MYP 4 UNIT 1
LESSON 8

Observing cells with a light microscope

Outcome

- I can use a light microscope to observe cells.
- I can prepare a microscope slide with a specimen of tissue, observe it using a microscope, and record my observations in a scientific line drawing.
- I can describe numbers and sizes of cells using appropriate units.

Keywords

A **cell** is the smallest living building block of a living organism.

A **lens** is a piece of curved glass which focuses light to alter the size of an image.

A **light microscope** is a piece of equipment that uses lenses to focus light and enlarge the object's image.

Adjusting the **focus** of a lens makes an image clearer.

Increasing the **magnification** of an object makes it look bigger.

Keywords

A **tissue** is a group of similar cells with the same job working together.

To observe a specimen using a light microscope, we have to put a thin layer of it on a glass microscope **slide**.

Stain is a coloured liquid that is put onto a specimen so that the cells and their structures can be more easily seen with a light microscope.

Observations from a light microscope can be recorded by making a labelled **scientific line drawing**.

Keywords

million	1 000 000, or one thousand thousand, or 10^6
billion	1 000 000 000 or one thousand million, or 10^9
standard form	a way of writing down very large or very small numbers easily; e.g. $1000 = 10^3$
micrometre	one millionth of a metre, or 1 m / 1 000 000, or 1×10^{-6} m
magnification	making small objects appear larger in order to see more detail

Lesson outline

Observing cells with a light microscope

- Living organisms are made up of cells
- Microscopes are used to view cells
- Using a microscope

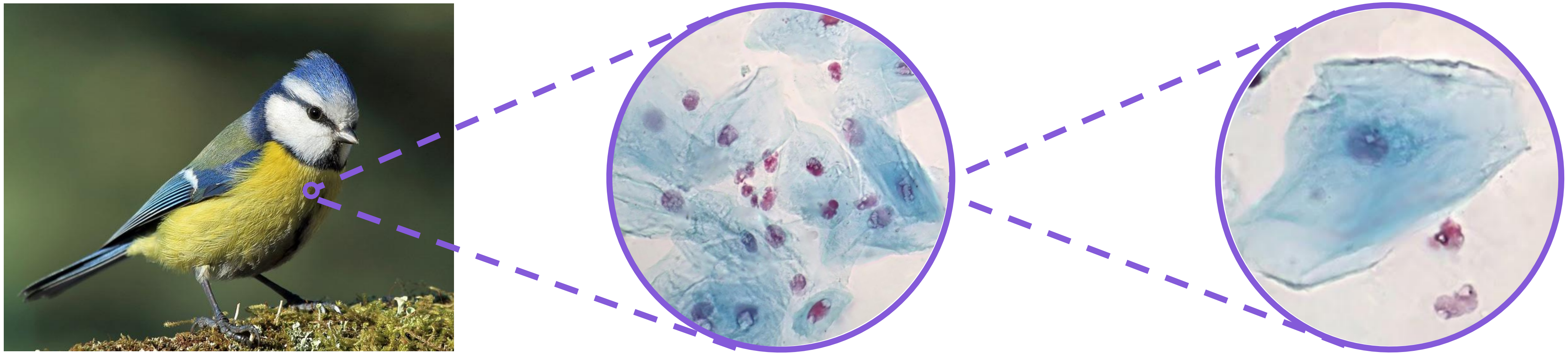
Living organisms are made up of cells

Explanation

All living organisms are made of living building blocks.

These living building blocks are called **cells.**

Cells are usually far too small for us to see unaided. We have to magnify them to see them.



an animal

magnified view of cells that make up the animal’s skin

one animal skin cell

Lesson outline

Observing cells with a light microscope

- Living organisms are made up of cells
- Microscopes are used to view cells
- Using a microscope

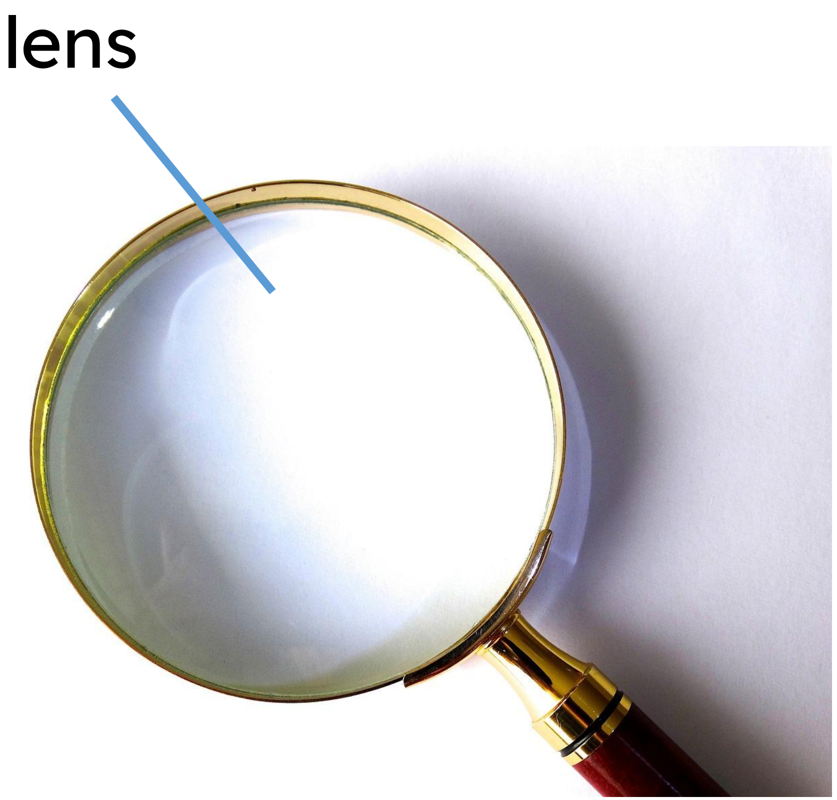
Microscopes are used to view cells

Explanation

Most cells are too small to see with our unaided eyes.

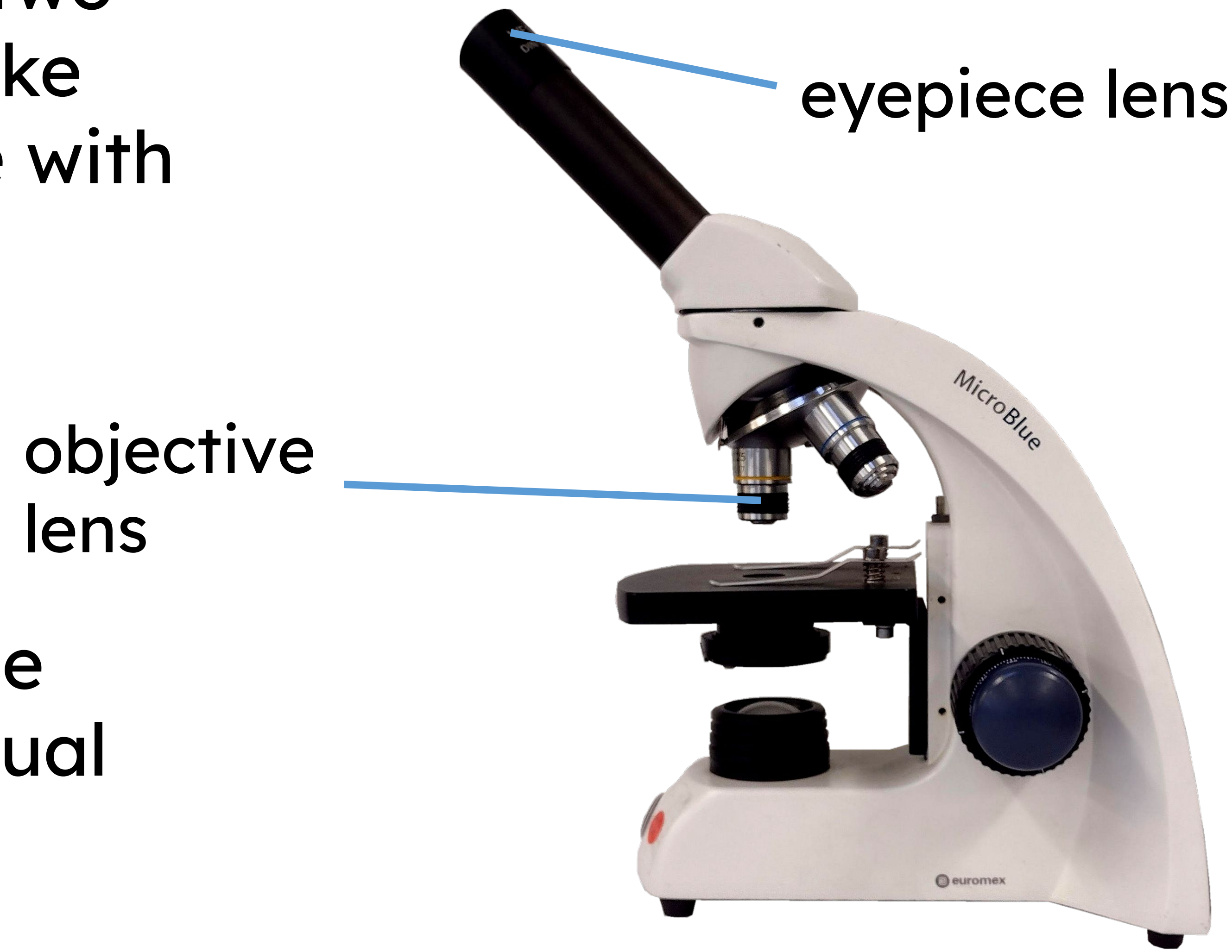
Cells can be magnified using a **lens.**

A magnifying glass has a lens, but even this doesn't make cells appear big enough for us to see them.



Microscopes are used to view cells

A **light microscope** has two magnifying lenses to make cells large enough to see with our eyes.

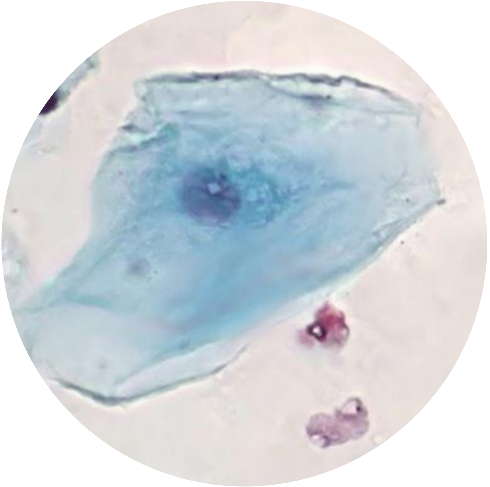


A sample of tissue can be magnified so the individual cells can be seen.

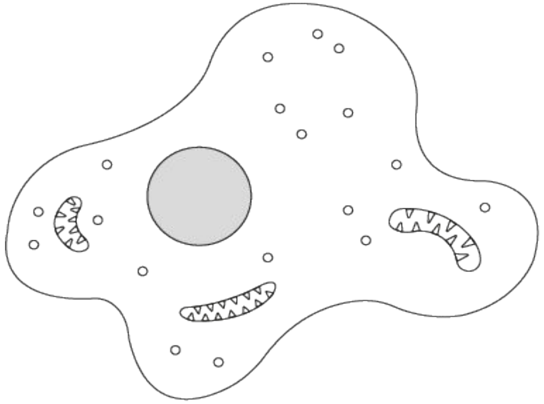
Microscopes are used to view cells

Explanation

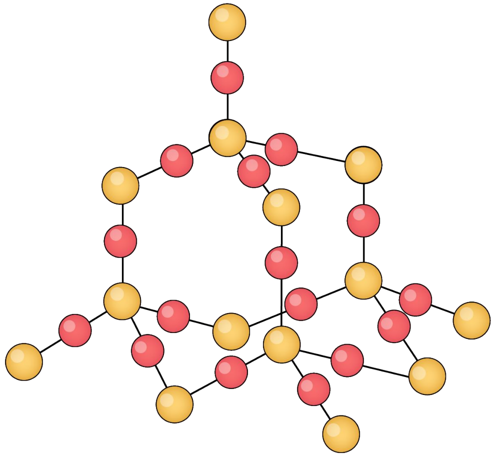
With a light microscope we can see some of the cell structures, but we cannot magnify enough to see atoms and molecules.



an animal cell seen through a light microscope



a diagram of a cell including its internal structures



a molecule

Images are not to scale

Which of these could you only see by using a light microscope?

a cell

b molecule

c tissue

d water

Lesson outline

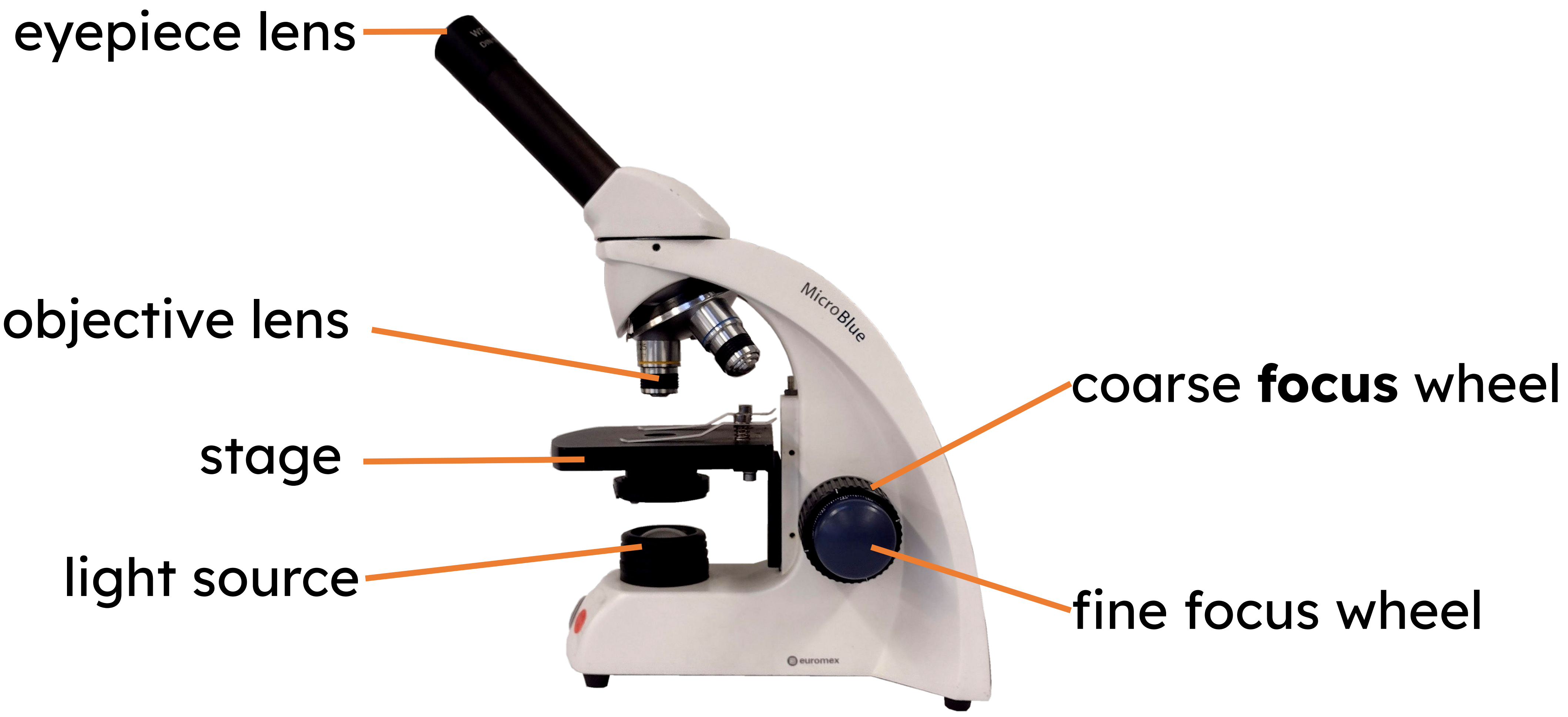
Observing cells with a light microscope

- Living organisms are made up of cells
- Microscopes are used to view cells
- Using a microscope

Using a microscope

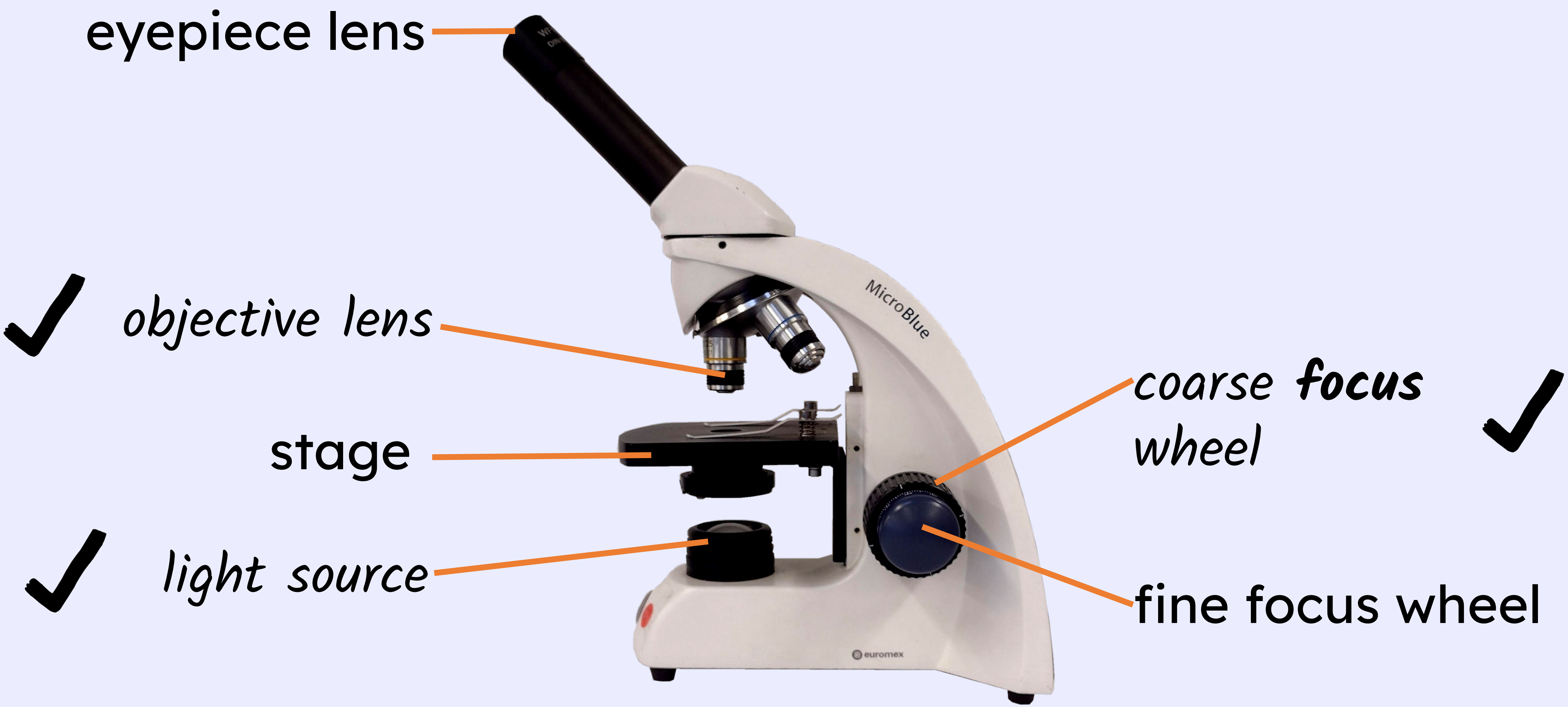
Explanation

This is a labelled diagram of a light microscope.



Check

Add the missing labels to the parts of the microscope



Using a microscope

Explanation

Watch the video clip to see how to use the microscope to observe the cells in a specimen.

Watch ▶

Using a microscope

The method for using a microscope is:

1. Turn the objective lens to the lowest magnification.
2. Place the slide on the stage under the clips.
3. Turn on the light source.
4. Looking from the side, turn the coarse focus wheel to move the stage up so it is close to the objective lens.
5. Looking into the eyepiece, turn the coarse focus wheel to bring your specimen into focus.
6. Turn the fine focus wheel to make the image clearer.
7. The **magnification** can be increased by changing to a higher power objective lens.

Using a microscope

Check

Put these statements in the correct order for using a microscope to view a slide:

a Use the fine focus wheel to make the image clearer. 4

b Place the slide on the stage. 2

c Turn to the lowest power objective lens. 1

d Use the coarse focus wheel to focus on the specimen. 3

Preparing and observing a microscope slide

Lesson outline

Preparing and observing a microscope slide

- Making a microscope slide
- Scientific line drawing

Making a microscope slide

Onions are made of plant cells.

an onion

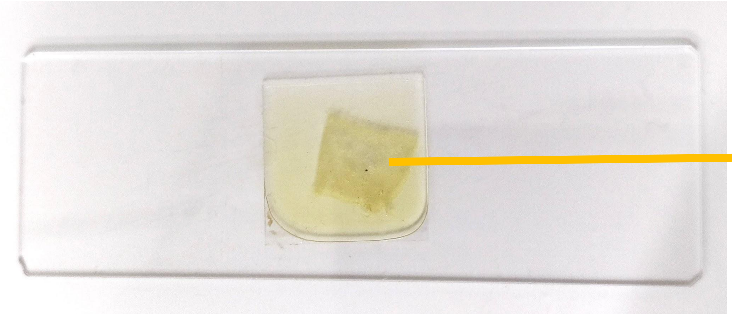
The cells are the living building blocks of the onion **tissue**.

Making a microscope slide

Explanation

We are able to use a light microscope to see onion cells.

We can prepare a microscope **slide** with a specimen of onion tissue.



tissue specimen

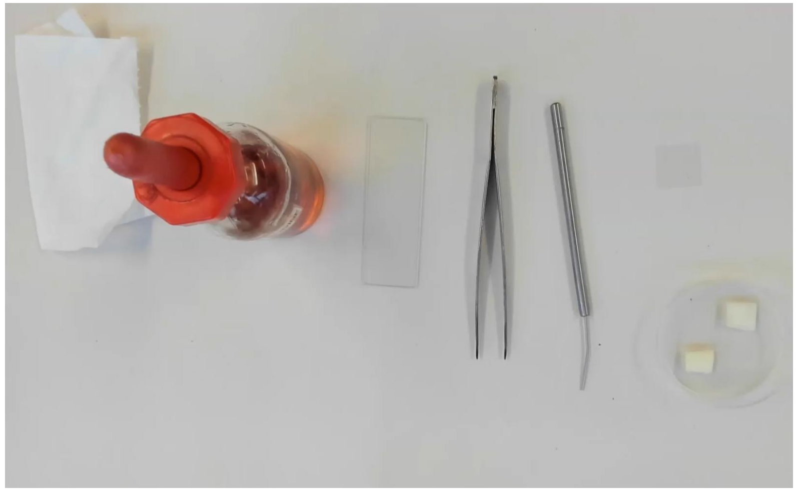
a microscope slide

a light microscope

Making a microscope slide

Explanation

Watch the video clip explaining the method for preparing a microscope **slide** with a specimen of onion **tissue**.



Watch ▶

Making a microscope slide

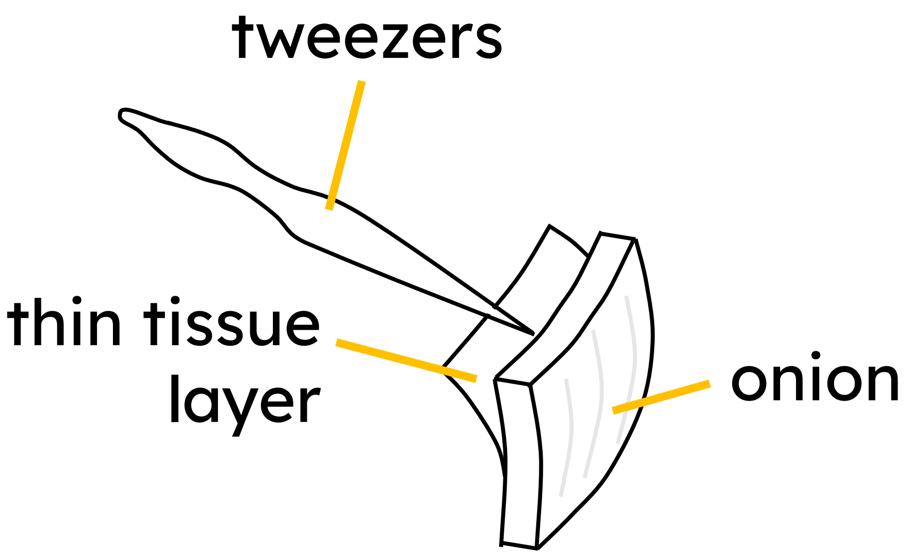
Explanation

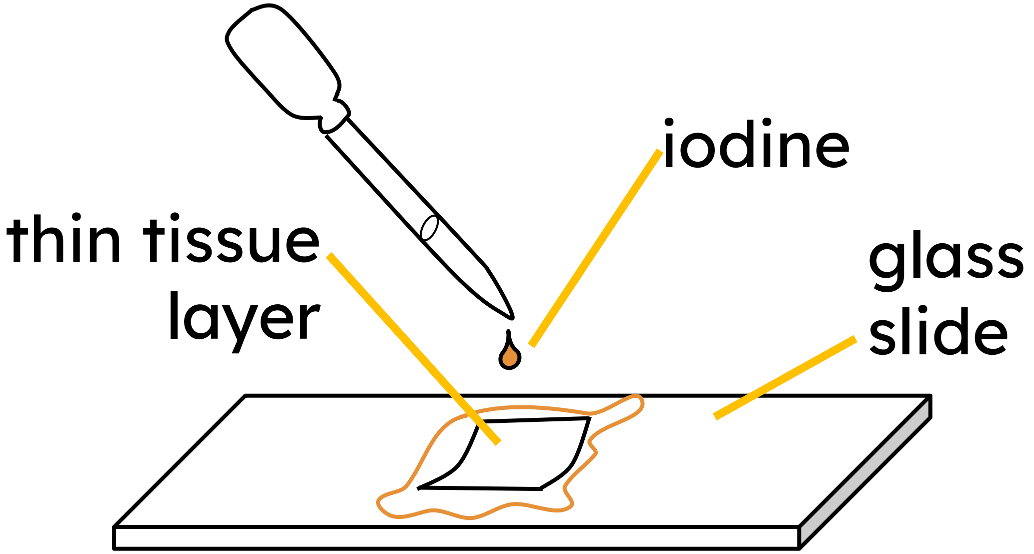
The method for preparing a **slide** of onion **tissue** is:

1. Take a thin sample of onion tissue (from between the layers) with tweezers.

2. Place the specimen on a slide.

3. Add a few drops of iodine stain (be careful not to **stain** your skin and clothes!).





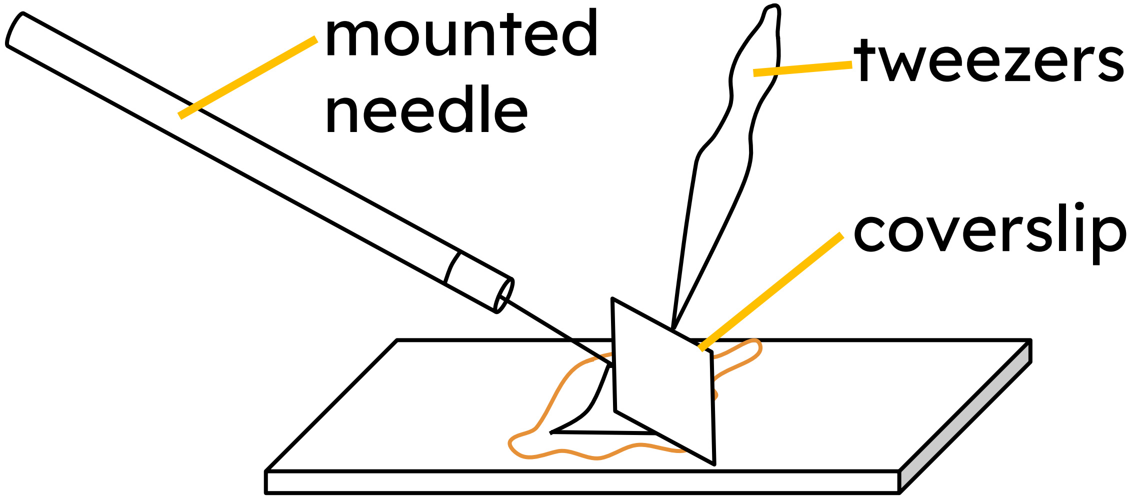
Making a microscope slide

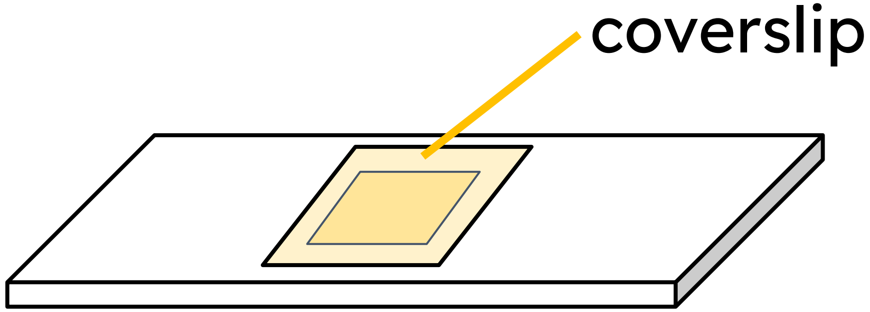
Explanation

4. Use tweezers to place a coverslip over the specimen of tissue, and gently lower it with a mounted needle.

5. Use a tissue to gently absorb excess stain.

6. Place the slide on the stage of the microscope.





Making a microscope slide

Check

Put the statements in the correct order to describe how to prepare a microscope slide with onion tissue.

a Lower the coverslip with a mounted needle. 4

b Add iodine stain. 3

c Take a thin piece of onion tissue with tweezers. 1

d Place the specimen of onion tissue on a slide. 2

Making a microscope slide

Explanation

We can also prepare a **slide** with some of our own animal cells to observe using a light microscope.

Watch the video clip, which explains the method for preparing a microscope slide with a specimen of cheek cells.

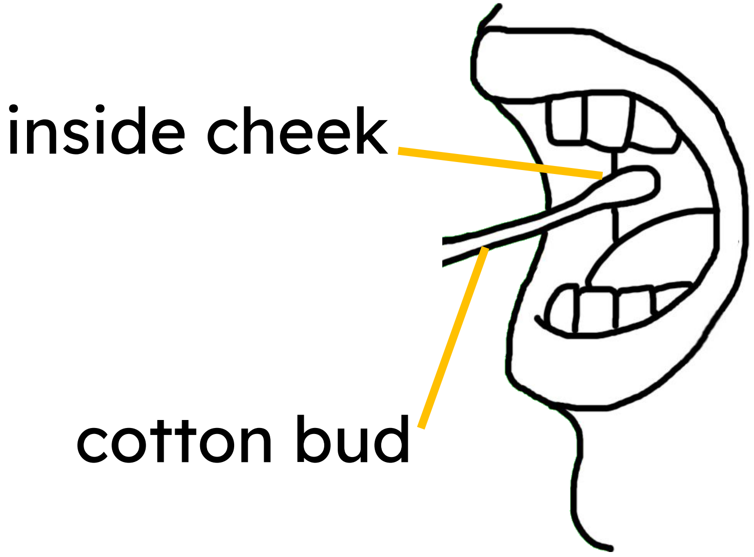
Watch

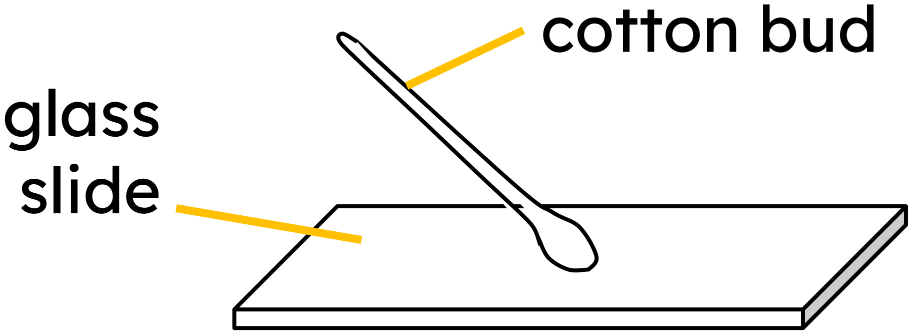
Making a microscope slide

Explanation

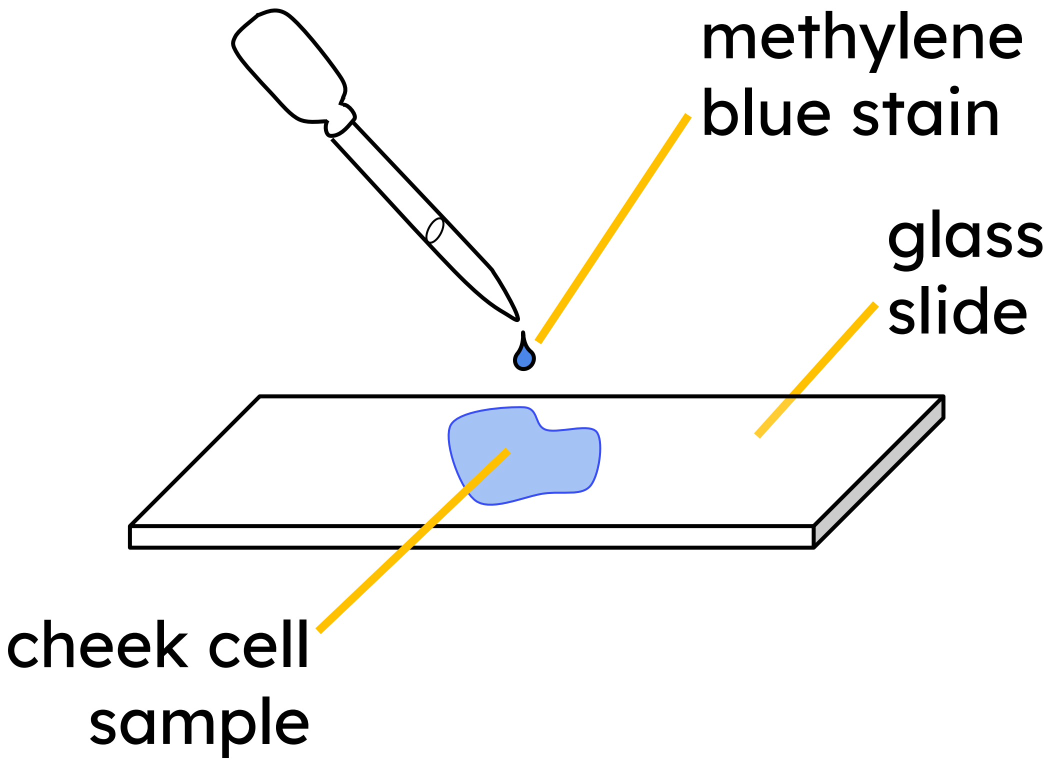
The method for preparing a **slide** of cheek cells is:

1. Take a cotton bud and rub over the inside surface of your cheek.
2. Rub this cotton bud in the centre of your slide, rolling back and forth.
3. Place the bud in a beaker of disinfectant.





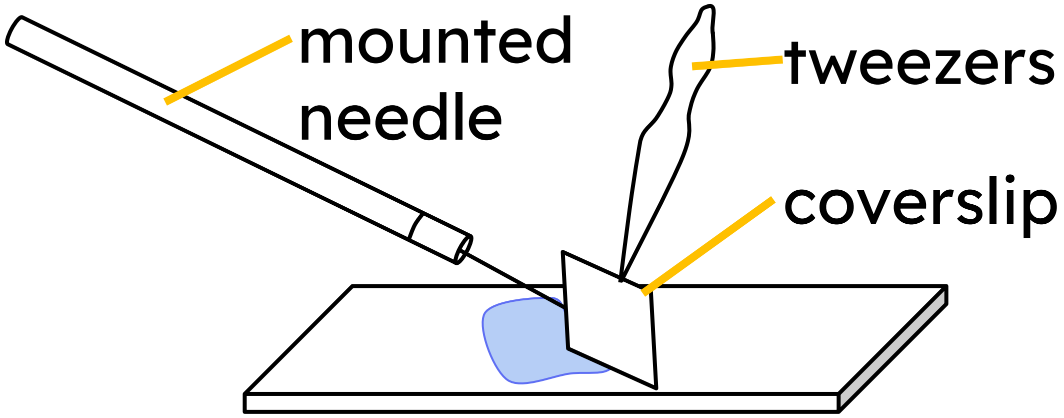
4. Add a few drops of methylene blue stain (be careful not to **stain** your skin and clothes!).



Making a microscope slide

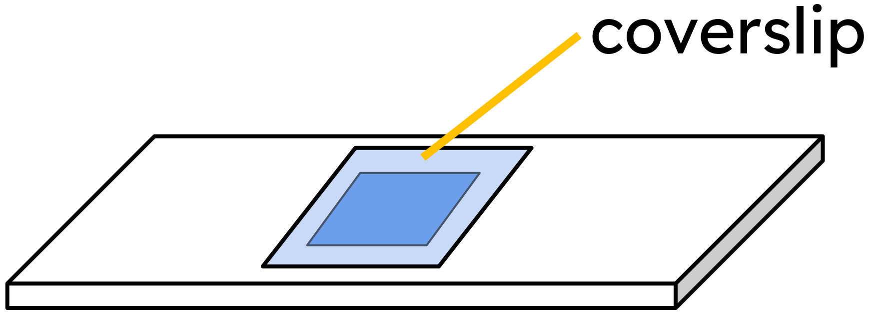
Explanation

5. Use tweezers to place a coverslip over the specimen of cells, and gently lower it with a mounted needle.



6. Use a tissue to gently absorb excess stain.

7. Place the slide on the stage of the microscope.



Making a microscope slide

Check

Put the statements in the correct order to describe how to prepare a microscope slide with cheek cells.

a	Lower the coverslip with a mounted needle.	4
b	Rub the cotton bud on the inside of your cheek.	1
c	Add methylene blue stain.	3
d	Rub the cotton bud on the slide to transfer cells.	2

Lesson outline

Preparing and observing a microscope slide

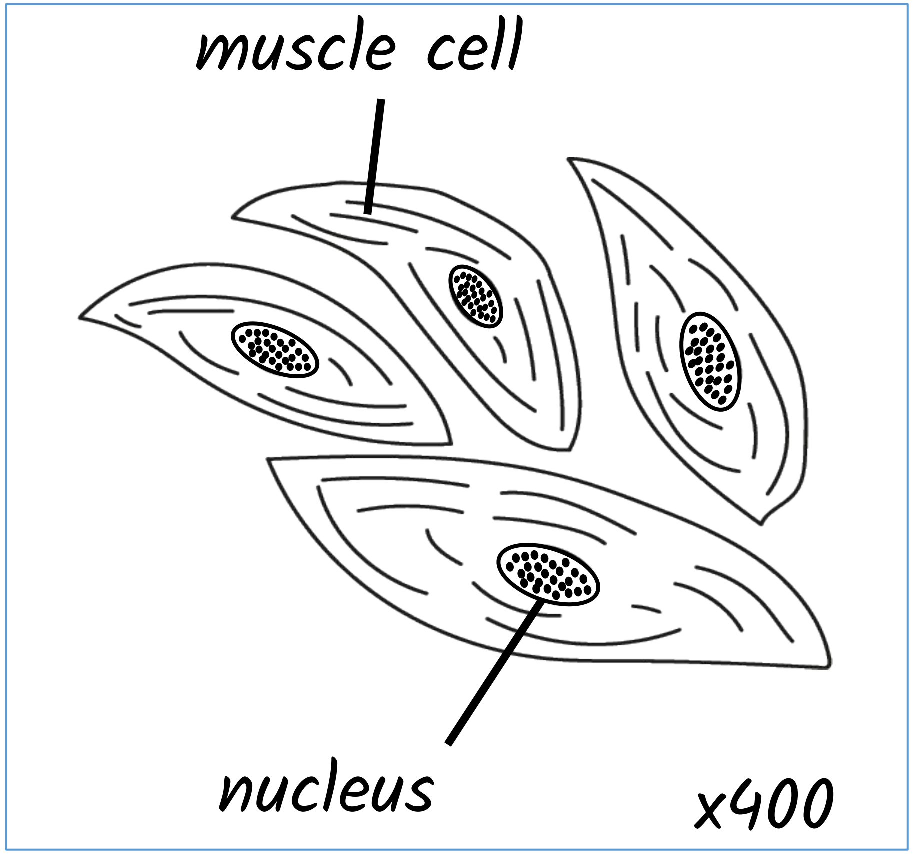
- Making a microscope slide
- Scientific line drawing

Scientific line drawing

Observations from a light microscope can be recorded by making a labelled **scientific line drawing**.

A scientific line drawing does not look exactly the same as the original image or object.

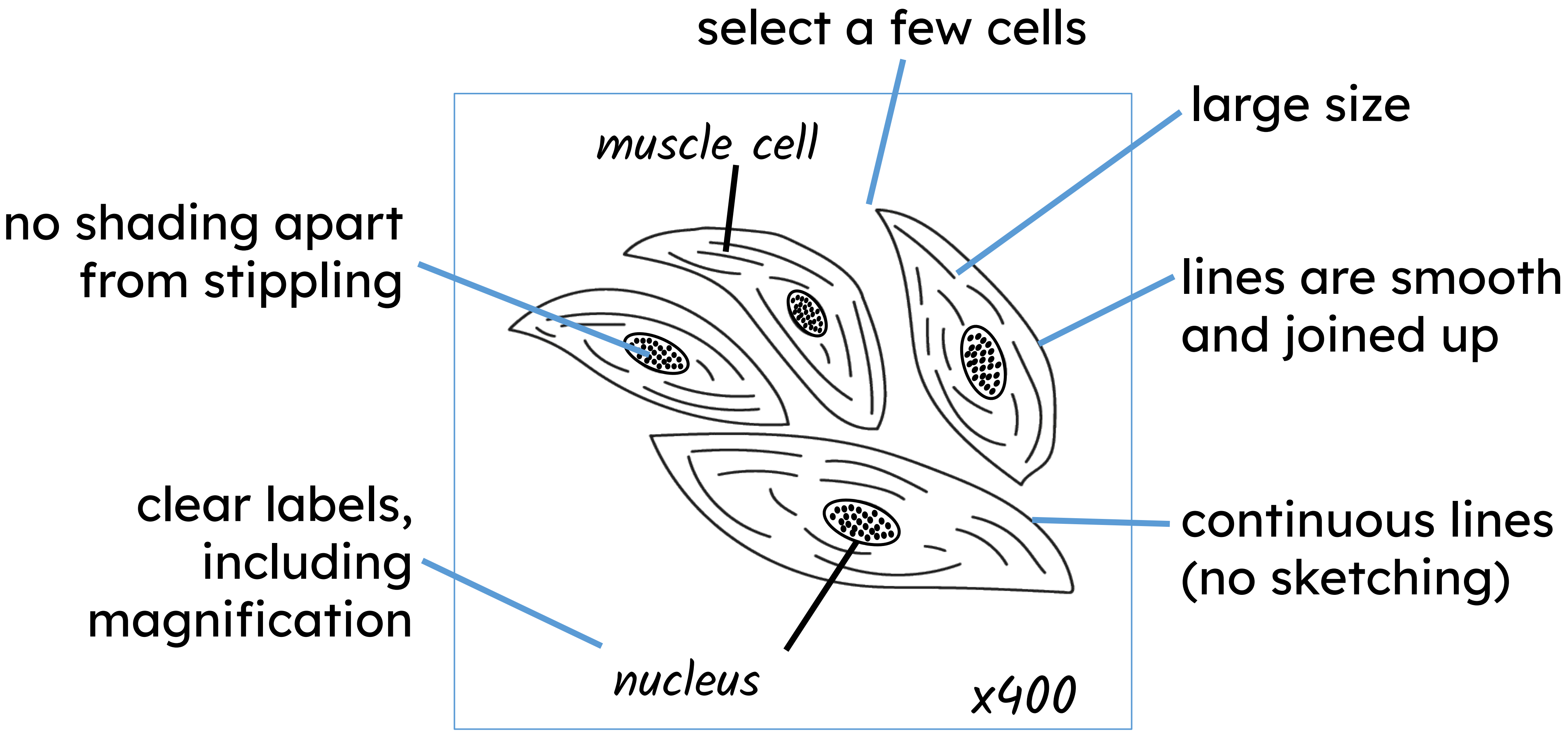
It is a clear and simple representation.



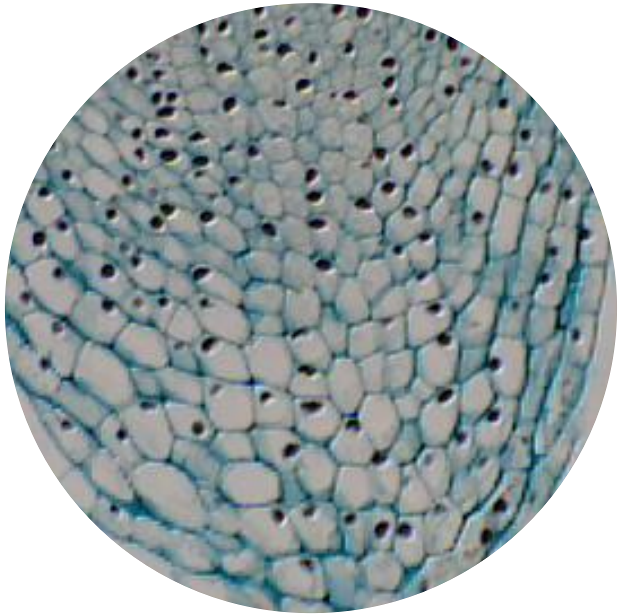
a scientific line drawing of muscle cells

Scientific line drawing

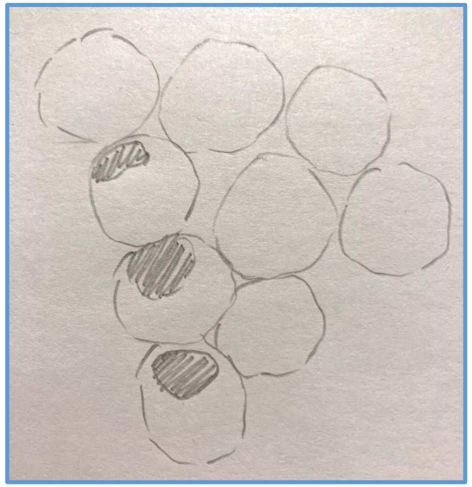
The rules for producing a **scientific line drawing** are:



Two examples of drawings from this microscope image:

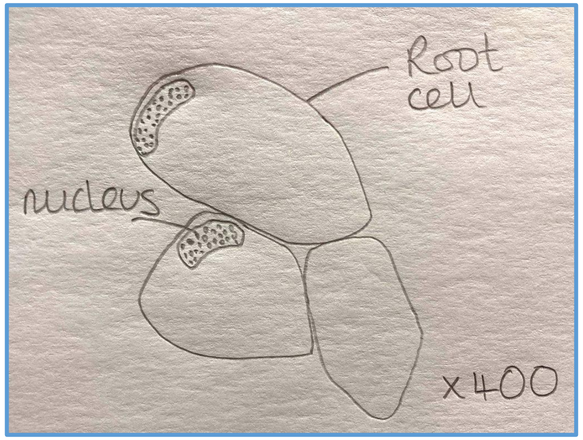


plant root tissue viewed through a microscope



Non-example:

- sketched lines
- shading
- too many cells
- not labelled
- no magnification



Example:

- smooth, continuous lines
- stippling
- few cells
- labelled
- magnification

Choose **two** things a scientific line drawing should have.

- **a** smooth, continuous lines ✓
- **b** sketching
- **c** labelling ✓
- **d** shading

Lesson outline

Light microscopy: observing and drawing cells

- Using a light microscope
- Observing and drawing cells
- Magnification and the size of cells

Magnification is a measurement of how many times an object has been enlarged. We can calculate magnification using the real size and the image size of a magnified image using the equation:

$$\text{magnification} = \frac{\text{size of image}}{\text{size of real object}}$$

Explanation

When carrying out calculations of size from microscope images of cells we sometimes need to convert units.

Unit	How many are there in a metre?
metre (m)	1
millimetre (mm)	1000
micrometre (μm)	1 000 000
nanometre (nm)	1 000 000 000

×1000

×1000

×1000

÷1000

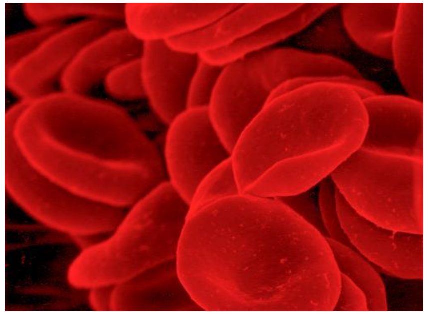
÷1000

÷1000

Magnification and the size of cells

Explanation Check

Calculate the magnification of a red blood cell with a diameter of 8 µm in an image measuring 5.6 mm.



5.6 mm = 5600 µm

magnification = image ÷ real

= 5600 ÷ 8

= 700x

Calculate the magnification of an *E. coli* cell with a length of 1.7 µm in an image measuring 10.2 mm.

10.2 mm = 10200 µm

magnification = image ÷ real

= 10200 ÷ 1.7

= 6000x

Edgloris Marys/Shutterstock.com

Magnification and the size of cells

Explanation Check

The image shows a pollen grain seen through a scanning electron microscope.

Use a ruler to measure the length of the scale bar and then calculate the magnification.

image size = 2.5 cm
= 25 mm
= 25 000 μm

real size = 10 μm

magnification = 25 000 ÷ 10
= 2 500x

bearacreative/Shutterstock.com

The image shows a micro fossil seen through a scanning electron microscope.

Use a ruler to measure the length of the scale bar and then calculate the magnification.

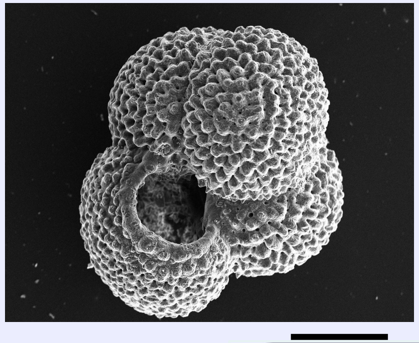


image size = 2.0 cm
= 20 mm
= 20 000 μm

real size = 100 μm

magnification = 20 000 ÷ 100
= 200x

Simona68/Shutterstock.com

Magnification and the size of cells

Explanation Check

1. Calculate the real size of a mitochondrion when the image size is 3.0 mm, and it is magnified 5000x.

real = image ÷ magnification

$= 3 \div 5000$

$= 0.0006 = 6 \times 10^{-4}$ mm

2. Convert your answer to micrometres.

$(6 \times 10^{-4}) \times 1000 = 0.6$ µm

1. Calculate the real size of a coronavirus when the image size is 0.84 mm, and it is magnified 7000x.

real = image ÷ magnification

$= 0.84 \div 7000$

$= 0.00012 = 1.2 \times 10^{-4}$ mm

2. Convert your answer to micrometres.

$(1.2 \times 10^{-4}) \times 1000 = 0.12$ µm

Task C Magnification and the size of cells

Practice

1) Calculate the magnification of a mitochondrion with a length of 0.8 μm in an image measuring 14 mm.

2) Calculate the magnification of a flea's leg with a length of 1.2 mm in an image measuring 15 cm.

3) Calculate the real size of a pollen grain given an image size of 30 mm and a magnification of 400x.

4) Calculate the real size of a bacterium with an image size of 0.25 mm and a magnification of 2000x.

5) Calculate the image size of a human hair strand with a real size of 20 μm and a magnification of 500x.

Task C Magnification and the size of cells

Feedback

1) Calculate the magnification of a mitochondrion with a length of 0.8 μm in an image measuring 14 mm.

$$14 \times 1000 = 14\ 000$$
$$14\ 000 \div 0.8 = 17\ 500\text{x}$$

2) Calculate the magnification of a flea’s leg with a length of 1.2 mm in an image measuring 15 cm.

$$15 \times 10 = 150$$
$$150 \div 1.2 = 125\text{x}$$

3) Calculate the real size of a pollen grain given an image size of 30 mm and a magnification of 400x.

$$30 \div 400 = 0.075 \text{ mm}$$

4) Calculate the real size of a bacterium with an image size of 0.25 mm and a magnification of 2000x.

$$0.25 \div 2000 = 0.000125 \text{ mm}$$
$$= 1.25 \times 10^{-4} \text{ mm}$$
$$= 0.125 \text{ μm}$$

5) Calculate the image size of a human hair strand with a real size of 20 μm and a magnification of 500x.

$$20 \times 500 = 10\ 000 \text{ μm} = 10 \text{ mm}$$

The size and scale of cells: including standard form

Lesson outline

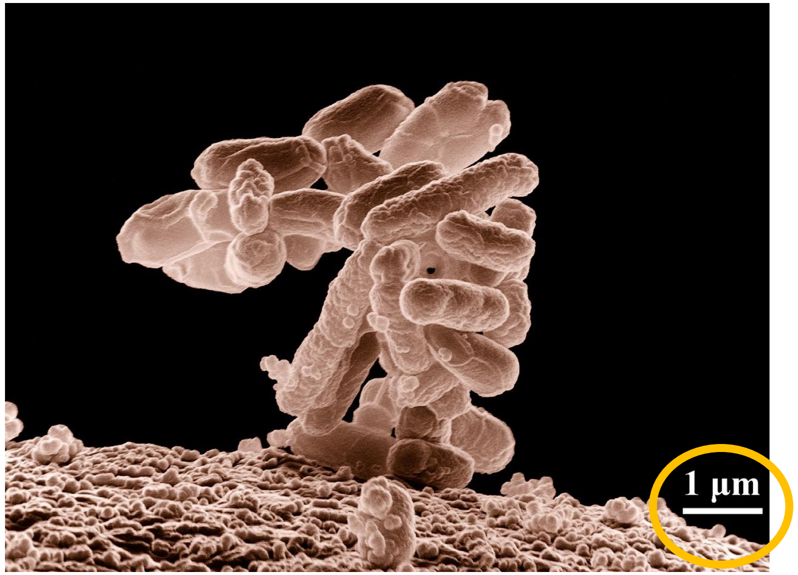
The size and scale of cells: including standard form

- Units of microscopy
- Comparing sizes
- Microscopy calculations

Units of microscopy

Most cells are too small to see with the unaided eye.

To observe cells in detail, a microscope is necessary. We use micrometres (μm) and nanometres (nm) when measuring cells and subcellular structures.



E coli measured in micrometres (μm)

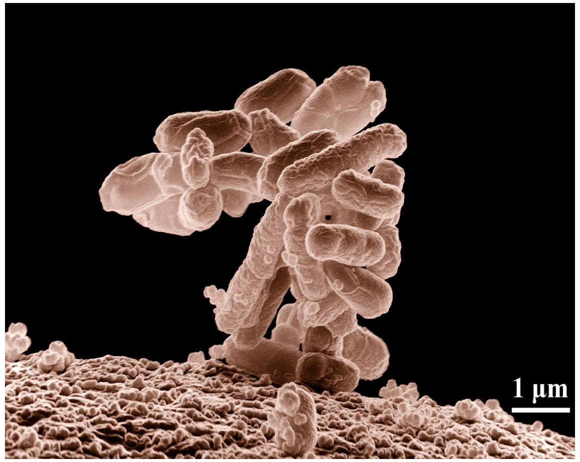
Why might it be better to use nanometres rather than micrometres to measure sub-cellular structures, such as ribosomes?

Units of microscopy

When working with very small or very big numbers, we use standard form.

Standard form numbers are written as $A \times 10^n$, where A is a number greater than one but less than 10, and ^{n} is the power of 10.

One of the bacteria in this image is 2.6 µm in length.



Escherichia coli

2.6 µm is 0.0026 mm

2.6 µm is 2600 nm

We can write these using standard form:

$0.0026 = 2.6 \times 10^{-3}$ mm

$2600 = 2.6 \times 10^{3}$ nm

Units of microscopy

Explanation

Units used in microscopy:

	relationship to other units	how many are there in a metre?	division of a metre in standard form
metre (m)	1/1000 kilometre	1	1×10^{0}
millimetre (mm)	1/1000 metre	1000	1×10^{-3}
micrometre (μm)	1/1000 millimetre	1 000 000	1×10^{-6}
nanometre (nm)	1/1000 micrometre	1 000 000 000	1×10^{-9}

What is the correct symbol for a micrometre?

a m

b mm

c nm

d µm ✓

Units of microscopy

Check

Starting with the largest, sort the units of measurement into decreasing size order.

a micrometre	b metre
b metre	c millimetre
c millimetre	a micrometre
d nanometre	d nanometre

Which of the following are correct?

a $1000 = 1 \times 10^{3}$ ✓

b $0.066 = 6.6 \times 10^{-2}$ ✓

c $476000 = 4.76 \times 10^{-5}$

d $0.000054 = 5.4 \times 10^{-5}$ ✓

Explanation

Converting between units:

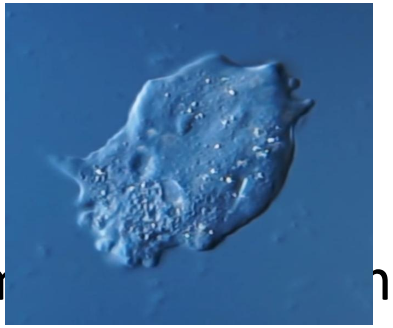
unit	division of a metre in standard form
metre (m)	1
millimetre (mm)	1×10^{-3}
micrometre (µm)	1×10^{-6}
nanometre (nm)	1×10^{-9}

×1000 ×1000 ×1000

÷1000 ÷1000 ÷1000

Units of microscopy

An amoeba has a diameter of 90 µm.



What is its diam etres?

$90 \times 1000 = 90\,000$ nm

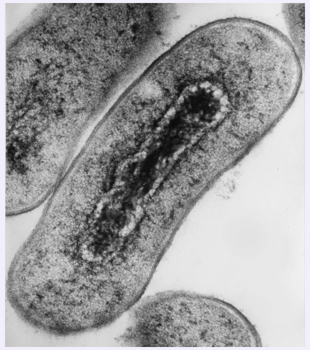
What is its diameter in millimetres?

$= 9.0 \times 10^4$ nm

$90 \div 1000 = 0.09$ mm

$= 9.0 \times 10^{-2}$ mm

An *E.coli* bacterium has a diameter of 2.2 µm.



What is its diameter in nanometres?

$2.2 \times 1000 = 2200$ nm

$= 2.2 \times 10^3$ nm

What is its diameter in millimetres?

$2.2 \div 1000 = 0.0022$ mm

$= 2.2 \times 10^{-3}$ mm

Task A Units of microscopy

Practice

1) Convert the following to complete the table using standard form.

metre (m)	millimetre (mm)	micrometre (µm)	nanometre (nm)
2.8×10^{-1}			
	6.4×10^{0}		
		1.5×10^{1}	

2) A human egg cell has a diameter of 118 µm. What is its diameter in nanometres? What is its diameter in millimetres? Give your answers in standard form.

3) An adult fruit fly has a length of 3 mm. What is its length in nanometres? What is its length in micrometres? Give your answers in standard form.

Task A Units of microscopy

Feedback

1) Convert the following to complete the table using standard form.

metre (m)	millimetre (mm)	micrometre (µm)	nanometre (nm)
2.8×10^{-1}	2.8×10^{2}	2.8×10^{5}	2.8×10^{8}
6.4×10^{-3}	6.4×10^{0}	6.4×10^{3}	6.4×10^{6}
1.5×10^{-5}	1.5×10^{-2}	1.5×10^{1}	1.5×10^{4}

2) A human egg cell has a diameter of 118 μm. What is its diameter in nanometres? What is its diameter in millimetres? Give your answers in standard form.

$$118\ \mu m = 118\ 000\ nm = 1.18 \times 10^{5}\ nm = 1.18 \times 10^{-1}\ mm$$

3) An adult fruit fly has a length of 3 mm. What is its length in nanometres? What is its length in micrometres? Give your answers in standard form.

$$3\ mm = 3\ 000\ 000\ nm = 3 \times 10^{6}\ nm = 3 \times 10^{3}\ \mu m$$

Lesson outline

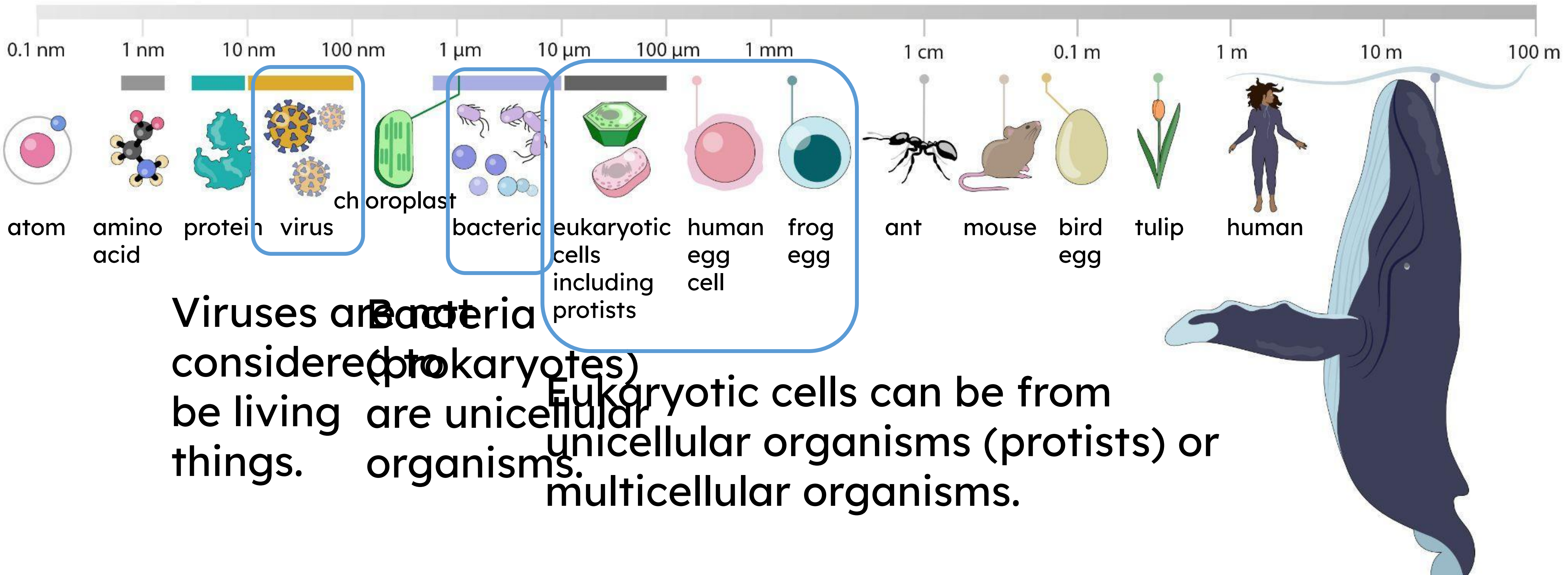
The size and scale of cells: including standard form

- Units of microscopy
- Comparing sizes
- Microscopy calculations

Comparing sizes

Explanation

Most plants and animals are multicellular and are made up of millions or billions of cells. Those that are unicellular (consist of one cell) are microscopic.



Viruses are not considered to be living things.

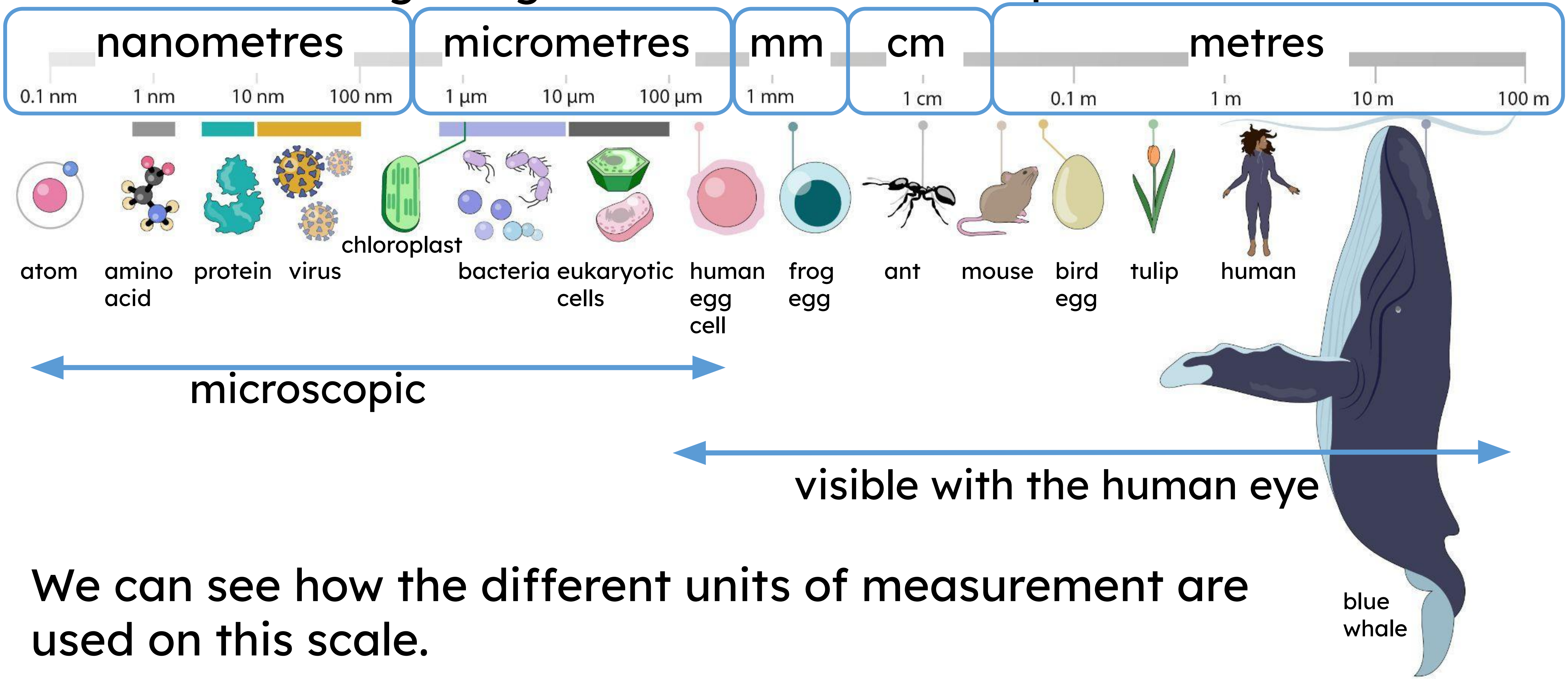
Bacteria (prokaryotes) are unicellular organisms.

Eukaryotic cells can be from unicellular organisms (protists) or multicellular organisms.

Comparing sizes

Explanation

The sizes of living things on Earth can be compared.



We can see how the different units of measurement are used on this scale.

How many cells make up a unicellular organism?

- **a** one ✓
- **b** thousands
- **c** millions
- **d** billions

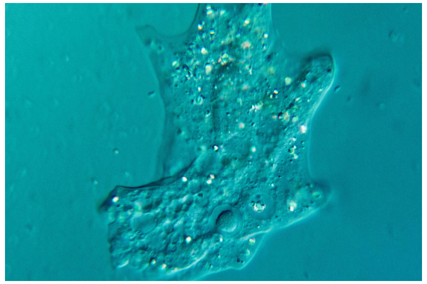
Comparing sizes

Comparing sizes:

ant

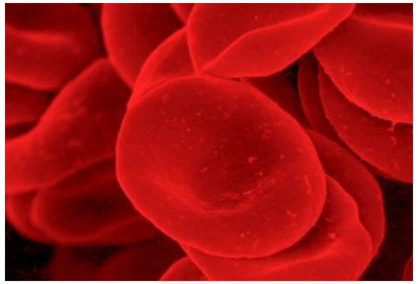
length
(9 mm)

amoeba



length
(90 µm)

red blood cell

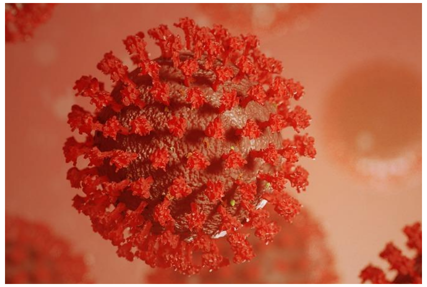


diameter
(9 µm)

bacterium

length
(1 µm)

virus



diameter
(100 nm)

The length of an amoeba is 10 times the diameter of a red blood cell:

$$90\ \mu m \div 9\ \mu m = 10$$

When comparing size, it is important to work in the same units.

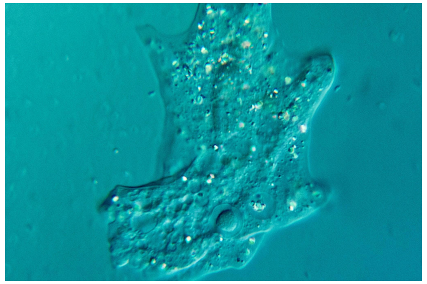
Comparing sizes

What is the length of the ant compared to the length of the amoeba?

ant

length (9 mm)

amoeba



length (90 μm)

convert 9 mm into μm:

$9 \times 1000 = 9000$ μm

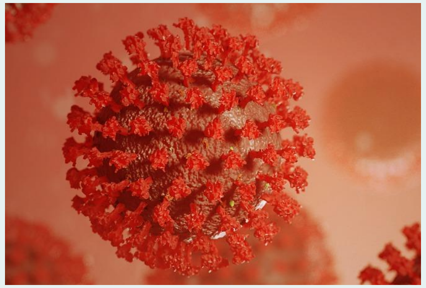
$9000 \div 90 = 100$ (the ant is 100 times longer than the amoeba)

What is the length of the bacterium compared to the diameter of the virus?

bacterium

length (1 μm)

virus



diameter (100 nm)

convert 1 μm into nm:

$1 \times 1000 = 1000$ nm

$1000 \div 100 = 10$ (the bacterium is 10 times longer than the diameter of the virus)

Task B Comparing sizes

Practice

1) An *E.coli* cell has a diameter of 1.5 μm, a human egg cell has a diameter of 120 μm. What is the diameter of the human egg cell compared to the diameter of the *E. coli* cell?

2) A palisade cell has a diameter of 70 μm, a *M. tuberculosis* (TB) cell has a diameter of 0.35 μm. How many times bigger is the palisade cell than the TB cell?

3) If a large amoeba has a diameter of 475 μm and a human red blood cell has a diameter of 9 μm, how many times smaller is the red blood cell than the amoeba?

Task B Comparing sizes

Feedback

1) An *E.coli* cell has a diameter of 1.5 µm, a human egg cell has a diameter of 120 µm. What is the diameter of the human egg cell compared to the diameter of the *E. coli* cell?

$120 \div 1.5 = 80x$ larger

2) A palisade cell has a diameter of 70 µm, a *M. tuberculosis* (TB) cell has a diameter of 0.35 µm. How many times bigger is the palisade cell than the TB cell?

$70 \div 0.35 = 200x$

3) If a large amoeba has a diameter of 475 µm and a human red blood cell has a diameter of 9 µm, how many times smaller is the red blood cell than the amoeba?

$475 \div 9 = 52.78x$ larger (to 2 d.p.)

Lesson outline

The size and scale of cells: including standard form

- Units of microscopy
- Comparing sizes
- Microscopy calculations

We can rearrange the **magnification** equation to calculate the size of an image or the size of a real object:

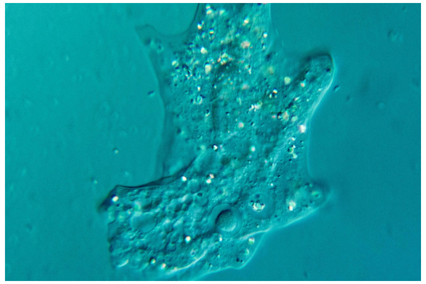
- size of image = magnification × size of real object

- $$\text{size of real object} = \frac{\text{size of image}}{\text{size of magnification}}$$

Microscopy calculations

Explanation Check

Calculate the magnification of an amoeba with a diameter of 90 µm in an image measuring 18 mm.



18 mm = 18 000 µm

magnification = image ÷ real

= 18 000 ÷ 90

= 200x

Calculate the magnification of an *E. coli* cell with a length of 1.7 µm in an image measuring 10.2 mm.

10.2 mm = 10 200 µm

magnification = image ÷ real

= 10 200 ÷ 1.7

= 6000x

Microscopy calculations

Explanation Check

Calculate the real size of a mitochondrion when the image size is 0.3 cm and it is magnified 5000x. Give your answer in mm using standard form.

convert: 0.3 cm = 3 mm

real = image ÷ magnification

$= 3 \div 5000$

$= 0.0006 = 6 \times 10^{-4}$ mm

Convert your answer to micrometres.

$(6 \times 10^{-4}) \times 1000 = 0.6\ \mu m$

Calculate the real size of a coronavirus when the image size is 8.4×10^{-2} cm and it is magnified 7000x. Give your answer in mm using standard form.

convert: 8.4×10^{-2} cm $= 0.84$ mm

real = image ÷ magnification

$= 0.84 \div 7000$

$= 0.00012 = 1.2 \times 10^{-4}$ mm

Convert your answer to micrometres.

$(1.2 \times 10^{-4}) \times 1000 = 0.12\ \mu m$

Task C Microscopy calculations

Practice

1) Calculate the magnification of a mitochondrion with a length of 0.7 µm in an image measuring 14 mm.

2) Calculate the magnification of an insect's wing with a length of 1.4 mm in an image measuring 17.5 cm.

3) An insect's leg is 0.5 mm long. A micrograph of the insect shows the leg to be 2 cm long. What is the magnification?

4) Complete the table. Give your answers for the size of the images in standard form.

size of real object	size of image (µm)	size of image (mm)	magnification
500 µm			850x
200 nm	5×10^3		
0.75 mm			50x
5×10^{-4} m	1×10^4		

Task C Microscopy calculations

Practice

5) Calculate the real size of an insect with an image size of 6.75×10^{-2} m, magnified 50x. Give your answer in metres (m) using standard form.

6) The length of a plant cell is 250 times that of a ribosome. The length of a ribosome is 20 nm. What is the length of the plant cell? Give your answer in nanometres, using standard form.

7) The plant cell is magnified 15 000x. Give the image size in mm.

Task C Microscopy calculations

Feedback

1) Calculate the magnification of a mitochondrion with a length of 0.7 μm in an image measuring 14 mm.

$14 \times 1000 = 14\ 000$

$14\ 000 \div 0.7 = 20\ 000x$

2) Calculate the magnification of an insect's wing with a length of 1.4 mm in an image measuring 17.5 cm.

$17.5 \times 10 = 175$

$175 \div 1.4 = 125x$

3) An insect's leg is 0.5 mm long. A micrograph of the insect shows the leg to be 2 cm long. What is the magnification?

$2 \times 10 = 20$

$20 \div 0.5 = 40x$

Task C Microscopy calculations

Feedback

4) Complete the table. Give your answers for the size of the images in standard form.

size of real object	size of image (μm)	size of image (mm)	magnification
500 μm	4.25×10^5	4.25×10^2	850x
200 nm	5×10^3	5×10^0	25 000x
0.75 mm	3.75×10^4	3.75×10^1	50x
5×10^{-4} m	1×10^4	1×10^1	20x

Task C Microscopy calculations

Feedback

5) Calculate the real size of an insect with an image size of 6.75×10^{-2} m, magnified 50x. Give your answer in metres (m) using standard form.

$$6.75 \times 10^{-2} = 0.0675 \text{ m}$$

$$0.0675 \div 50 = 1.35 \times 10^{-3} \text{ m}$$

6) The length of a plant cell is 250 times that of a ribosome. The length of a ribosome is 20 nm. What is the length of the plant cell? Give your answer in nanometres, using standard form.

$$250 \times 20 = 5000 \text{ nm} = 5 \times 10^{3} \text{ nm}$$

7) The plant cell is magnified 15 000x. Give the image size in mm.

$$5000 \div 1\,000\,000 = 0.005 \text{ mm}$$

$$0.005 \times 15\,000 = 75 \text{ mm}$$

END