are **in the cytoplasm**; the wall is **outside** the membrane.
- **"Which two parts contain DNA?"** in a bacterium: the circular DNA and the plasmids.
- **Photomicrographs** look less tidy than drawings. A mitochondrion is a sausage-shaped body with folds inside; don't confuse it with a chloroplast (animal cells have no chloroplasts) or a ribosome (far too small to show detail).

6. State the function of a cell structure (28 questions)

1. **Use the "What it does" column** from the tables in "Understand it", with its key words: nucleus – **genetic material**, **controls** the cell; mitochondria – **aerobic respiration**, **releases energy**; ribosomes – **protein synthesis**; membrane – **controls what enters and leaves**; wall – **support**, **stops bursting**; chloroplast – **photosynthesis**; vacuole – **cell sap**, keeps the cell firm; plasmid – small ring of DNA.

Variations you will meet:

- **Draw lines** from a structure to its function, or fill in a table of name, letter and function.
- **"Which structure does a job?"**: "where is glucose made?" → chloroplast; "site of aerobic respiration?" → mitochondrion; "makes proteins?" → ribosome.
- **Applied questions**: a very active cell (heart muscle) needs **many mitochondria**; an antibiotic that breaks down the **cell wall** makes a bacterium burst, while one that stops **ribosomes** stops it making proteins.
- **Membrane and wall together** in a plant cell: the membrane controls what enters and leaves; the wall gives strength and support.

7. Recall the magnification formula or the information needed (11 questions)

1. **Magnification = image size ÷ actual size.** Choose this from the options; rearranged versions must still keep image size on top.
2. **"Write the formula to calculate the actual size"**: actual size = image size ÷ magnification.
3. **"State the two pieces of information needed to calculate the actual size"**: the **magnification** and the **image size** (length of the image).

Variations you will meet:

- **Wrong options** to reject: image size × actual size, image size − actual size, actual size ÷ image size, or any version with $\times 100$.
- **"Name the equipment used to view cells"**: a (light) microscope.

8. Convert units of cell size between mm and µm (Extended, 9 questions)

1. **mm → µm: multiply by 1000.** 0.0472 mm $= 47.2$ µm.
2. **µm → mm: divide by 1000.** 85 µm $= 0.085$ mm.
3. **Check the size of the number**: µm numbers are always 1000 times bigger than the same length in mm.

Variations you will meet:

- **Subtract first, then convert**: the space (lumen) inside a tube is the outer diameter minus **two** wall thicknesses (one on each side). An artery 4.2 mm across with walls 0.6 mm thick has a lumen of $4.2 - 2 \times 0.6 = 3.0$ mm $= 3000$ µm.
- **"How many times larger?"**: convert both to the same unit, then divide.
- **Units in the answer**: if the answer line has no unit printed, write µm or mm yourself.

Worked examples

The bold codes show where marks are earned, as in Cambridge mark schemes. The number is how many marks.

- **M1** method mark: for a correct method, even if the numbers slip.
- **A1** accuracy mark: for a correct answer; it needs the M mark before it.
- **B1** mark for a correct result on its own, with no method needed.

Example 1

A student looks at a cell from a leaf and a cell from the lining of the human cheek under a light microscope.

(a) State **three** structures that the leaf cell has but the cheek cell does not. **[3]**

(b) State **two** structures present in both cells, and give the function of each. **[4]**

(c) The leaf cell came from the palisade mesophyll. State **one** way a palisade mesophyll cell is adapted for its function. **[1]**

(d) Some bacteria were also seen. State **two** structures found in the bacterial cells but not in the cheek cell. **[2]**

(a) Cell wall **B1**, chloroplasts **B1**, large permanent vacuole **B1**.

(b) Any two structures **B1 B1**, each with its function **B1 B1**:

- nucleus: contains the genetic material and controls the cell's activities;
- mitochondria: the site of aerobic respiration, which releases energy;
- cell membrane: controls what enters and leaves the cell;
- ribosomes: make proteins;
- cytoplasm: where most chemical reactions happen.

(c) It contains many chloroplasts (to absorb light for photosynthesis). **B1**

(d) Any two of: cell wall, plasmids, circular DNA. **B1 B1** (Not "no nucleus": that is something missing, not a structure.)

Example 2

A student draws a pollen grain seen through a microscope. The drawing is 45 mm long. The magnification of the drawing is $\times 300$.

(a) State the formula that links magnification, image size and actual size. **[1]**

(b) Calculate the actual length of the pollen grain in mm. Show your working. **[2]**

(c) **Extended only:** convert your answer to (b) into micrometres. **[1]**

(d) The student then draws a leaf. The drawing is 84 mm long and the real leaf is 28 mm long. Calculate the magnification of this drawing. **[1]**

(a) magnification $=$ image size $\div$ actual size. **B1**

(b) actual size $=$ image size $\div$ magnification $= 45 \div 300$ **M1** $= 0.15$ mm **A1**.

(c) $0.15 \times 1000 = 150$ µm. **B1**

(d) $84 \div 28 = \times 3$. **B1** (No units: magnification is a number of times.)

Example 3

(a) Complete the table by naming the level of organisation of each structure. **[4]**

Structure	Level of organisation
kidney	
xylem	
neurone	
digestive system	

(b) Explain why a leaf is described as an organ. **[2]**

(c) Root hair cells are specialised cells. State the function of a root hair cell and explain how its shape helps it to carry out this function. **[3]**

(d) State where in the body ciliated cells are found, and describe their function. **[2]**

(a) kidney: organ **B1**; xylem: tissue **B1**; neurone: cell **B1**; digestive system: organ system **B1**.

(b) It is made of several different tissues **B1** that work together to carry out a function, photosynthesis. **B1**

(c) It absorbs water **B1** and mineral ions from the soil. The long, thin root hair gives a large surface area **B1**, so more water and ions can be absorbed at once. **B1**

(d) Lining the trachea and bronchi. **B1** Their cilia beat to move mucus (with trapped dust and bacteria) up and away from the lungs. **B1**

Example 4 (Extended)

A photomicrograph of a cheek cell has a scale bar 24 mm long, labelled 20 µm. The image of the cell is 96 mm long.

(a) Calculate the magnification of the photomicrograph. **[2]**

(b) Calculate the actual length of the cell. Give your answer in µm and in mm. **[2]**

(c) A mitochondrion in another image is 35 mm long at a magnification of $\times 14\,000$. Calculate its actual length in μm. **[2]**

(a) Convert the bar to μm: 24 mm $= 24\,000$ μm. **M1** magnification $= 24\,000 \div 20 = \times 1200$. **A1**

(b) 96 mm $= 96\,000$ μm; actual size $= 96\,000 \div 1200 = 80$ μm **B1** $= 0.08$ mm. **B1** (Check with the bar as a ruler: the cell is $96 \div 24 = 4$ bars long, and $4 \times 20 = 80$ μm.)

(c) 35 mm $= 35\,000$ μm **M1**; $35\,000 \div 14\,000 = 2.5$ μm. **A1**

Common mistakes

- **Saying mitochondria "make" or "produce" energy.** Energy can't be made. Say mitochondria are the site of **aerobic respiration**, which **releases** energy.
- **Giving "vacuole" alone as the plant-only structure.** Animal cells can have small vacuoles; write "**large permanent** vacuole", or use the cell wall or chloroplasts.
- **Thinking every plant cell has chloroplasts.** Root hair cells don't. Check the actual cell in the question.
- **Forgetting that plant cells have a membrane too.** The cell wall is outside the membrane, not instead of it.
- **Calling a structure inside a cell a tissue.** A chloroplast is not a tissue; the tissue is the palisade mesophyll layer. Examiners also see "tissue is smaller than a cell".
- **Writing "root cells" or "cilia cells" loosely.** Name the cell exactly as the syllabus does: root hair cell, ciliated cell, palisade mesophyll cell. Don't confuse ciliated cells (move mucus) with goblet cells (make mucus).
- **Turning the magnification formula upside down.** It is image ÷ actual. If the "actual size" of a cell comes out bigger than its drawing, you have divided the wrong way.
- **Measuring in cm instead of mm.** Examiners say this is the most common measuring error. Rulers show mm; use them. If a size is given in cm, multiply by 10 to get mm before using the formula; leaving it in cm gives an answer 10 times too small or too big.
- **Giving magnification a unit.** Write $\times 300$, not "300 mm".
- **Not converting units before dividing** (Extended). Mixing mm and μm gives an answer 1000 times too big or too small.
- **Rounding badly.** Keep the full value until the end, then round to the number of significant figures or decimal places asked for.

How to get the marks

- **"State"** or **"Name"** needs one word or a short phrase: "cell wall", "mitochondrion". **"Describe"** a function needs the key word (controls, releases energy, makes protein). **"Explain"** an adaptation needs the feature **and** how it helps ("large surface area, **so** more absorption").
- **Use the scientific name** of each structure. "Wall", "skin" or "outer layer" is not enough; write "cell wall" or "cell membrane". Spell so that the word is clearly recognisable.

- **Functions score with key ideas**: nucleus – genetic material or controls the cell; mitochondria – aerobic respiration or release of energy; ribosome – protein synthesis; membrane – controls entry and exit; wall – support, prevents bursting.
- **"Two structures present in all the cells"**: cell membrane, cytoplasm and ribosomes are always safe.
- **Calculations**: show the formula and the numbers substituted; the method mark can be earned even if the final answer slips. Give units on sizes (mm or µm) but none on magnification. Measure lengths from the page in mm.
- **"State the two pieces of information needed"**: magnification and image size, both needed for the mark.
- **Levels of organisation**: "several different tissues working together" (organ) and "similar cells with the same function" (tissue) are the key phrases.
- **When labelling**, make each label line touch the structure exactly and use a ruler.
- **Multiple choice**: in tick grids, test one column at a time and cross out any row with a wrong entry.

Quick check

1. Name the **three** structures found in plant cells but not in animal cells.
2. The image of a cell is 48 mm long. The magnification is $\times 400$. Calculate the actual length of the cell in mm. **Extended only:** give it in µm too.
3. A drawing of an ant is 90 mm long. The real ant is 6 mm long. Calculate the magnification of the drawing.
4. State the level of organisation of: (a) xylem; (b) a kidney; (c) a root hair cell; (d) the digestive system.
5. Name the specialised cell that: (a) carries oxygen; (b) has an acrosome; (c) moves mucus in the bronchi.
6. **Extended only:** convert (a) 0.045 mm to µm; (b) 350 µm to mm.

Answers

1. Cell wall, chloroplasts and a large permanent vacuole.
2. Actual size $= 48 \div 400 = 0.12$ mm. **Extended:** $0.12 \times 1000 = 120$ µm.
3. Magnification $= 90 \div 6 = \times 15$.
4. (a) Tissue. (b) Organ. (c) Cell. (d) Organ system.
5. (a) Red blood cell. (b) Sperm cell. (c) Ciliated cell.
6. (a) $0.045 \times 1000 = 45$ µm. (b) $350 \div 1000 = 0.35$ mm.

Past questions to try

- **0610/31/O/N/25 Q3**: labelling an animal cell and naming a plant-only structure.
- **0610/31/O/N/24 Q1**: comparing an animal cell with a bacterial cell, and sperm and egg adaptations.
- **0610/12/M/J/25 Q5**: ranking three specimens by actual size from their magnifications.
- **0610/32/O/N/22 Q8**: ticking the level of organisation for five examples.