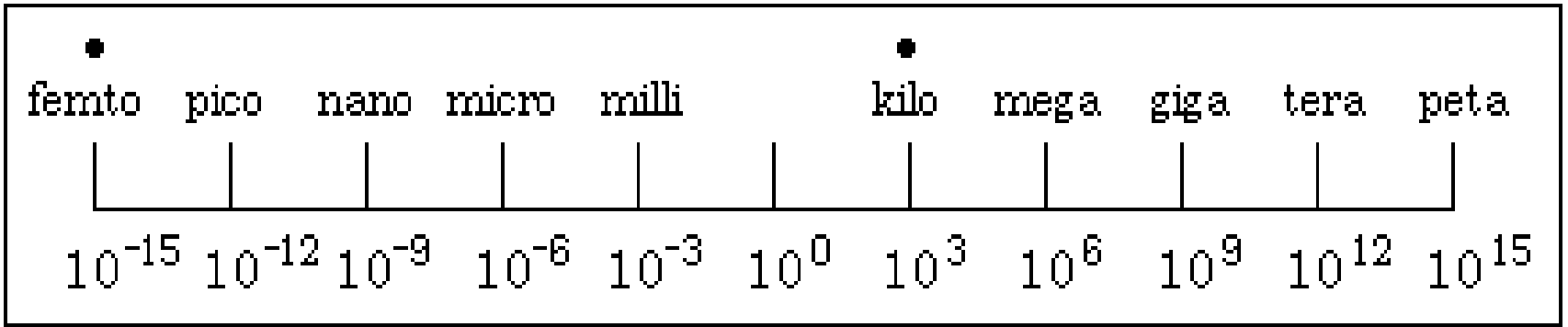
Cells are studied by a combination of methods



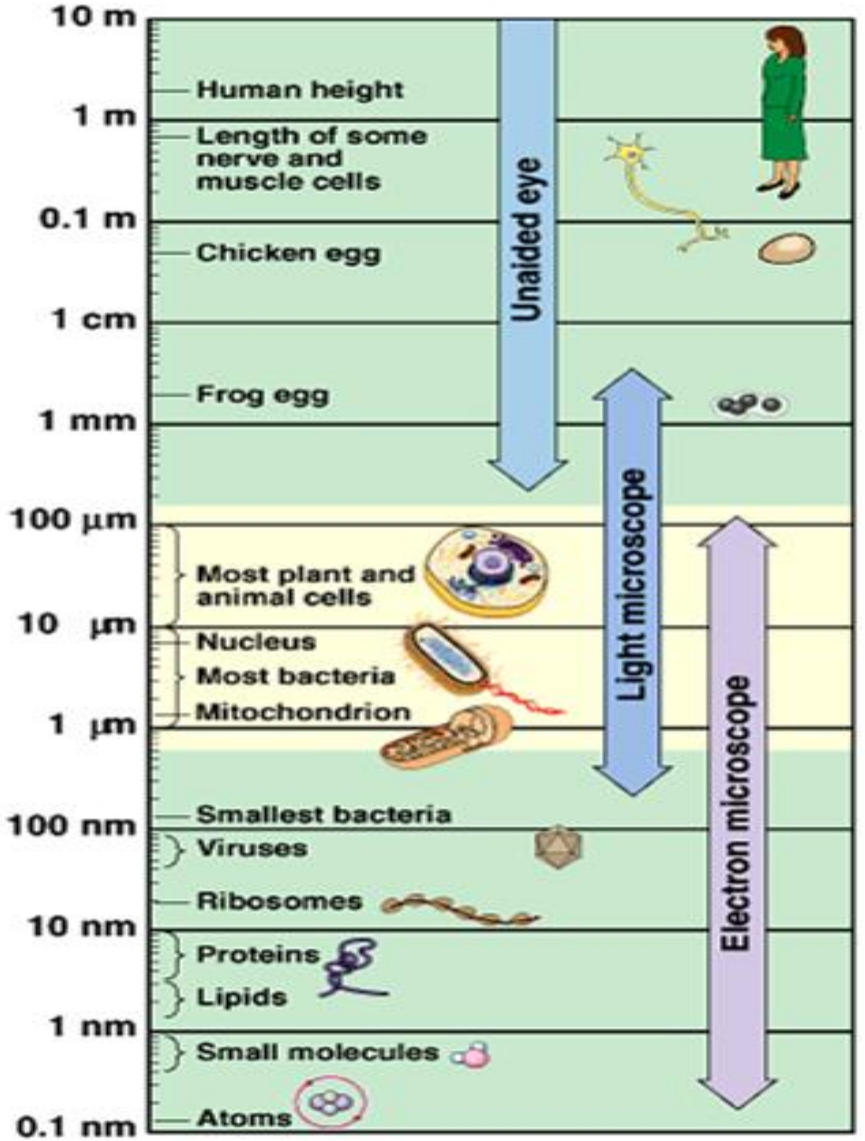

Scales of measurement

- Nanometer (nm): 1 billionth of a meter
- Micrometer (um): 1 millionth of a meter
- Millimeter (mm): 1 thousandth of a meter
- Centimeter (cm): 1 hundredth of a meter



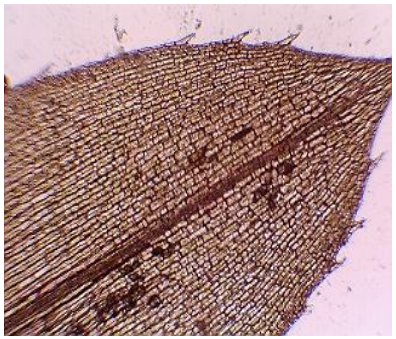
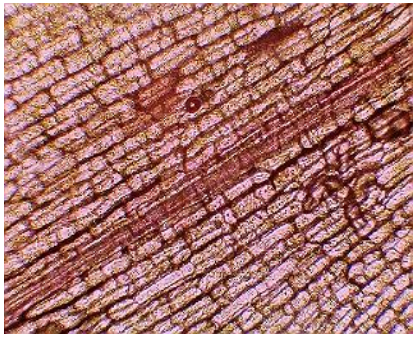
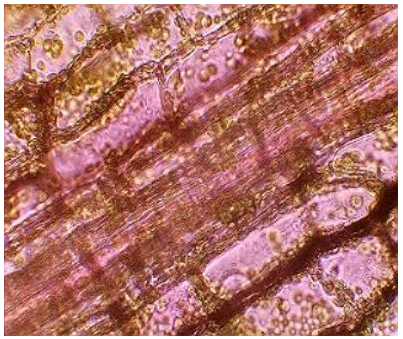
Relative sizes (larae to small)

- Cells (up to 100 um)
- Organelles (up to 10 um)
- Bacteria (1um)
- Viruses (100nm)
- Cell membrane thickness (10nm)
- Molecules (1nm)



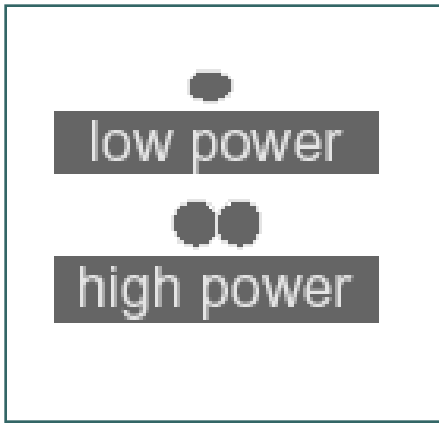
Microscopes are instruments that can magnify and resolve objects

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

Microscopes are instruments that can magnify and resolve objects

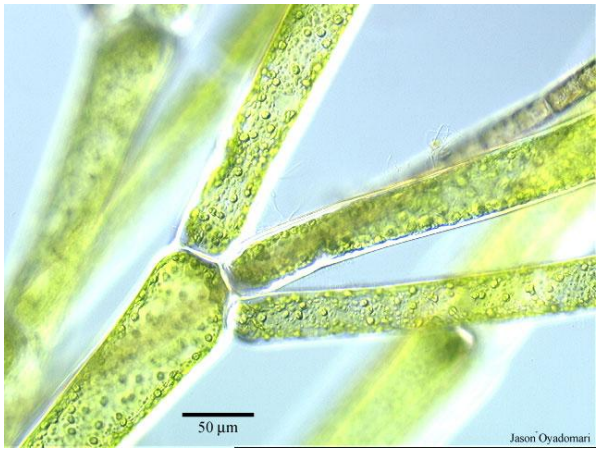
- Resolution
  - The ability to form separate images of objects that are very close together.
  - Resolving power is stated as the minimum distance two points can be separated and still be distinguished as two separate points.
  - The smaller the resolving power, the better the resolution



Light microscopes
(use lenses and light)

- Inexpensive and easy to use
- Used to study stained or living cells in color
- Objects can be magnified up to 2000X

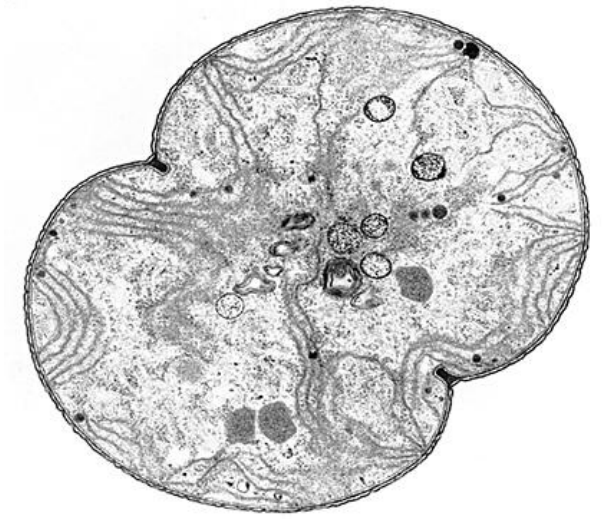
  Ours at school only magnify 1000X
- Can resolve objects 200 nm apart (500 times better than the human eye)

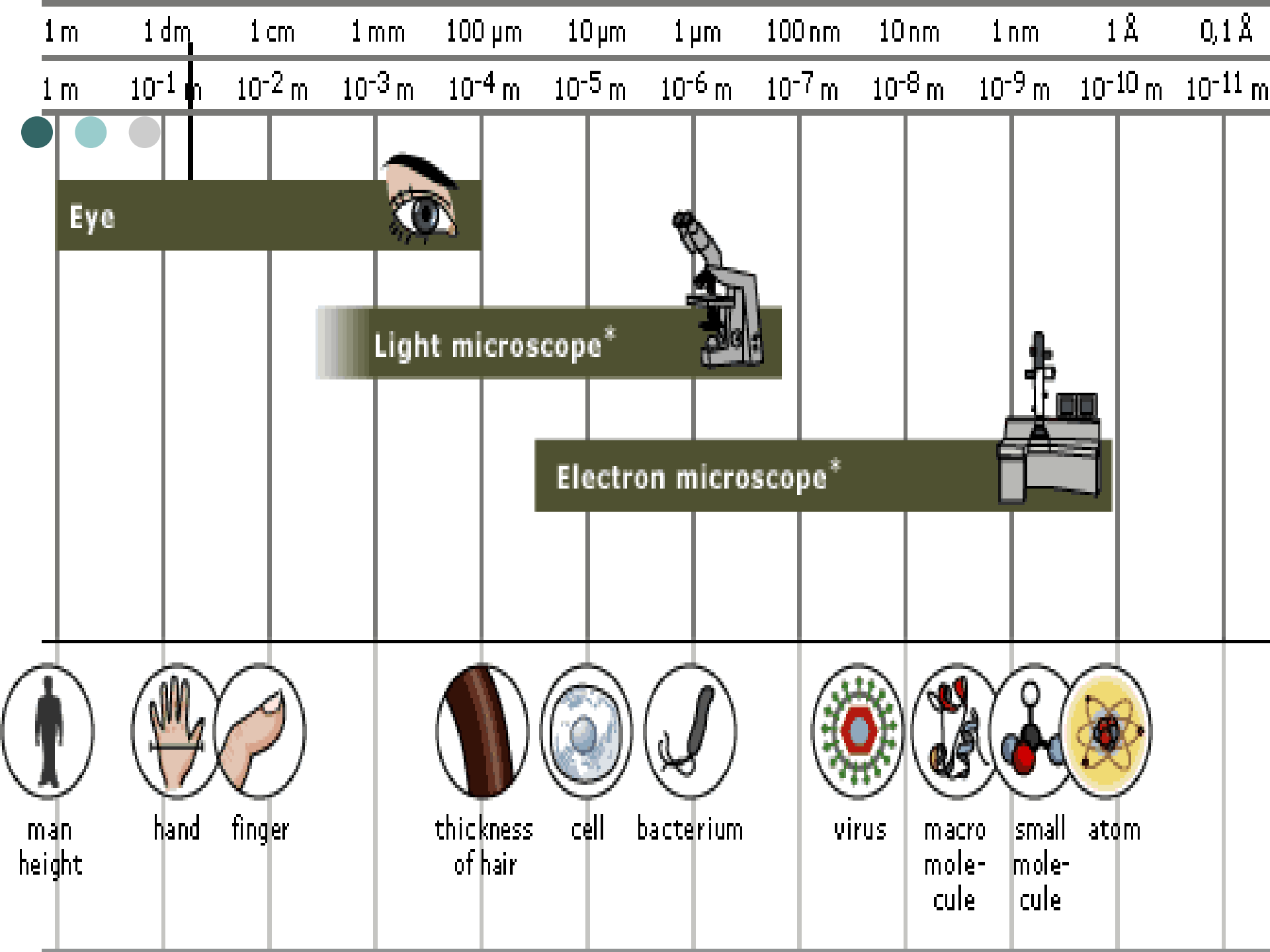


Electron microscopes

(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 color can be seen




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		

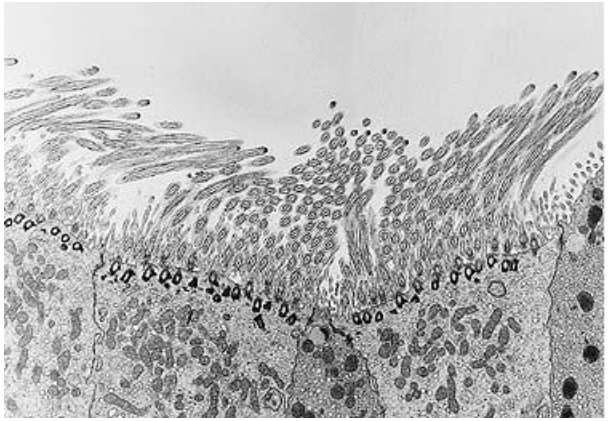
TRY ON YOUR OWN FIRST!!

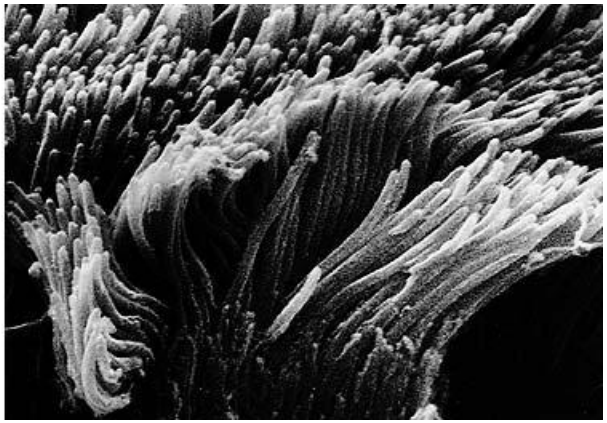
IS IT VISIBLE?

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.

Total Magnification:

X


= 40 X

4X Scanning Objective 10X Eyepiece

X


= 100 X

10X Objective 10X Eyepiece

X


= 400X

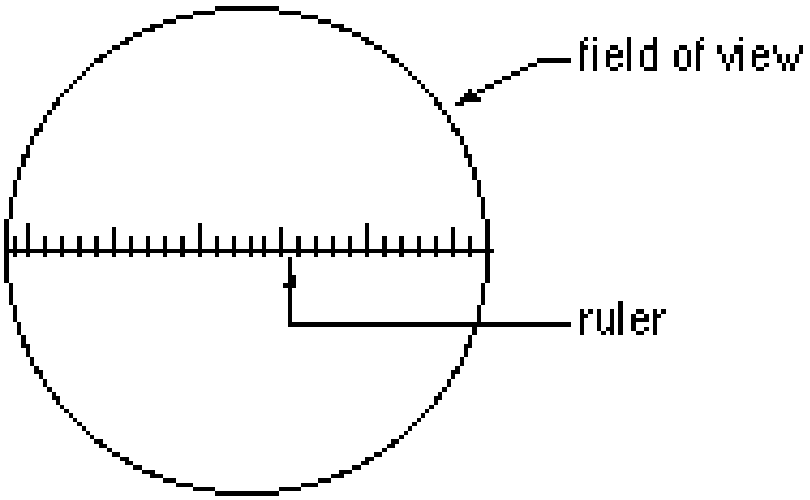
40X Objective 10X Eyepiece

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)

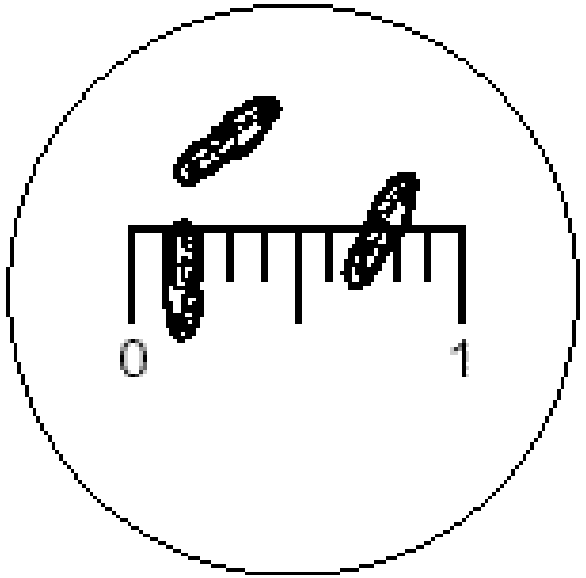
(3) (5) = (FOV higher power) (40)
15 = (FOV higher power) (40)
0.375 mm = FOV higher power

Microscope math

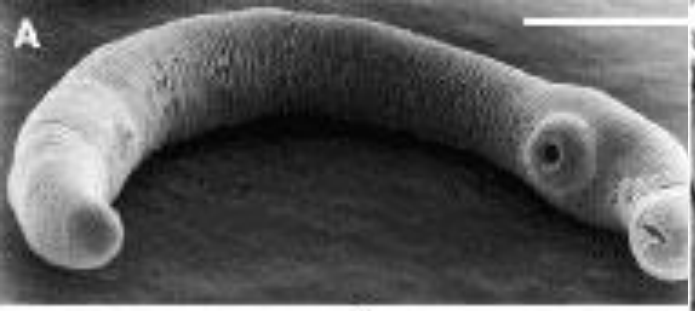
- Estimating the size of an object

  Size of object =

  (FOV) / # of objects which fit across field

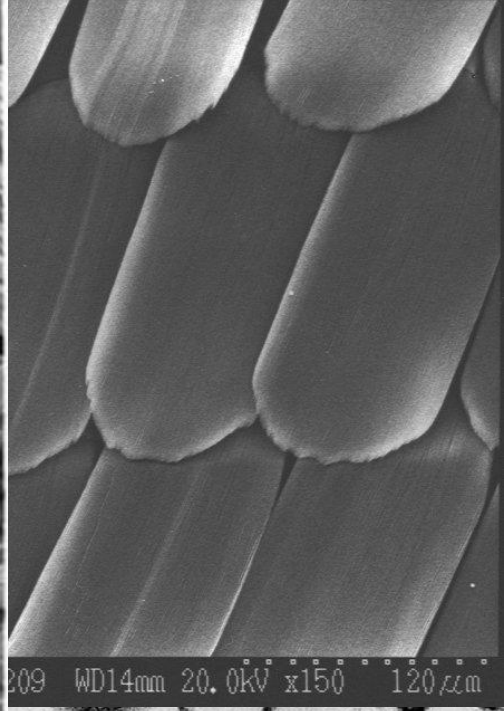


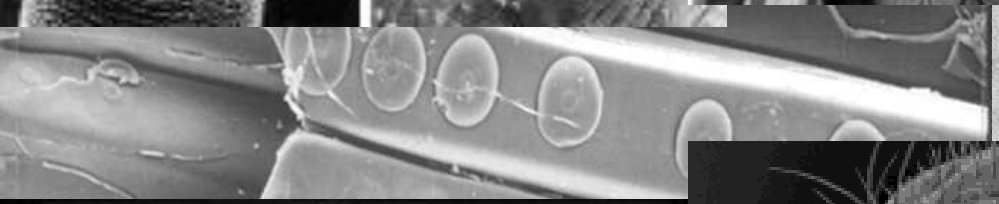
Low Power

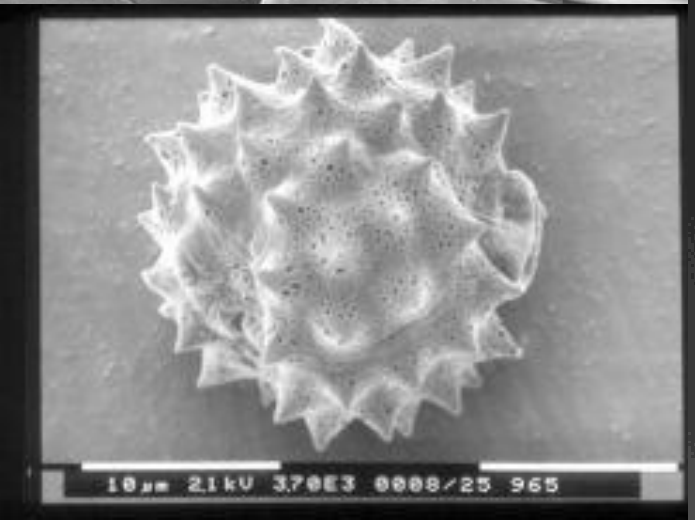

A


B


C


209 WD14mm 20.0kV x150 120μm




10μm 21kV 3.70E3 0008/25 965