CELLS AND SIZES

Cell Size

- Cells are made up of microscopic subunits
- Various types of microscopes are used to view the images
- Stains may also be used to improve viewing

Cell Size

- Cell size order
  - Organelles
  - Bacteria
  - Viruses
  - Membranes
  - Molecules

Cell Size

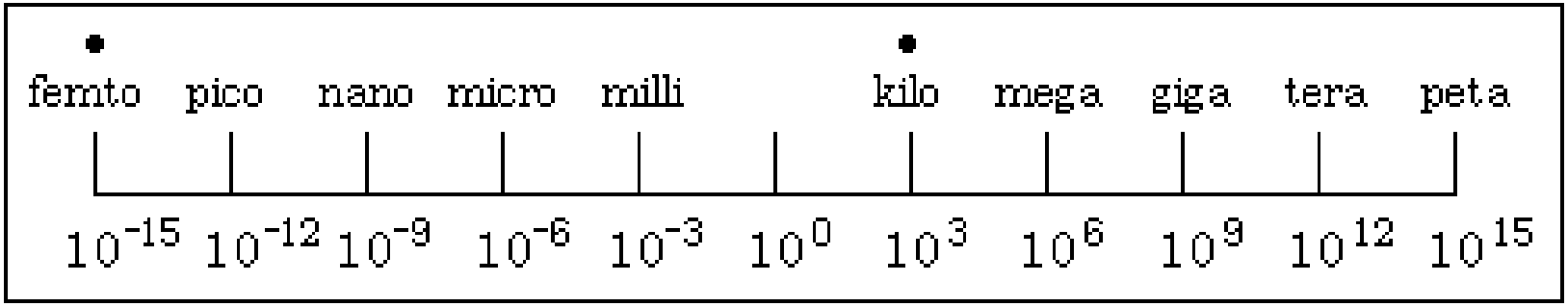
- Actual sizes can be determined with a microscope and a micrometer
- The size of the specimen are calculated in the field of view
- Important conversions for these calculations

1 millimetre (1 mm) = 1000 micrometre (1000 um)

1 micrometre (1 um) = 1000 nanometres (1000 nm)

Scales of measurement

- Nanometre (nm): 1 billionth of a meter
- Micrometer (um): 1 millionth of a meter
- Millimetre (mm): 1 thousandth of a meter
- Centimetre (cm): 1 hundredth of a meter



Biological Size and Cell Diversity

Human Eye: 1mm - meter+

LM: 1μm – 1mm

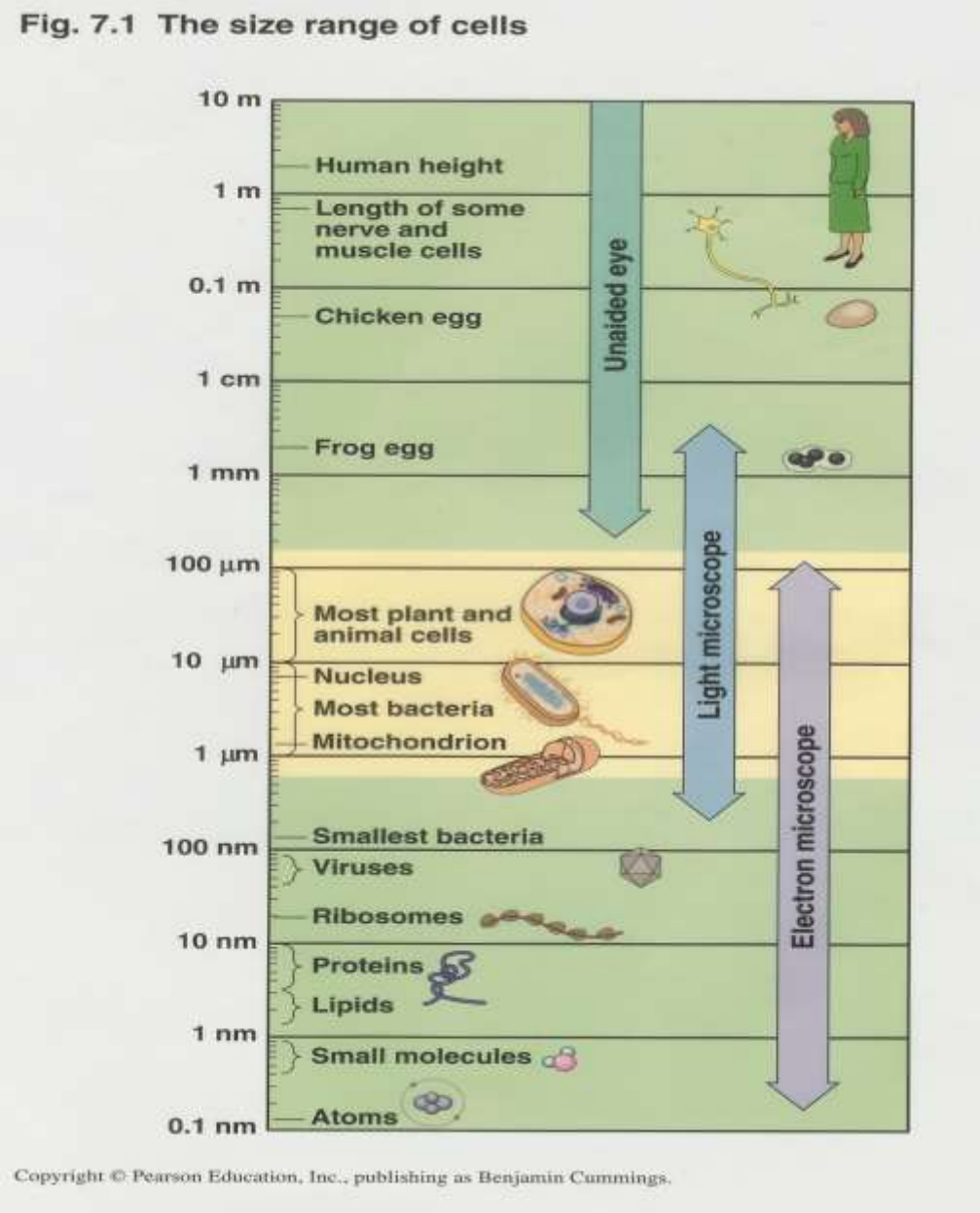
EM: 1nm – 1mm

Chicken Egg (lgst cell)

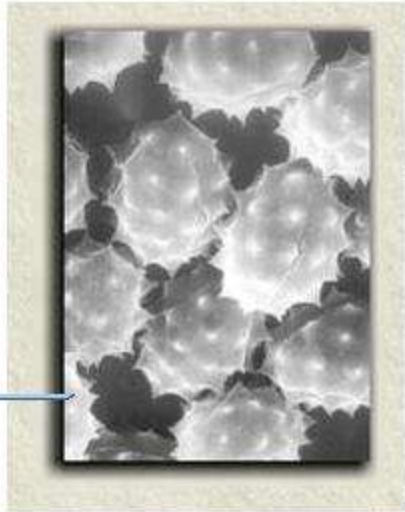
Mitochondria (1μm)

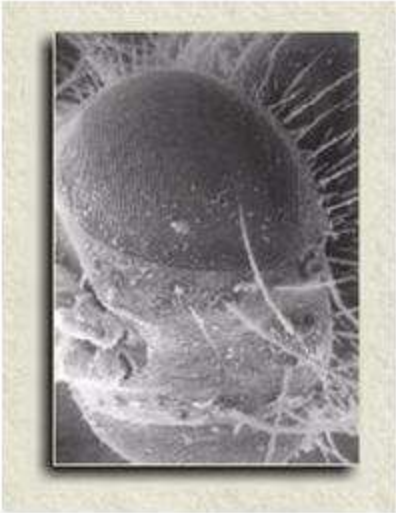
Ribosomes (20-30 nm)

Viruses (80-100 nm)



Cells are studied by a combination of methods





Microscopes provide windows to the world of the cell

- The light microscope enables us to see the overall shape and structure of a cell

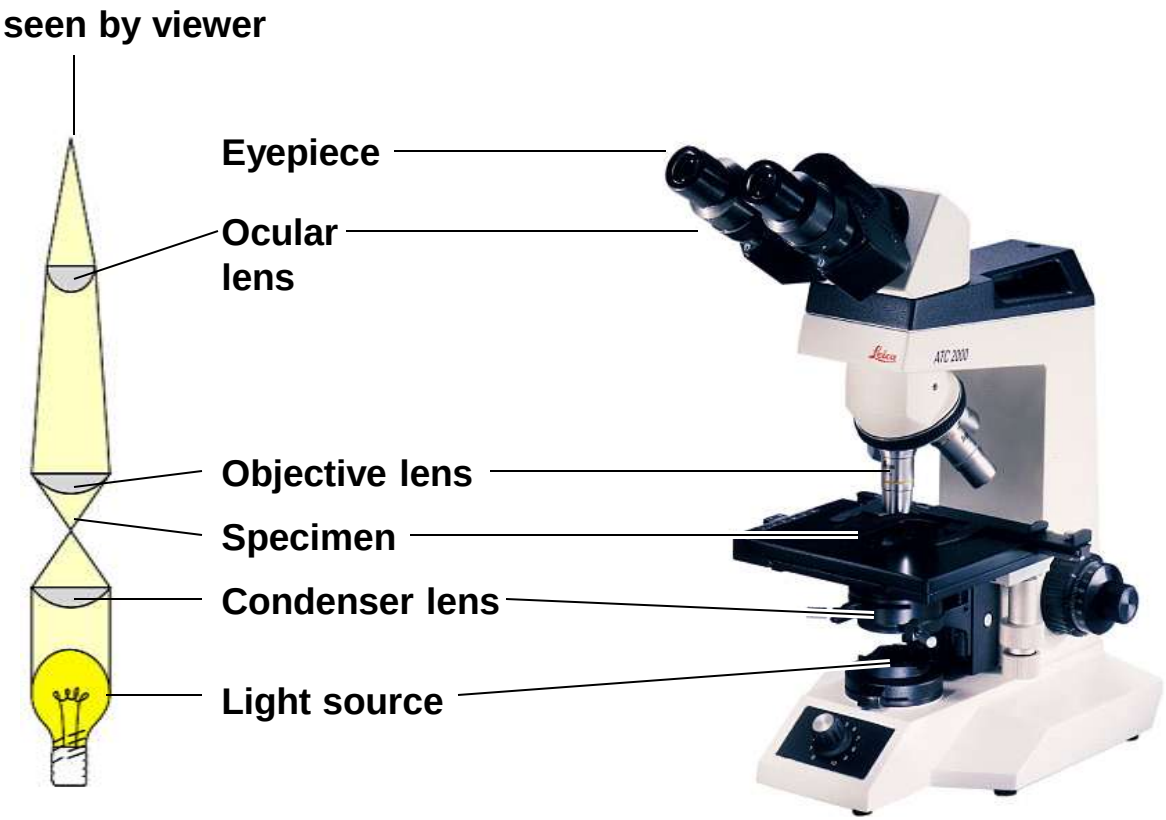
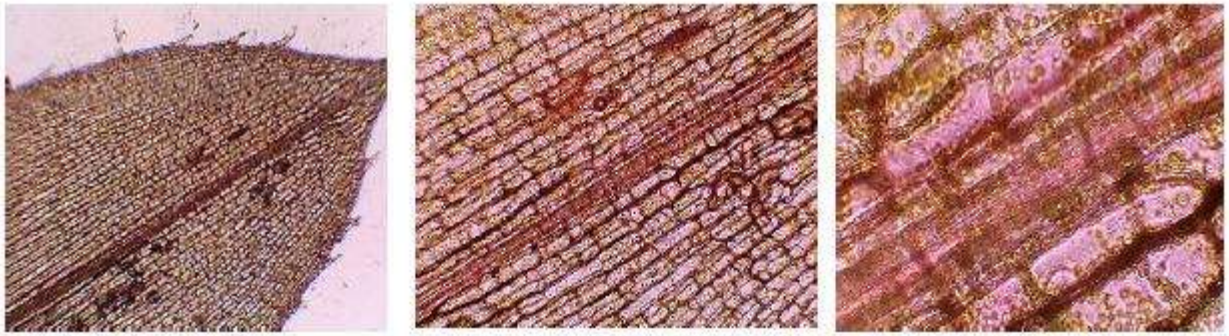


Figure 4.1A

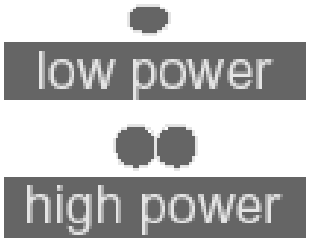
Microscopes are instruments that can magnify and resolve objects

- Magnification
  - How much larger the object appears compared to its real size.



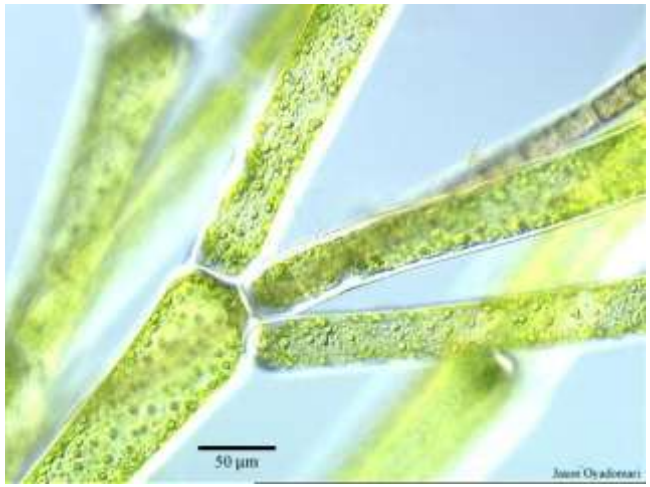
Microscopes are instruments that can magnify and resolve objects

- Resolution
  - The ability to form separate images of objects that are very close together.
  - Resolving power is stated as the minimum distance two points can be separated and still be distinguished as two separate points.
  - The smaller the resolving power, the better the resolution



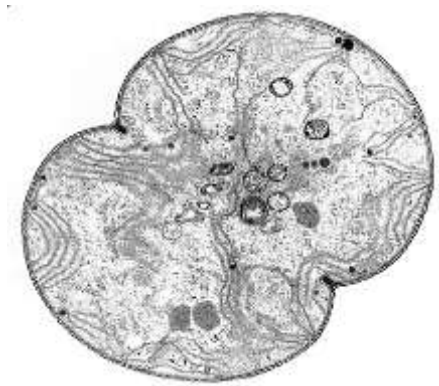
Light microscopes(use lenses and light)

- Inexpensive and easy to use
  - Used to study stained or living cells in colour
  - Objects can be magnified up to 2000X
  - *Ours at school only magnify 400X*
  - Can resolve objects 200 nm apart (500 times better than the human eye)



Electron microscopes (use electron beams)

- Can magnify up to 250,000 times. This is 125 times the magnifying power of light microscopes.
  - Can resolve objects that are 0.2 nm apart. This is 1000 times the resolving power of light microscopes.
  - Requires cells to be killed and chemically treated before viewing.
  - No colour can be seen



- Scanning electron microscope (SEM)

- Scanning electron micrograph of cilia

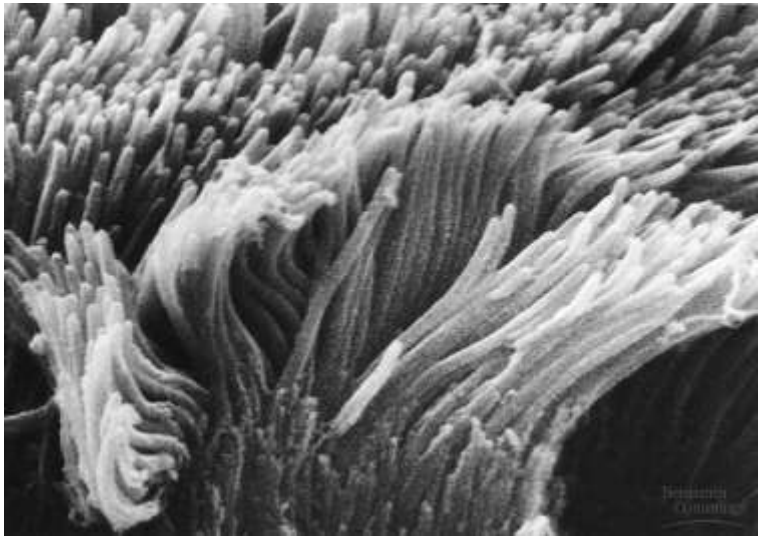


Figure 4.1B

- Transmission electron microscope (TEM)

- Transmission electron micrograph of cilia

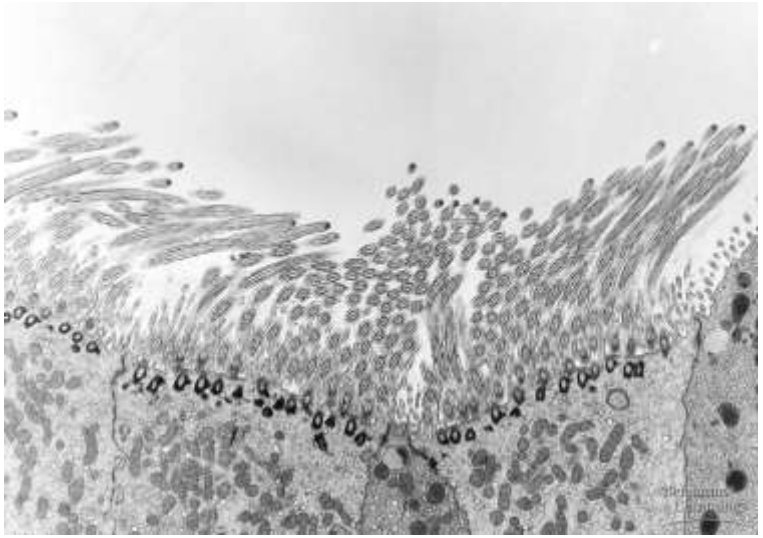
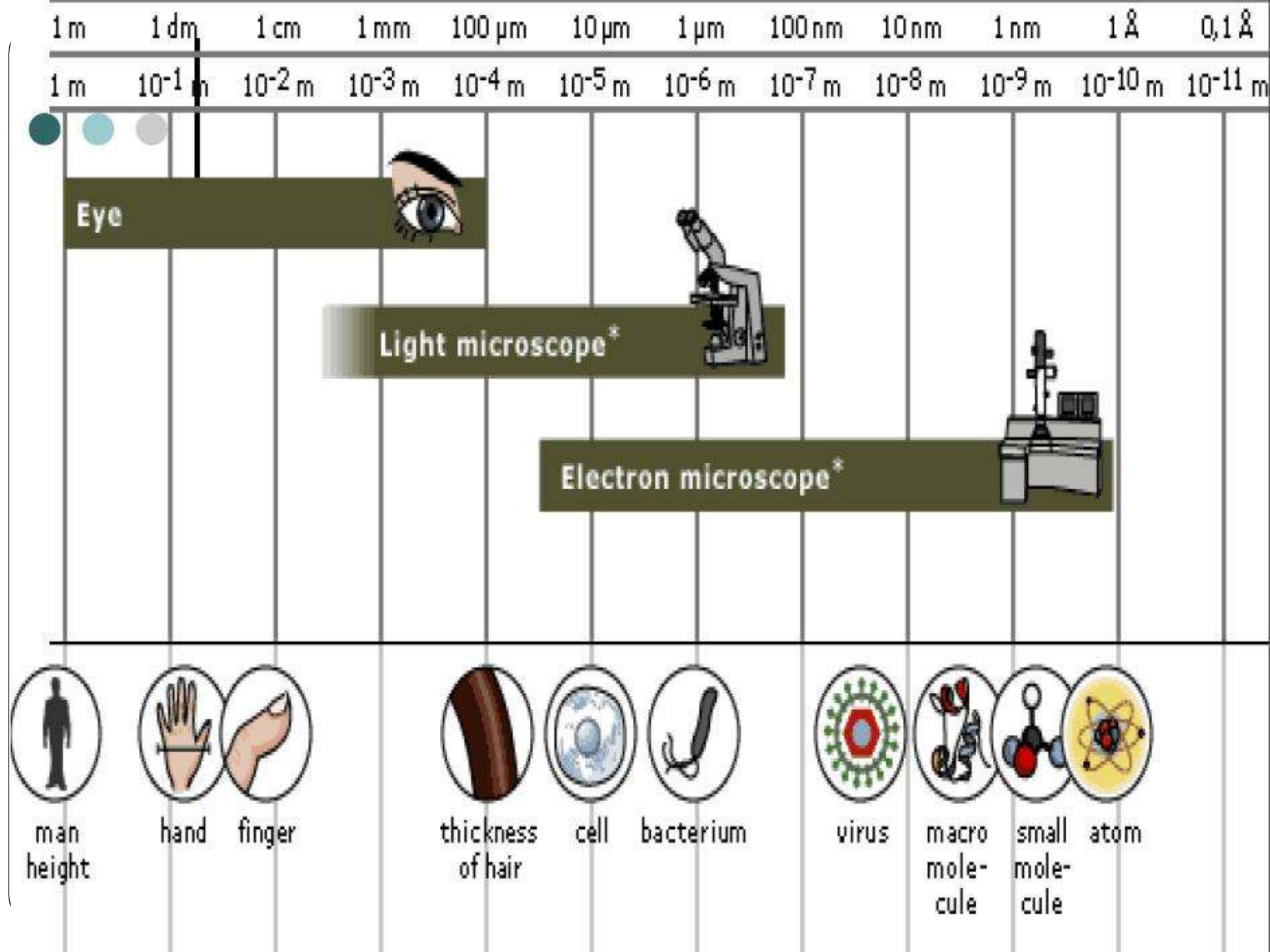


Figure 4.1C


1 m
1 dm
1 cm
1 mm
100 µm
10 µm
1 µm
100 nm
10 nm
1 nm
1 Å
0,1 Å
1 m
10-1 m
10-2 m
10-3 m
10-4 m
10-5 m
10-6 m
10-7 m
10-8 m
10-9 m
10-10 m
10-11 m
Eye
Light microscope*
Electron microscope*
man height
hand
finger
thickness of hair
cell
bacterium
virus
macro mole-cule
small mole-cule
atom

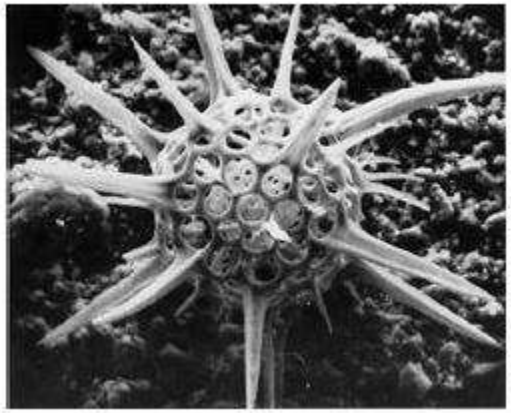
Cell Structure	Light Microscope	Electron Microscope
Membrane		
Ribosome		
Mitochondria		
Golgi apparatus		
Endoplasmic Reticulum		
Chloroplast		
Cytoskeleton		
Flagella		
Lysosome		
Vacuole		
Nucleus		
Cell wall		

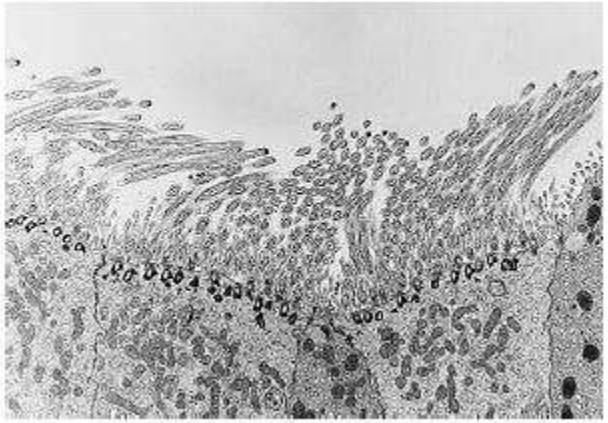
TRY ON YOUR OWN FIRST!!

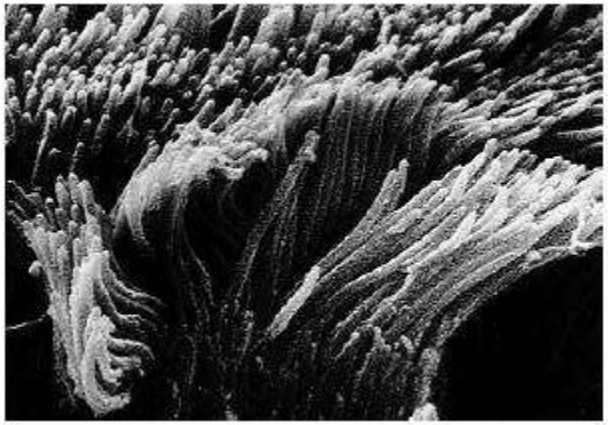
IS IT VISIBLE?
YES OR NO?

Cell Structure	Light Microscope	Electron Microscope
Membrane	YES – but not in much detail	YES
Ribosome	NO	YES
Mitochondria	YES (if stained)	YES
Golgi apparatus	NO	YES
Endoplasmic Reticulum	NO	YES
Chloroplast	YES	YES
Cytoskeleton	NO	YES
Flagella	YES	YES
Lysosome	YES – but hard to distinguish	YES
Vacuole	YES – but hard to distinguish	YES
Nucleus	YES	YES
Cell wall	YES	YES

Micrographs are pictures taken through microscopes

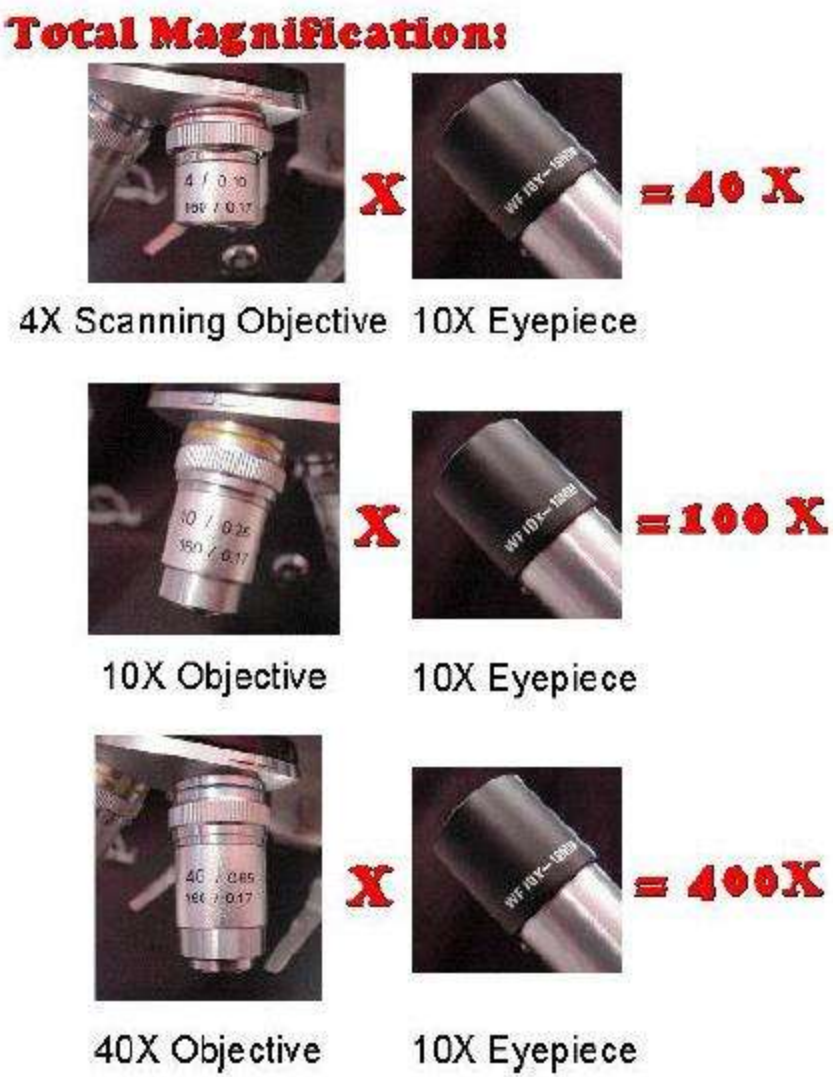






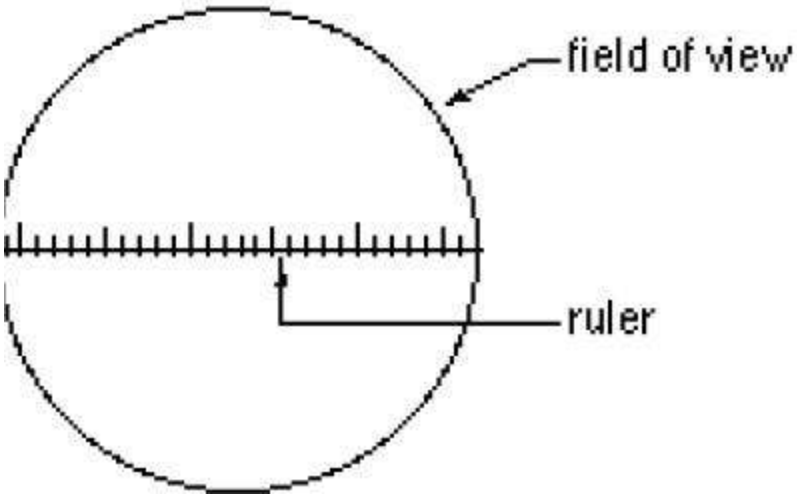
Microscope Math

- To find the total magnification of an image you are viewing under the microscope, multiply the power of the eyepiece lens by the power of the objective lens.



Microscope math:

- Field of view: the diameter of the circle you see in the microscope
  - To determine the field of view (FOV):
    (FOV lower power) (Magnification lower power) =
    (FOV higher power) (Magnification higher power)



Microscope math:

For example, if a 5X FOV is 3mm, what is the 40X FOV of that microscope?

(FOV lower power) (Magnification lower power) =

(FOV higher power) (Magnification higher power)

(3) (5) = (FOV higher power) (40)

15 = (FOV higher power) (40)

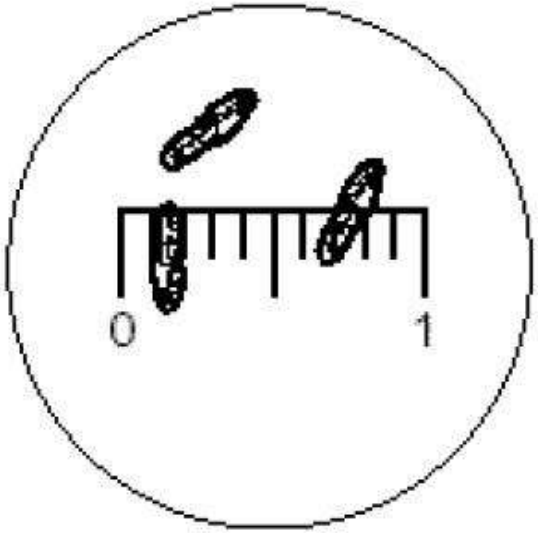
0.375 mm = FOV higher power

Microscope math

- Estimating the size of an object

  Size of object =

  (FOV) / # of objects which fit across field



Low Power

Cell Size

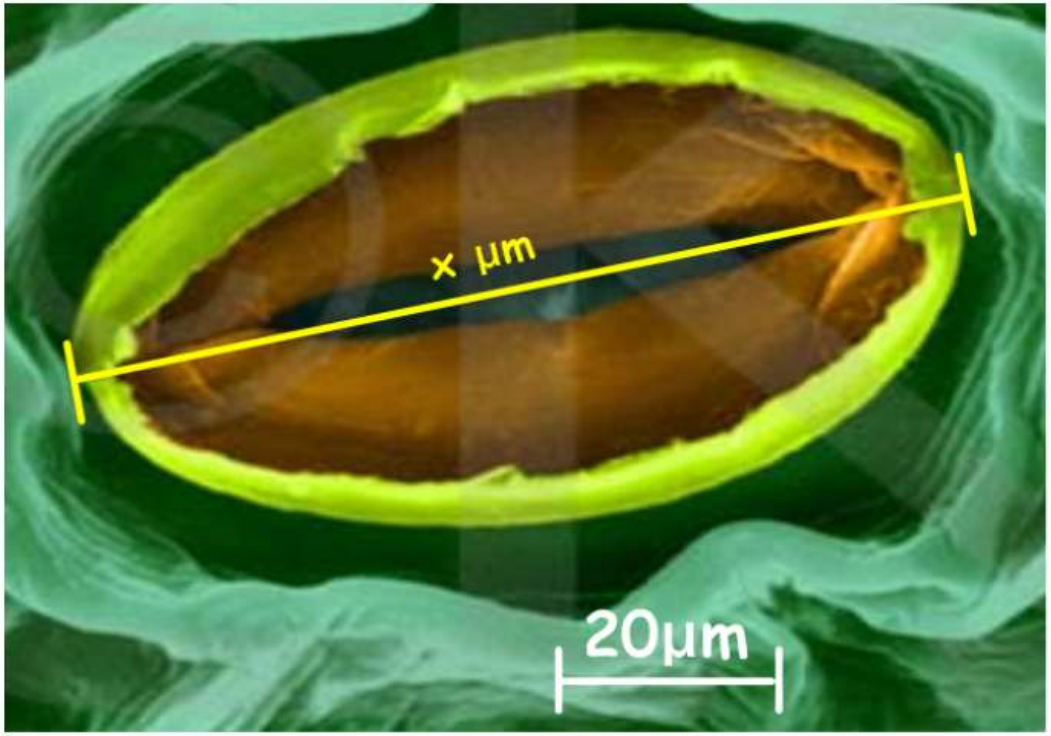
- Most light microscopes have a field of vision at low power of about 1.4 millimetres

Cell Size

- Scale bars are often used with micrographs so actual sizes can be determined

Magnification = size of image / size of specimen

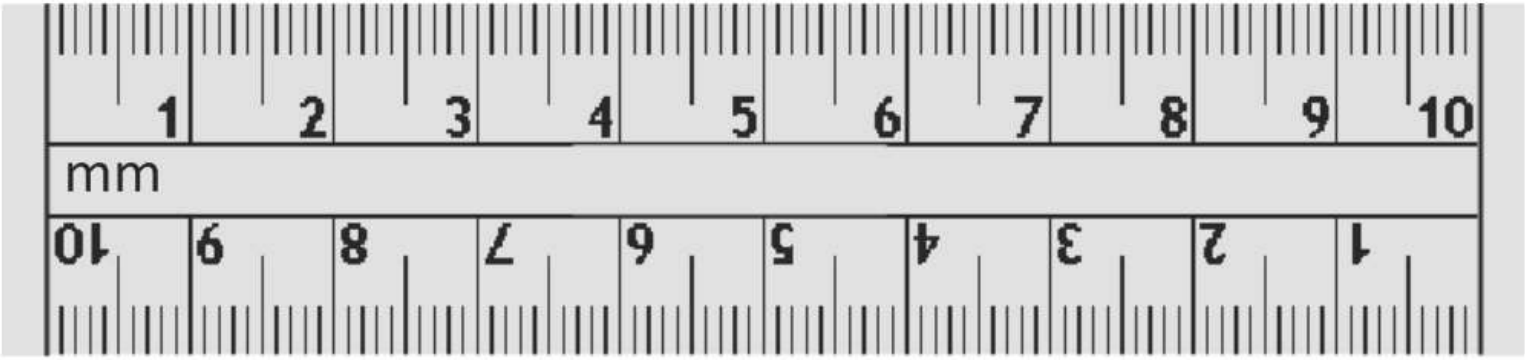
USING SCALE BARS



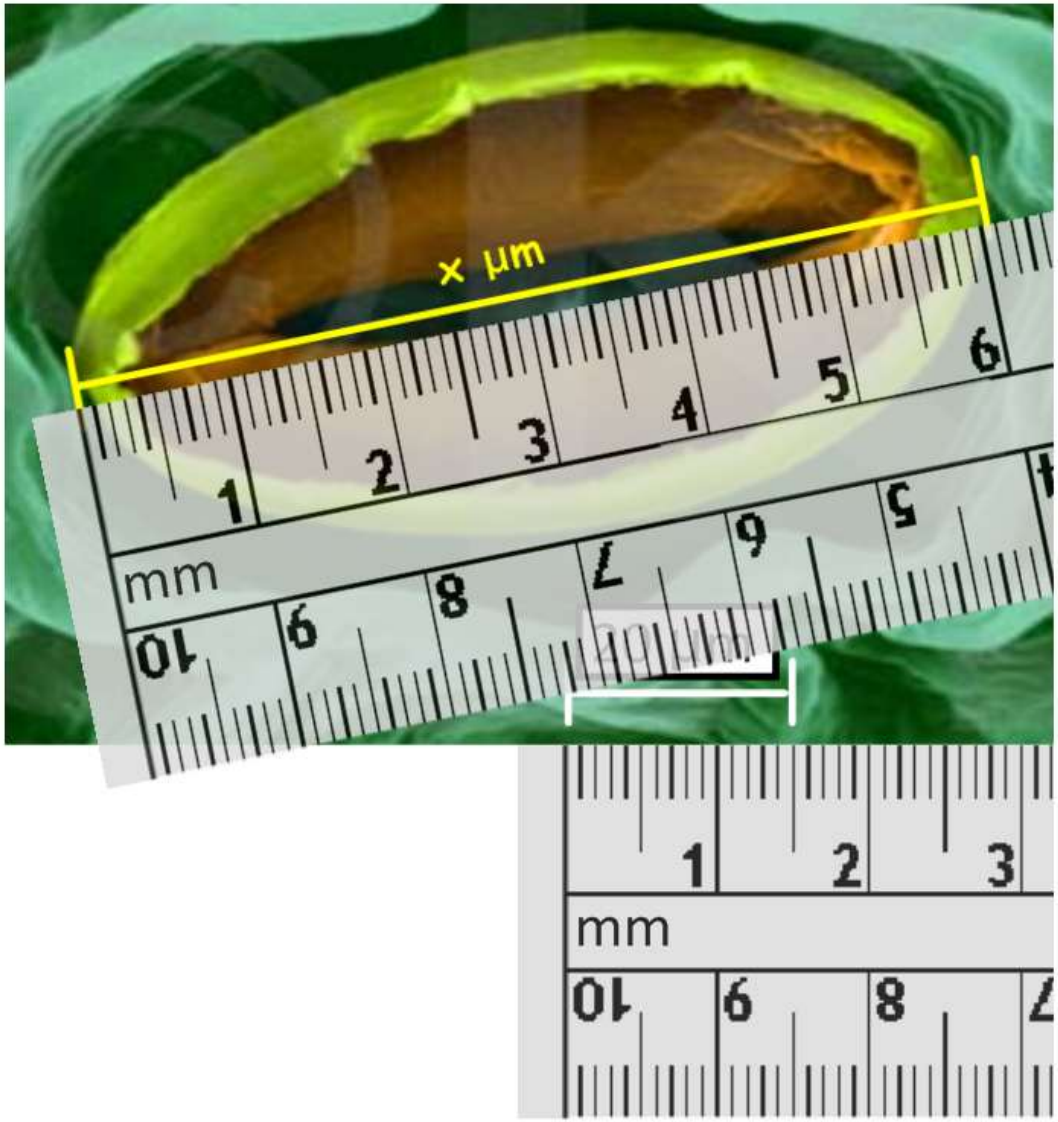
When asked to find the length of an object, look for the longest dimension.

Here the length of the stoma has been marked as xµm.

Our scale bar shows us 20µm in real life - so we can use a ruler or micrometer eyepiece to determine the actual size of the stoma.



USING SCALE BARS



First calculate the scale on the scale bar:

$$\frac{\text{scale length}}{\text{ruler length}} = \frac{20\ \mu m}{15mm}$$

= 1.33 µm per mm

(real life) (image)

Then measure the image with the ruler:

x µm is 60mm on the image.

Now calculate the true length:

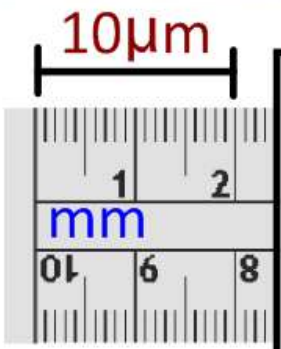
1.33 x 60 = 80 µm

(scale) (image length)

CALCULATING MAGNIFICATION

We might want to know how many times an image has been magnified.

The scale bar represents the 'real' size of the sample in the image, so we only need to work with the scale bar.



First convert your units so that they are all the same:

scale bar = µm, so convert ruler to µm

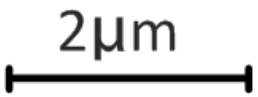
1 mm = 1,000 µm so 20mm = 20,000µm

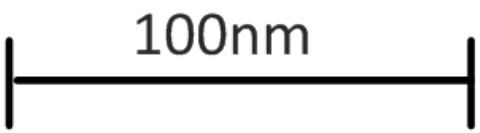
Now we can calculate the magnification:

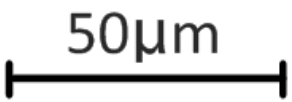
$$\frac{\text{scale bar measurement (we just measured)}}{\text{scale bar label ('real life' of sample)}} = \frac{20{,}000\ \mu m}{10\ \mu m}$$

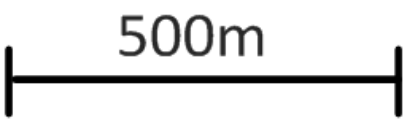
magnification = 2,000 times

Now calculate the magnification of these scale bars:

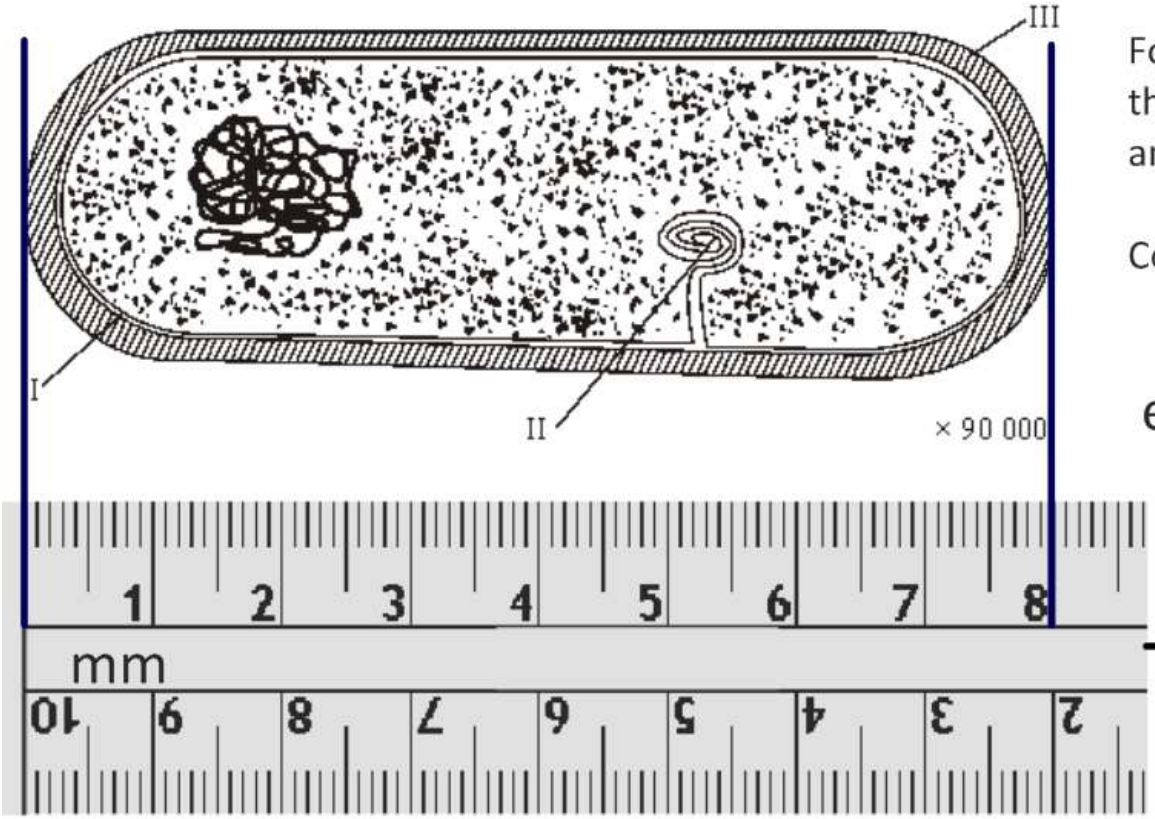








CALCULATING ACTUAL SIZE (NO SCALE BAR)



For this type of question, simply measure the part of the image you are instructed to and divide it by the magnification.

Convert to the most appropriate units.

e.g. $\frac{\text{measured length}}{\text{magnification}}$

$\frac{80\text{mm}}{90{,}000} = 8.9 \times 10^{-4}\text{mm}$

or 0.00089mm

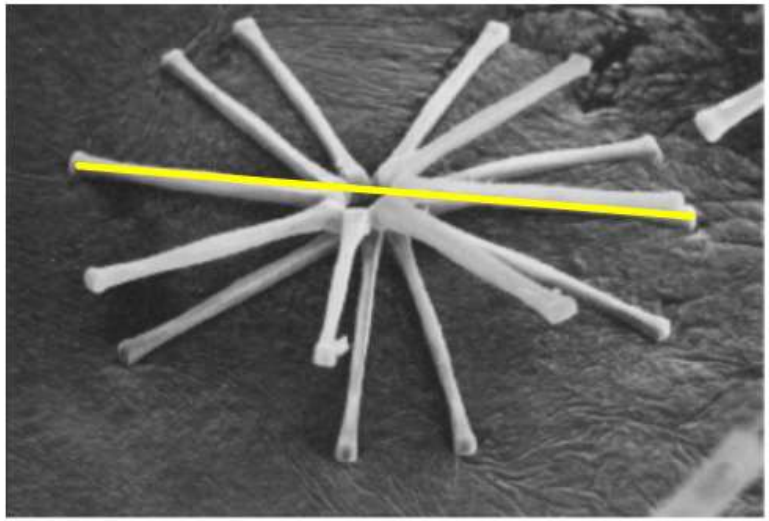
converts to: 0.89µm

should have an integer on this side of the point

this is best - gives us clear whole numbers

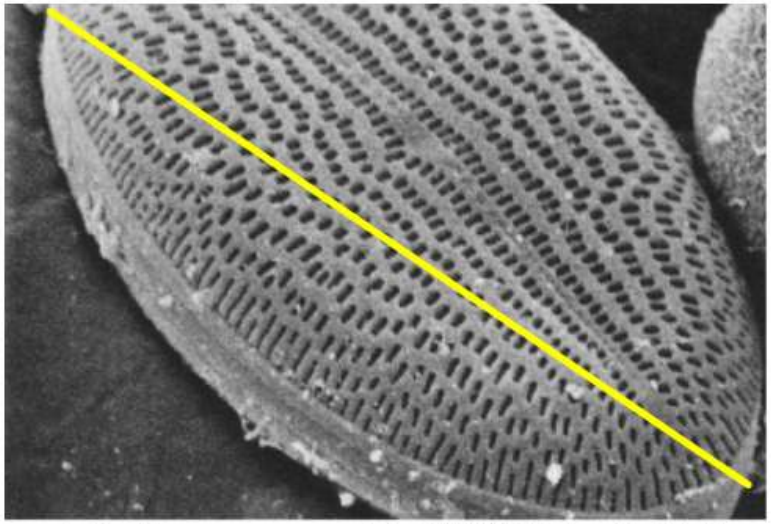
or 890nm

Diatom x 1,000



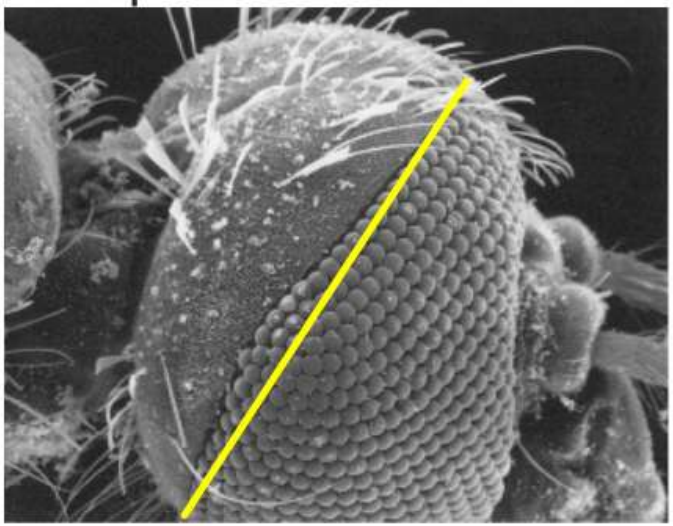
http://www.mos.org/sln/SEM/diatom.html

Diatom x 5,000



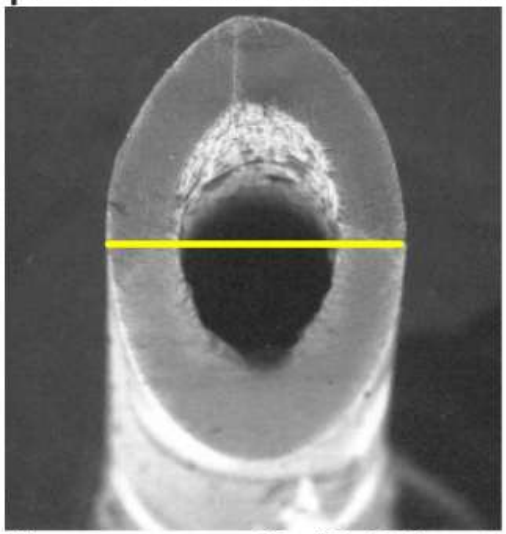
http://www.mos.org/sln/SEM/diatomb.html

Mosquito head x 200



http://www.mos.org/sln/SEM/mhead.html

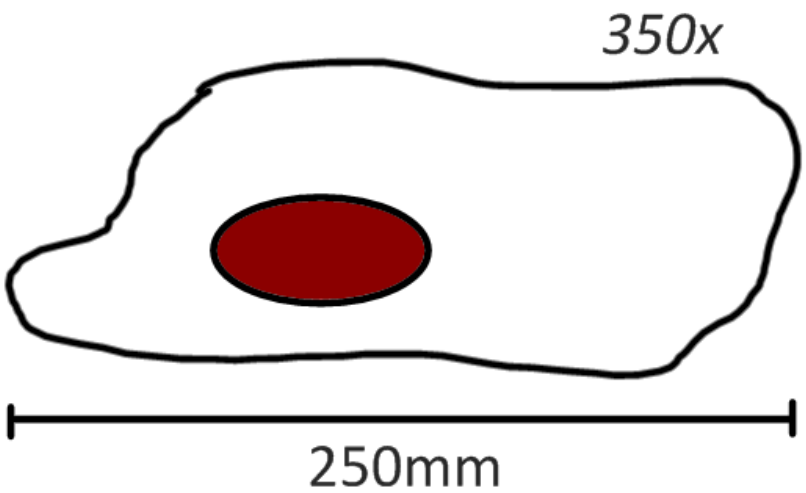
Hypodermic needle x100



http://www.mos.org/sln/SEM/needle.html

1. A student views an image of a cell magnified 350 times. The image is 250mm long. What is the actual length of the sample in the image?

If you're stuck, draw it out...



$$\text{Actual length} = \frac{\text{image length}}{\text{magnification}}$$

$$= 250\text{mm}/350$$

$$= 0.71\text{mm}^*$$

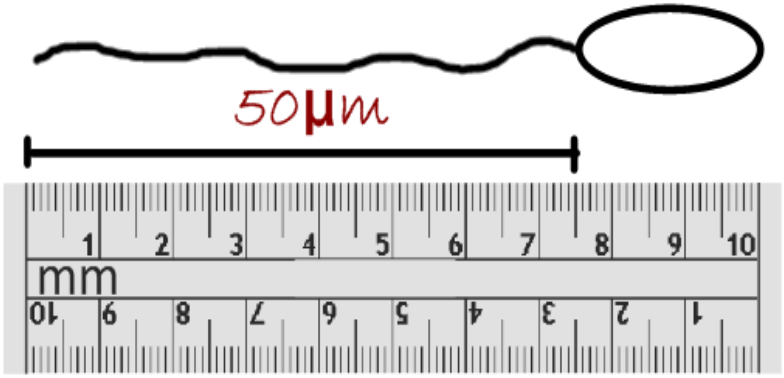
(or 710 μm)

* isn't that a bit big for a cell?
More on size of cells later...

2. A sperm cell has a tail 50µm long. A student draws it 75mm long. What is the magnification?

2.A sperm cell has a tail 50µm long. A student draws it 75mm long. What is the magnification?

If you're stuck, draw it out...



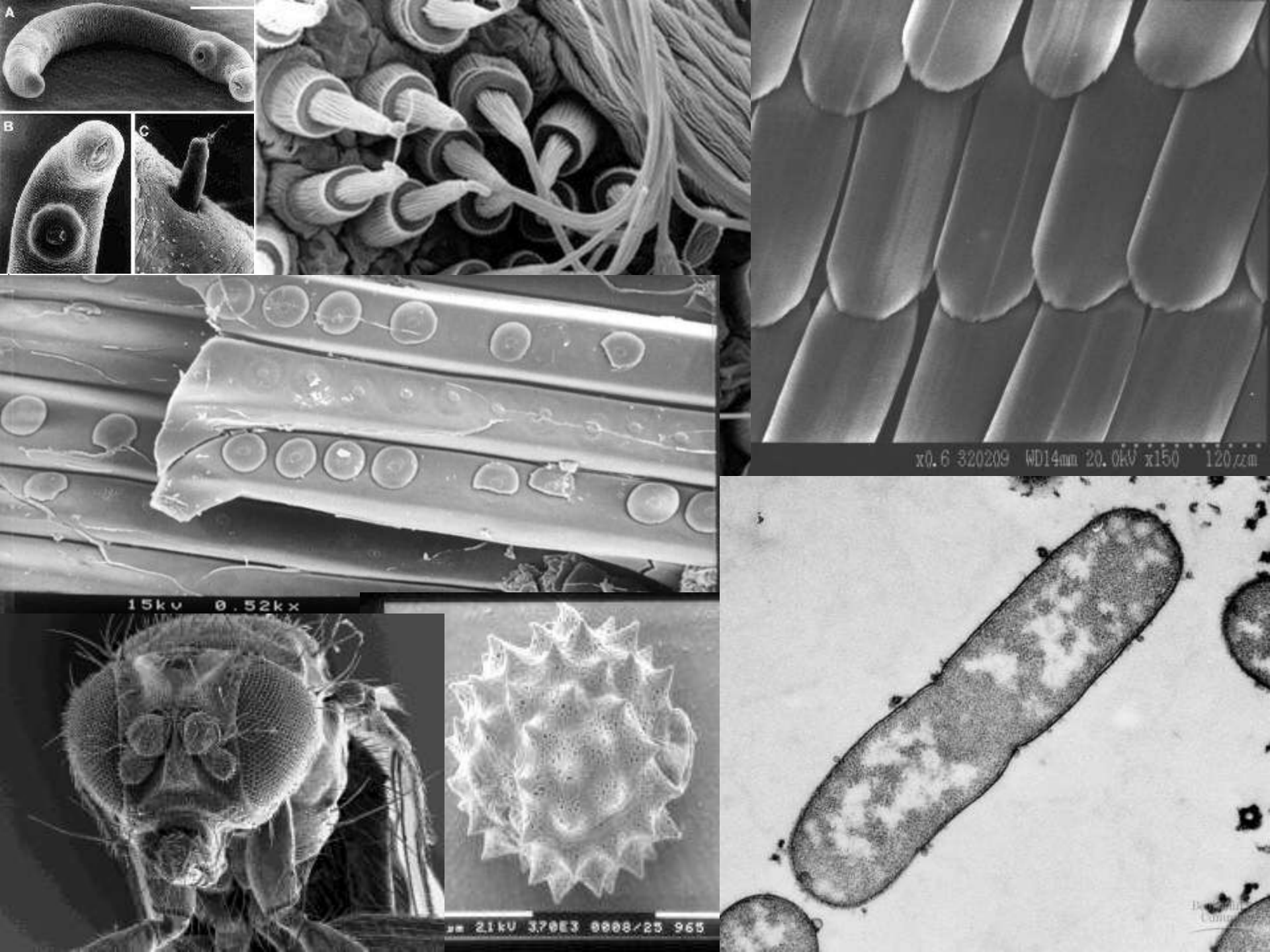
1. Convert mm to µm:

75mm = 75,000um

2. $\frac{\text{drawing length}}{\text{scale bar label}}$

= 75000/50

= 1500x magnification


A
B
C
x0.6 320209 WD14mm 20.0kV x150 120μm
15kv 0.52kx
μm 21kV 3.70E3 0008/25 965