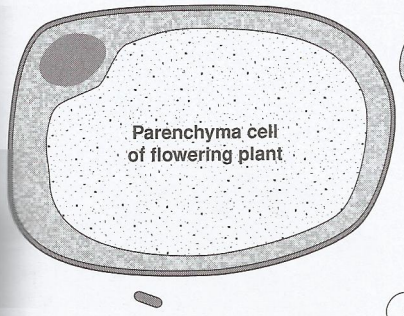
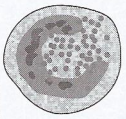
Cell Sizes

Cells are extremely small and can only be seen properly when viewed through the magnifying lenses of a microscope. The diagrams below show a variety of cell types, together with a virus and a microscopic animal for comparison. For each of these images, note the scale and relate this to the type of microscopy used.

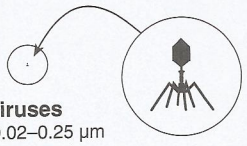




Human white blood cell

Eukaryotic cells
(e.g. plant and animal cells)
Size: 10–100 µm diameter. Cellular organelles may be up to 10 µm.

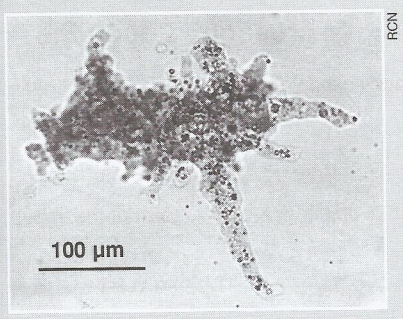
Prokaryotic cells
Size: Typically 2–10 µm length, 0.2–2 µm diameter. Upper limit, 30 µm long.



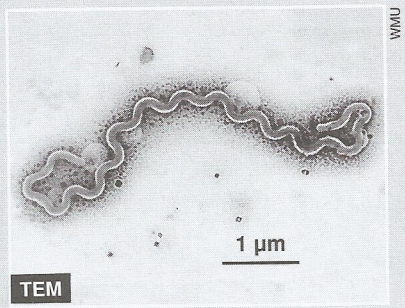
Viruses
Size: 0.02–0.25 µm (20–250 nm)

Unit of length (International System)		
Unit	**Metres**	**Equivalent**
1 metre (m)	1 m	= 1000 millimetres
1 millimetre (mm)	10^{-3} m	= 1000 micrometres
1 micrometre (µm)	10^{-6} m	= 1000 nanometres
1 nanometre (nm)	10^{-9} m	= 1000 picometres

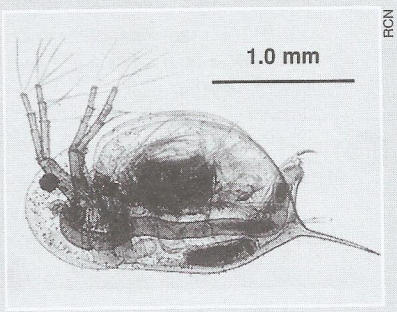
Micrometres are sometime referred to as microns. Smaller structures are usually measured in nanometres (nm) e.g. molecules (1 nm) and plasma membrane thickness (10 nm).



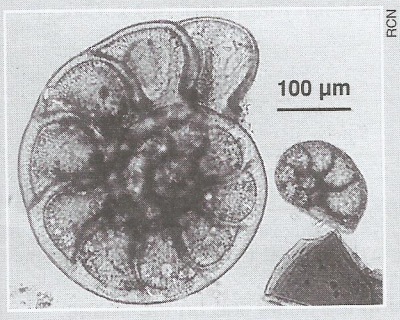
An ***Amoeba*** showing extensions of the cytoplasm called pseudopodia. This protoctist changes its shape, exploring its environment.



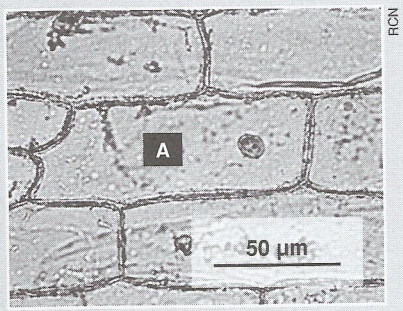
A long thin cell of the spirochete bacterium ***Leptospira pomona***, which causes the disease leptospirosis.



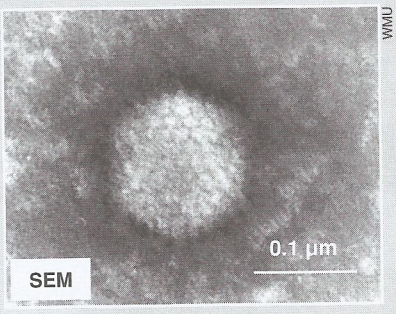
Daphnia showing its internal organs. These freshwater microcrustaceans are part of the zooplankton found in lakes and ponds.



A **foraminiferan** showing its chambered, calcified shell. These single-celled protozoans are marine planktonic amoebae.



Epidermal cells (skin) from an onion bulb showing the nucleus, cell walls and cytoplasm. Organelles are not visible at this resolution.



Papillomavirus (human wart virus) showing its polyhedral protein coat (20 triangular faces, 12 corners) made of ball-shaped structures.

Cell Structure

1. Using the measurement scales provided on each of the photographs above, determine the longest dimension (length or diameter) of the cell/animal/virus in µm and mm (choose the cell marked **A** for epidermal cells):

   (a) *Amoeba*: _____ µm _____ mm (d) Epidermis: _____ µm _____ mm

   (b) Foraminiferan: _____ µm _____ mm (e) *Daphnia*: _____ µm _____ mm

   (c) *Leptospira*: _____ µm _____ mm (f) *Papillomavirus*: _____ µm _____ mm

2. List these six organisms in order of size, from the smallest to the largest: _____

   _____

3. Study the scale of your ruler and state which of these six organisms you would be able to see with your unaided eye:

   _____

4. Calculate the equivalent length in millimetres (mm) of the following measurements:

   (a) 0.25 µm: _____ (b) 450 µm: _____ (c) 200 nm: _____

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Calculating Linear Magnification

Microscopes produce an enlarged (magnified) image of an object allowing it to be observed in greater detail than is possible with the naked eye. **Magnification** refers to the number of times larger an object appears compared to its actual size. The degree of magnification possible depends upon the type of microscopy used. **Linear magnification** is calculated by taking a ratio of the image height to the object's actual height. If this ratio is greater than one, the image is enlarged, if it is less than one, it is reduced. To calculate magnification, all measurements should be converted to the same units. Most often, you will be asked to calculate an object's actual size, in which case you will be told the size of the object and given the magnification.

Calculating Linear Magnification: A Worked Example

1. Measure the body length of the bed bug image (right). Your measurement should be 40 mm (*not* including the body hairs and antennae).

2. Measure the length of the scale line marked 1.0 mm. You will find it is 10 mm long. The magnification of the scale line can be calculated using equation 1 (below right).

   The magnification of the scale line is **10** (10 mm / 1 mm)

   **NB: The magnification of the bed bug image will also be 10x because the scale line and image are magnified to the same degree.*

3. Calculate the actual (real) size of the bed bug using equation 2 (right):

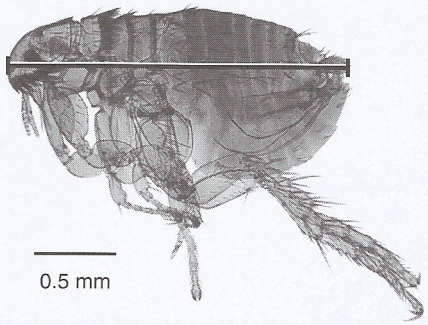
   The actual size of the bed bug is **4 mm**
   (40 mm / 10 x magnification)

Microscopy Equations

1. Magnification = $\frac{\text{size of the image}}{\text{actual size of object}}$

2. Actual object size = $\frac{\text{size of the image}}{\text{magnification}}$

1. The bright field microscopy image on the left is of onion epidermal cells. The measured length of the onion cell in the centre of the photograph is 52 000 µm (52 mm). The image has been magnified 140 x. Calculate the actual size of the cell:



2. The image of the flea (left) has been captured using light microscopy.

   (a) Calculate the magnification using the scale line on the image:

   (b) The body length of the flea is indicated by a line. Measure along the line and calculate the actual length of the flea:

3. The image size of the *E.coli* cell (left) is 43 mm, and its actual size is 2 µm. Using this information, calculate the magnification of the image:

Related activities: Cell Sizes

Periodicals:
Size does matter

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