

Exercise walk-through

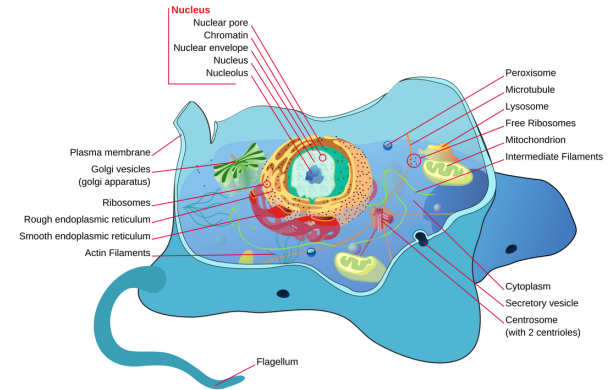
1.1

The microscope in cell studies

A-Level Biology

What we will cover

- 1 The light microscope
- 2 Magnification & resolution
- 3 Animal & plant cells
- 4 Organelles
- 5 Prokaryotic cells
- 6 Viruses



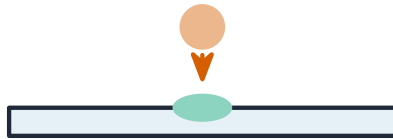
a eukaryotic cell

Making a slide

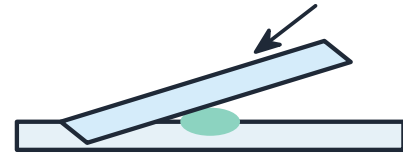
A **temporary wet mount** : specimen on a **slide** , a drop of stain, then lower the **cover slip** at an angle (no bubbles). Drawings: sharp single lines, **no shading**, parts in the right proportions, and labels on straight lines that **do not cross**. A **microscope** makes a bigger picture, because cells are far too small to see unaided.



1. specimen
on a slide



2. add a drop
of stain



3. lower the cover
slip at an angle

The rules for a biological drawing

clean continuous lines

sharp pencil, no shading, no sketchy overlapping strokes

only what you can see

draw **what is on the slide**, not what a textbook diagram shows

correct proportions

the parts in the sizes they really are relative to each other

label lines

straight, ruled, not crossing, and ending exactly on the structure

a magnification or scale

stated on the drawing

plan or high-power

a plan drawing shows **tissue outlines only**; a high-power drawing shows a few **named cells** in detail

The commonest lost mark is drawing the textbook rather than the slide. If your organelle is not visible under a light microscope, it does not belong in the drawing.

Exercise 2.1

2.1 Convert each length.

[3]

length	convert to
0.005 mm	μm
2 μm	nm
1.5 mm	μm

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2.1

- 1 mm = 1000 μm and 1 μm = 1000 nm
- 0.005 mm = **5** μm
- 2 μm = **2000** nm
- 1.5 mm = **1500** μm

Exercise 2.2

2.2 A cell of actual width $50\text{ }\mu\text{m}$ is drawn 100 mm wide. Calculate the magnification of the drawing. (*Hint: put both sizes in μm first.*) [2]

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2.2

- put both sizes in μm : image = $100\text{ mm} = 100\,000\text{ }\mu\text{m}$
- magnification = $\frac{\text{image size}}{\text{actual size}}$

$$\text{magnification} = \frac{\text{image size}}{\text{actual size}} = \frac{100\,000\text{ }\mu\text{m}}{50\text{ }\mu\text{m}} = \times \mathbf{2000}$$

Exercise 2.3 (a)

2.3 Using the same eyepiece graticule and objective, 100 graticule divisions line up with 1.0 mm on a stage micrometer.

(a) Calculate the actual length of **one** graticule division, in μm .

[2]

Exercise 2.3 (a)

2.3 Using the same eyepiece graticule and objective, 100 graticule divisions line up with 1.0 mm on a stage micrometer.

(a) Calculate the actual length of **one** graticule division, in μm . [2]

(a)

- 100 divisions line up with 1.0 mm

$$\frac{1.0 \text{ mm}}{100} = 0.010 \text{ mm} = \mathbf{10} \mu\text{m}$$

Exercise 2.3 (b)

2.3 Using the same eyepiece graticule and objective, 100 graticule divisions line up with 1.0 mm on a stage micrometer.

(b) A nucleus measures 8 graticule divisions across. State its actual width. [1]

Exercise 2.3 (b)

2.3 Using the same eyepiece graticule and objective, 100 graticule divisions line up with 1.0 mm on a stage micrometer.

(b) A nucleus measures 8 graticule divisions across. State its actual width. [1]

(b)

- $8 \times 10 \text{ } \mu\text{m} = \mathbf{80 \text{ } \mu\text{m}}$

Exercise 3.1

3.1 An electron micrograph printed at $\times 12\,000$ shows a **mitochondrion** that is 36 mm long. The actual length of the mitochondrion is: [1]

☐

A 0.3 μm

B 3 μm

C 30 μm

D 432 μm

Exercise 3.1

3.1 An electron micrograph printed at $\times 12\,000$ shows a **mitochondrion** that is 36 mm long. The actual length of the mitochondrion is: [1]

☐

A 0.3 μm

B 3 μm

C 30 μm

D 432 μm

3.1 B

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

$$\frac{36 \text{ mm}}{12\,000} = 0.003 \text{ mm} = \mathbf{3} \mu\text{m}$$

- D multiplies by the magnification instead of dividing; A is $10\times$ too small; C is $10\times$ too large

Exercise 3.2

3.2 Which structure can **only** be seen using an electron microscope, not a high-power light microscope? [1]

☐

A cell wall

B chloroplast

C nucleus

D ribosome

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3.2 Which structure can **only** be seen using an electron microscope, not a high-power light microscope? [1]

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A cell wall

B chloroplast

C nucleus

D ribosome

3.2 D

- a ribosome (≈ 25 nm) is far below the ≈ 200 nm resolution of a light microscope
- A, B and C are large enough to see with a high-power light microscope

Exercise 3.3 (a)

3.3 A student lines up an eyepiece graticule with a stage micrometer whose smallest divisions are 0.01 mm. The diagrams show that 40 graticule divisions cover 0.20 mm. The same eyepiece is used to view a blood smear, and a **lymphocyte** measures 2 graticule divisions across.

(a) Calculate the actual length of one graticule division, in μm . [2]

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(a) Calculate the actual length of one graticule division, in μm . [2]

(a)

- 40 divisions = 0.20 mm

$$\frac{0.20 \text{ mm}}{40} = 0.005 \text{ mm} = \mathbf{5 \mu\text{m}}$$

Exercise 3.3 (b)

3.3 A student lines up an eyepiece graticule with a stage micrometer whose smallest divisions are 0.01 mm. The diagrams show that 40 graticule divisions cover 0.20 mm. The same eyepiece is used to view a blood smear, and a **lymphocyte** measures 2 graticule divisions across.

(b) Calculate the diameter of the lymphocyte, in μm .

[1]

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(b) Calculate the diameter of the lymphocyte, in μm . [1]

(b)

- $2 \times 5 \mu\text{m} = \mathbf{10 \mu\text{m}}$

Exercise 3.4 (a)

3.4 Fig. 3.1 is a scanning electron micrograph of a *Plasmodium* ring cell inside a red blood cell. The actual diameter of the ring cell is $2.0\text{ }\mu\text{m}$. In the image, this diameter measures 80 mm.

(a) Calculate the magnification of the image. Give your answer to 3 significant figures.[2]

Exercise 3.4 (a)

3.4 Fig. 3.1 is a scanning electron micrograph of a *Plasmodium* ring cell inside a red blood cell. The actual diameter of the ring cell is $2.0\text{ }\mu\text{m}$. In the image, this diameter measures 80 mm .

(a) Calculate the magnification of the image. Give your answer to 3 significant figures.[2]

(a)

- put both sizes in μm : image = $80\text{ mm} = 80\,000\text{ }\mu\text{m}$

$$\text{magnification} = \frac{\text{image size}}{\text{actual size}} = \frac{80\,000\text{ }\mu\text{m}}{2.0\text{ }\mu\text{m}} = 40\,000 = \times 4.00 \times 10^4$$

Exercise 3.4 (b)

3.4 Fig. 3.1 is a scanning electron micrograph of a *Plasmodium* ring cell inside a red blood cell. The actual diameter of the ring cell is $2.0\text{ }\mu\text{m}$. In the image, this diameter measures 80 mm.

(b) The ring cell could not be seen clearly with a light microscope. Use the idea of **resolution** to explain why. [2]

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3.4 Fig. 3.1 is a scanning electron micrograph of a *Plasmodium* ring cell inside a red blood cell. The actual diameter of the ring cell is $2.0\text{ }\mu\text{m}$. In the image, this diameter measures 80 mm.

(b) The ring cell could not be seen clearly with a light microscope. Use the idea of **resolution** to explain why. [2]

(b)

- the ring cell ($2\text{ }\mu\text{m}$) and its detail are near or below the light microscope's resolution ($\approx 200\text{ nm} = 0.2\text{ }\mu\text{m}$)
- the electron microscope has far higher resolution, so it shows the ring cell as a separate, detailed structure

Exercise 3.5 (a)

3.5 Define each term.

[2]

(a) magnification

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3.5 Define each term.

[2]

(a) magnification

(a)

- **magnification** is how many times larger the image is than the actual object

Exercise 3.5 (b)

3.5 Define each term.

[2]

(b) resolution

Exercise 3.5 (b)

3.5 Define each term.

[2]

(b) resolution

(b)

- **resolution** is the smallest distance between two points that can still be seen as two separate points