Your notes

GCSE Biology: revision notes

Microscopy

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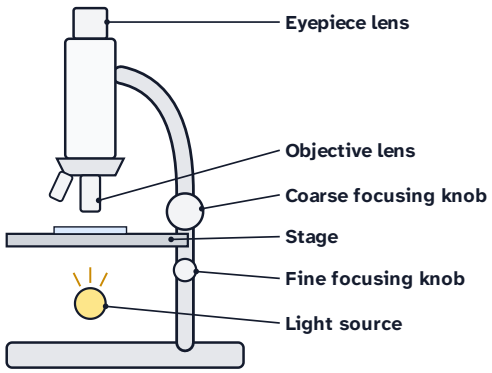
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Start here: why we need microscopes

- Most cells are about 10 to 100 micrometres (µm) across. A millimetre is 1000 µm, so you cannot see cells with your eyes alone.
- A microscope makes an image bigger (**magnification**) and shows fine detail (**resolution**). The best microscopes do both.
- There is one equation to learn: **magnification** = size of image ÷ size of real object. Get the units right (mm, µm and nm) and you can do every calculation.

Light and electron microscopes

- **Light microscopes** use light and lenses. They are cheap, easy to use and can show living cells, but only magnify up to about ×2000.
- **Electron microscopes** use a beam of electrons. They have a much higher **magnification** (up to about ×2 000 000) and a much higher **resolution**.
- **Electron microscopes** let scientists see sub-cellular structures in detail, such as mitochondria, ribosomes and plasmids.
- A transmission **electron microscope** (TEM) gives flat, detailed images of the inside of cells; a scanning **electron microscope** (SEM) gives 3D images of surfaces.



Magnification and resolution

- **Magnification** is how many times bigger the image is than the real object.
- **Resolution** is the ability to tell apart two points that are close together; higher **resolution** gives a sharper, more detailed image.
- **Magnification** = size of image ÷ size of real object. Rearranged: real size = image size ÷ **magnification**.
- Always use the same units for image size and real size before dividing.

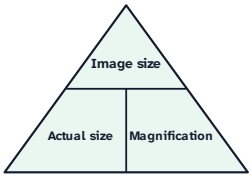


Image size = Actual size × Magnification

Actual size = Image size ÷ Magnification

Magnification = Image size ÷ Actual size

Cover the one you want: what's left shows how to work it out.

Units and standard form

- 1 millimetre (mm) = 1000 micrometres (µm); 1 µm = 1000 nanometres (nm).
- 1 µm = 1×10^{-6} m and 1 nm = 1×10^{-9} m.
- Cells are usually measured in micrometres; ribosomes and viruses in nanometres.
- **Standard form** writes very big or small numbers as $A \times 10^{n}$, where A is between 1 and 10.

Required practical: using a light microscope

- Put a thin layer of the specimen (such as onion epidermis) on a slide and add a drop of water or **stain**, like iodine, to make structures visible.
- Lower a coverslip at an angle to avoid trapping air bubbles.
- Start with the lowest-power **objective lens**, focus with the coarse focusing wheel, then use the fine focusing wheel.
- Switch to a higher-power objective and refocus to see more detail.
- Draw what you see with clear, unshaded pencil lines, label structures and write the **magnification**. A scale bar shows the real size.

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Working out total magnification

- Total **magnification** = **eyepiece lens magnification** × objective lens magnification.
- Example: a ×10 eyepiece with a ×40 objective gives a total **magnification** of ×400.

Exam tip

- **Magnification** = image size ÷ actual size. Convert to the same units before you divide, and rearrange it if you're asked for the actual size.
- **Resolution** is the ability to tell two close points apart. A question comparing microscopes usually wants that word.

Common mistakes

- Forgetting that 1 mm = 1000 µm.
- Confusing **magnification** with **resolution**.
- Giving a **magnification** with a unit: it doesn't have one.

Worked examples

A cell is 0.01 mm across. Its image under a microscope is 20 mm across. Find the magnification.

Use magnification = image size ÷ real size (both in the same units). **20 ÷ 0.01**

Answer: × 2000

An image is 15 mm long at a magnification of × 300. Find the real length in micrometres.

Rearrange: real size = image size ÷ magnification. **15 ÷ 300 = 0.05 mm**

Change mm to µm (multiply by 1000). **0.05 × 1000 = 50**

Answer: 50 µm

A mitochondrion is 0.000 002 m long. Write its length in micrometres and in standard form.

There are 1 000 000 µm in a metre, so multiply by 1 000 000. **0.000 002 × 1 000 000 = 2 µm**

For standard form, move the decimal point until the number is between 1 and 10: it moves 6 places right. **2×10^{-6} m**

Answer: 2 µm, or 2×10^{-6} m

Key terms

Magnification	How many times larger an image is than the real object: image size ÷ real size.

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Resolution	The ability to distinguish between two points that are close together; the smallest detail that can be seen.
Light microscope	A microscope that uses light and glass lenses; it can view living cells up to about ×2000.
Electron microscope	A microscope that uses a beam of electrons; it has much higher magnification and resolution.
Micrometre (µm)	One thousandth of a millimetre (1×10^{-6} m).
Nanometre (nm)	One thousandth of a micrometre (1×10^{-9} m).
Objective lens	The lens nearest the specimen; changing it changes the magnification.
Eyepiece lens	The lens you look through, usually ×10.
Stain	A dye, such as iodine or methylene blue, that makes parts of a cell easier to see.
Standard form	A way of writing numbers as $A \times 10^n$, where $1 \leq A < 10$.

Your notes

Quick questions

Cover the answers and test yourself: remembering is what makes it stick.

1. What does an electron microscope use to form an image?
2. Which microscope can be used to look at living cells?
3. What is resolution?
4. What is the formula for magnification?
5. A ×10 eyepiece is used with a ×40 objective lens. What is the total magnification?
6. How many nanometres are in 1 micrometre?
7. Which structure is too small to see clearly with a light microscope?
8. Why is a stain added to a slide?

Answers

1. A beam of electrons
2. Light microscope
3. The ability to tell apart two points that are close together
4. Size of image ÷ size of real object
5. ×400
6. 1000
7. Ribosome
8. To make parts of the cell easier to see

What to do next

Practise 12 questions on this topic

Try 6 exam questions, with mark schemes

Read the lesson, one step at a time

Your notes