Reading: Cells & the Microscope

In this lesson you will be learning about…

Types of Cells

- Parts of a Compound Microscope
- Using the Compound Microscope
- Calculations Related to the Microscope

Cell Types

All living things are composed of one or more cells. All cells are basically the same in chemical composition and metabolic activities, but may be divided into two main groups:

PROKARYOTES & EUKARYOTES

The difference between the two groups is the presence or absence of a nucleus surrounded by a nuclear membrane.

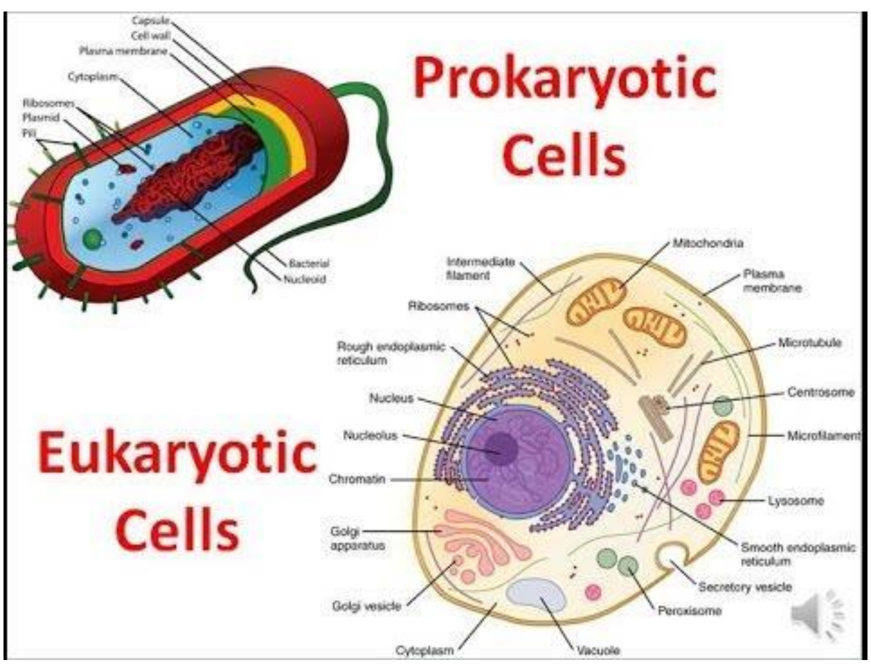
Prokaryotes

Prokaryotic cells do not contain a membrane-bound nucleus. They are generally smaller and less complicated than eukaryotic cells. Bacteria are prokaryotic.

Eukaryotes

Eukaryotic cells, contain a membrane-bound nucleus. They are generally larger and more complex than prokaryotic cells. The cells of protists, fungi, plants, and animals are all eukaryotic.

Eukaryotes vs. Prokaryotes



Note that the DNA in the Eukaryotic cell is contained within a membrane-bound nucleus.

Animal vs Plant Cells

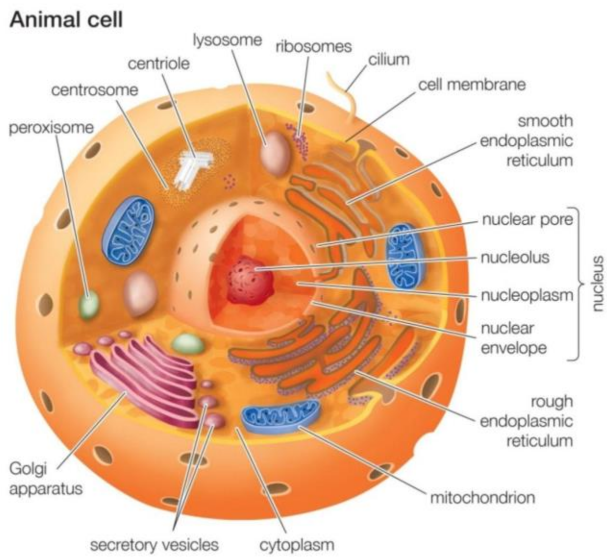
Plant and animal cells are alike in that they are both eukaryotic (have a nucleus). Plant cells differ from animal cells in that they:

– have a cell wall surrounding the cell membrane

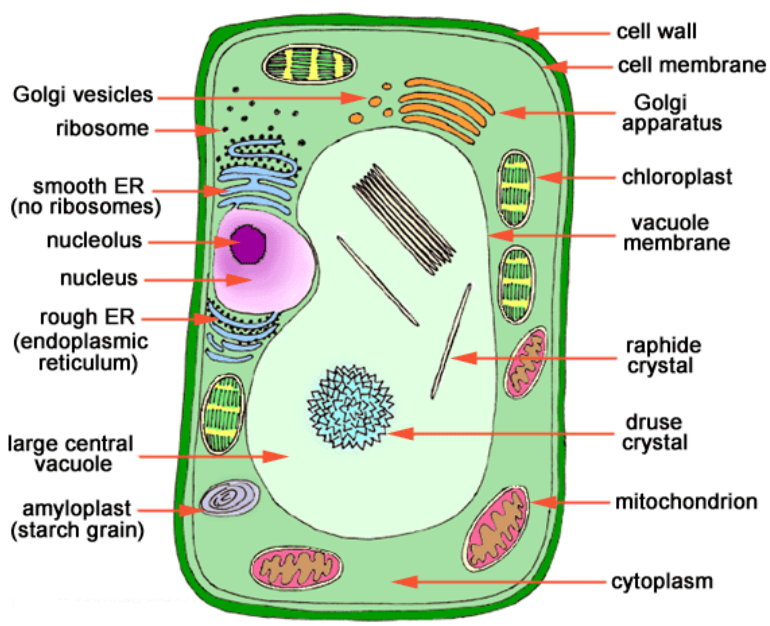
– have chloroplasts containing chlorophyll responsible for photosynthesis

– have a large central vacuole that stores water

– lack cilia and/or flagella



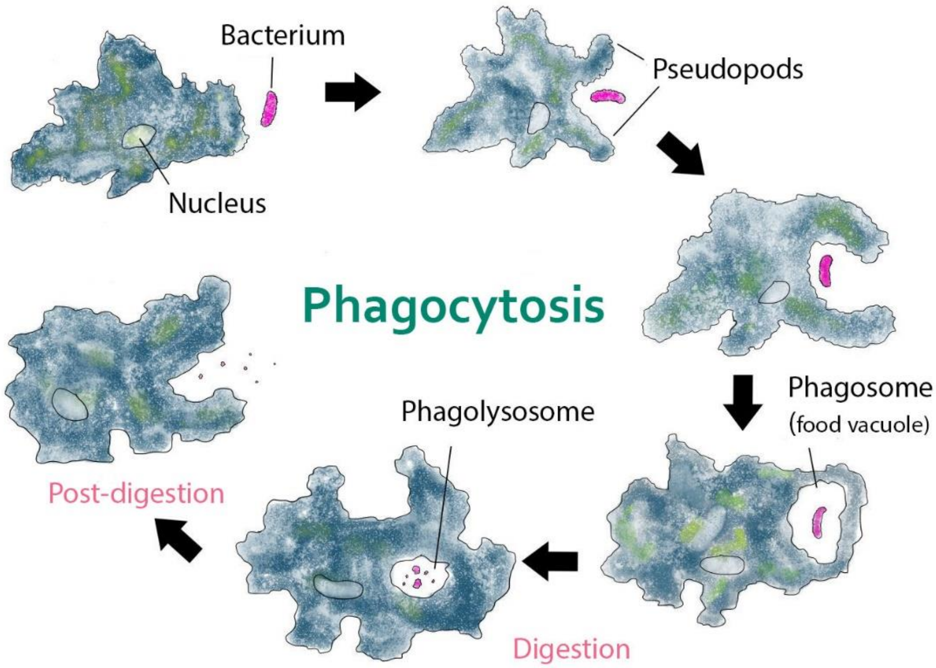
Plant Cell:



For more on cells visit: https://www.cellsalive.com/

Check out the Interactive Cell Models, and Cell Photo Gallery.

The illustration below shows the phagocytosis (eating) of a unicellular protest (Chlamydomonas) by a larger unicellular protist (Amoeba).



Are these cells eukaryotic or prokaryotic?

Cilia & Flagella

Cilia and flagella are long, thin structures extending from the surface of many types of eukaryotic cells. They are essentially the same except for number and length. They are used for movement.

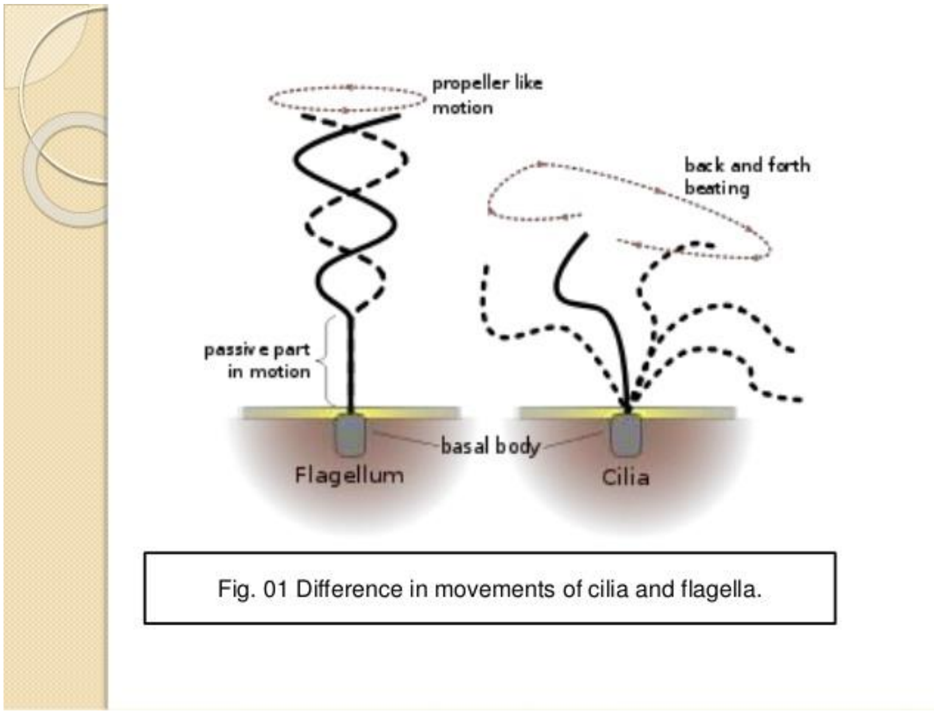


Fig. 01 Difference in movements of cilia and flagella.

The Compound Microscope

"Of all the inventions none there is Surpasses
the noble Florentine's Dioptrick Glasses For what a better, fitter guift Could bee
in this World's Aged Luciosity.
To help our Blindnesses so as to devize a paire of new & Artificial eyes
By whose augmenting power wee now see

more than all world Has ever doun Before." Henry Powers, 1664

Microscopes

The development of the microscope at the end of the 16th century would lead to a great step forward for science, particularly in biology and medicine. The human eye has a resolution of 0.1 mm, which is about the thickness of a hair. The exploration of the micro cosmos has led to numerous discoveries, without which we would be left with the limited knowledge our eyes give us.

How Small is Small?

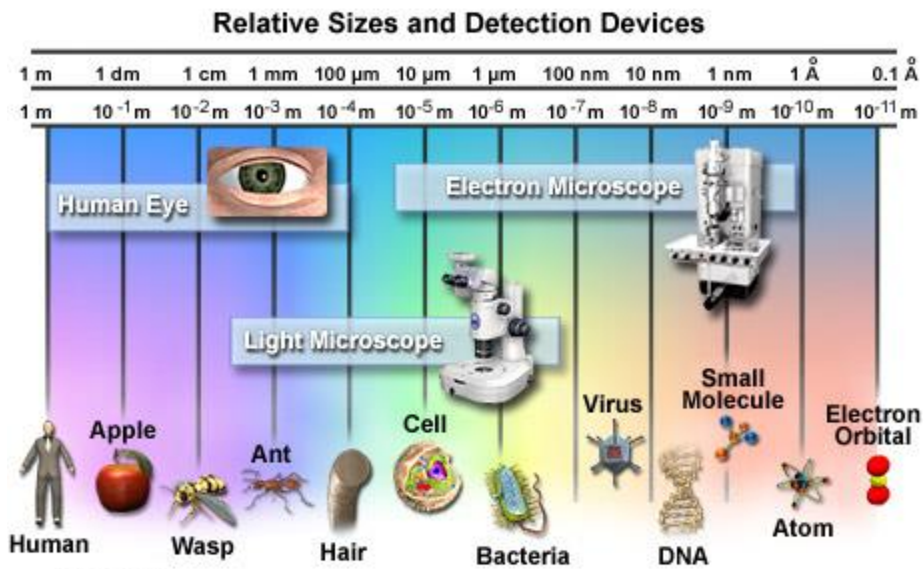


Figure 1

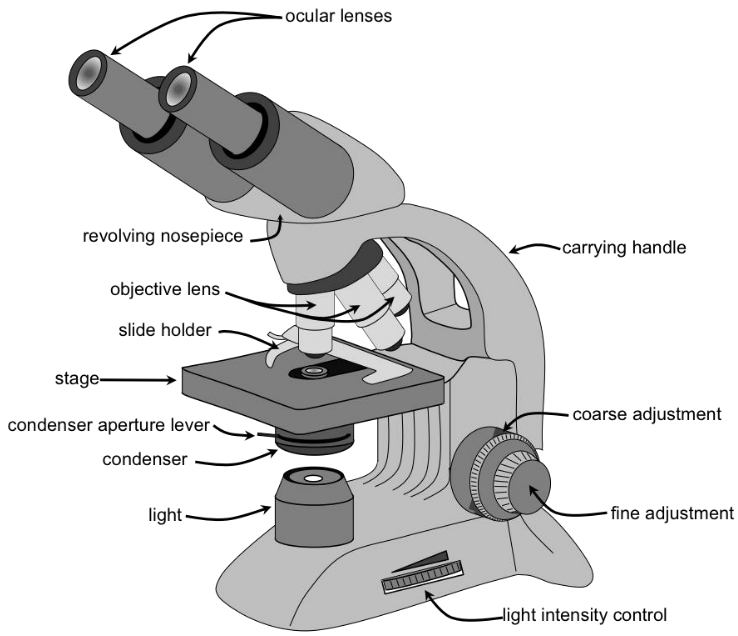
History of the Microscope

Early Compound Microscope

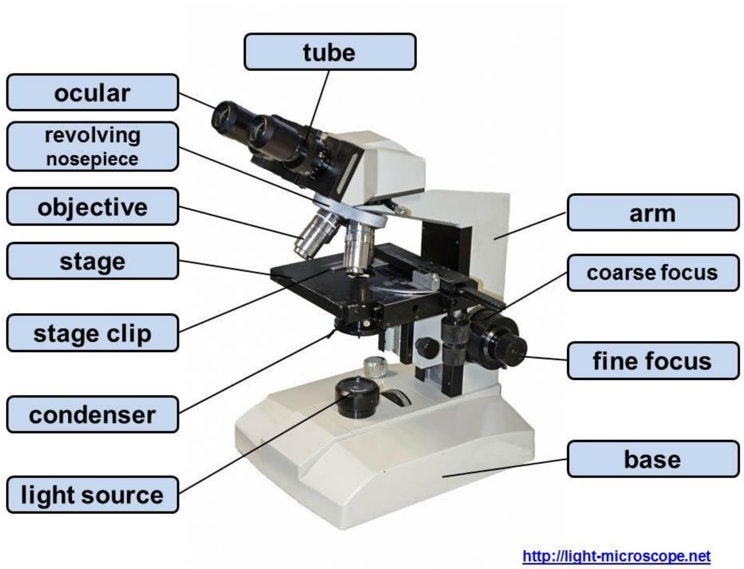
If you are interested in the history of the microscope, visit the following sites:

- [Microscope Museum]
- [Microscope Timeline]

The microscope is an important tool used by biologists to magnify small objects like cells. There are many types of microscopes. The ones most commonly used in high school biology classes are the dissection microscope and the compound light microscope.



Anatomy of a Dissection Microscope



Anatomy of a Compound Microscope

The Compound Microscope

Note: You will be responsible for knowing the parts of the compound microscope and their functions.

There are numerous websites on this topic. Have a look at a few and compare to the diagram in your textbook. To help you remember them, you might want to try this link: Microscope Parts Flashcards

Here are a few important terms and concepts that you will need to know about microscopy:

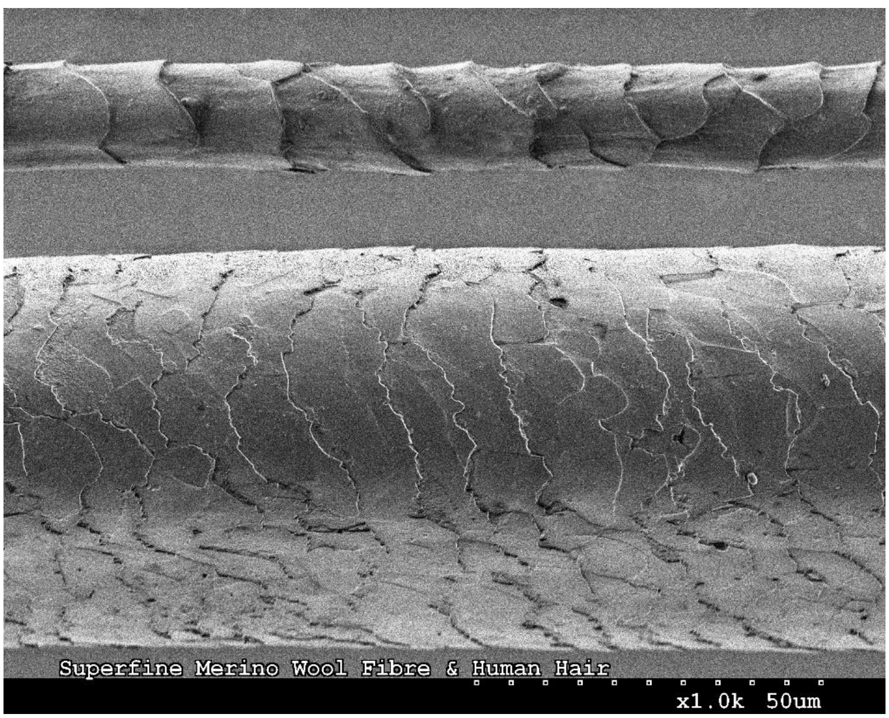
Magnification: Magnification is ratio between the size of the specimen and the size of the image. To calculate magnification we multiply the power of each lens through which the specimen is viewed. In a light microscope this is the ocular lens (located in the eyepiece) and objective lens.

Example: if a microscope has a 10X ocular value and a 40X objective value, you would find the total magnification by multiplying 10 X 40 = 400, or 400X.

Try this Link: Virtual Magnification

Resolution: Resolution is the clarity or sharpness of the image---the amount of detail that can be seen. Different types of microscope have different resolving powers. Light microscopes let us distinguish objects as small as a bacterium. Electron microscopes have much higher resolving power.

Objects such as a human hair appear smooth when viewed with the unaided eye. However, put a hair under a microscope and it looks quite different!

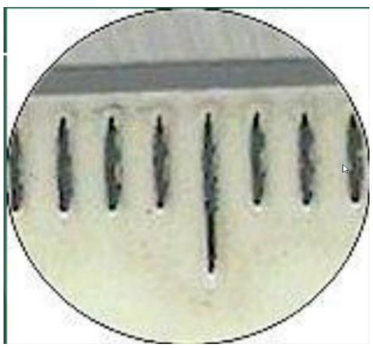


Important Note: It is important to realize that images viewed under the microscope are inverted (flipped top to bottom and left to right).

Field of View

Field of View is the 'circle' that you see when looking through a microscope. Field Diameter is the distance across the center of this circle. Since objects viewed under the microscope are very small, the micrometer is used in making such measurements. There are 1000 micrometers (µm) in 1 millimeter (mm).

The field of view (and thus the field diameter) is different from microscope to microscope, therefore it must be calculated each time you use a new microscope. To do this, simply view a clear ruler using low power. Measure the distance across your field of view in millimeters and convert to micrometers by multiplying by 1000.



In this example, about 7 spaces are shown.

7 spaces = 7 mm

7 mm x 1000 = 7000 µm

Once the low power field diameter has been determined, you can now calculate the fields at higher powers. Using the previous example, calculate the field diameter under medium power (10 X).

– Lower power field diameter (4 X) = 7000 µm

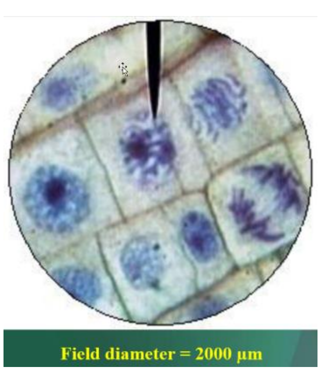
– Medium power field diameter (10 X) = (4 / 10) x 7000 µm = 2800 µm

– In other words, the field diameter under medium power is 4/10ths as big as the field diameter under low power.

Field Diameter

When you increase the magnification, you are 'zooming in' on a smaller area, therefore the field diameter will decrease proportionately. For example, if the magnification is doubled (multiplied by 2), the field diameter will be half as large (divide by 2). Once you know the field diameter of your microscope, you can estimate the size of objects viewed under each objective lens.

Estimating Specimen Size



To determine the size of a specimen, simply estimate how many times it would fit across the field of view. About 3 cells fit across the field of view in this example. Since the field diameter = 2000 µm, the size of each cell would be 2000 µm / 3 = 667 µm.

Determine the approximate length and width of these pollen grains.

Widthwise about 5 pollen grains fit across the field of view. Since the field diameter = 4500 µm, the width of each pollen grain would be 4500 µm / 5 = 900 µm

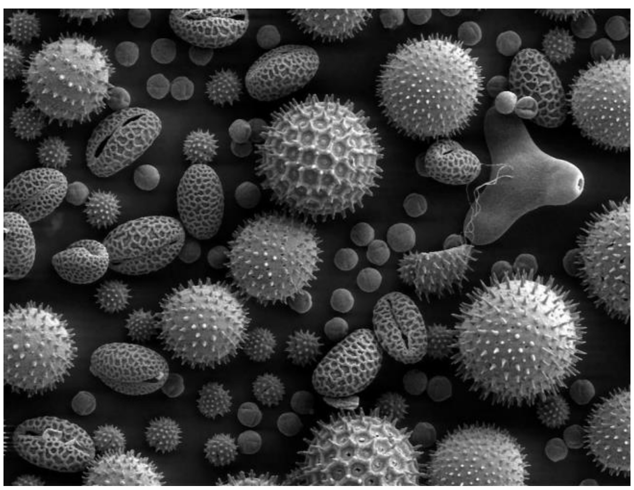
Lengthwise about 3 pollen grains fit across the field of view.

Since the field diameter = 4500 µm, the length of each pollen grain would be 4500 µm / 3 = 1500 µm.

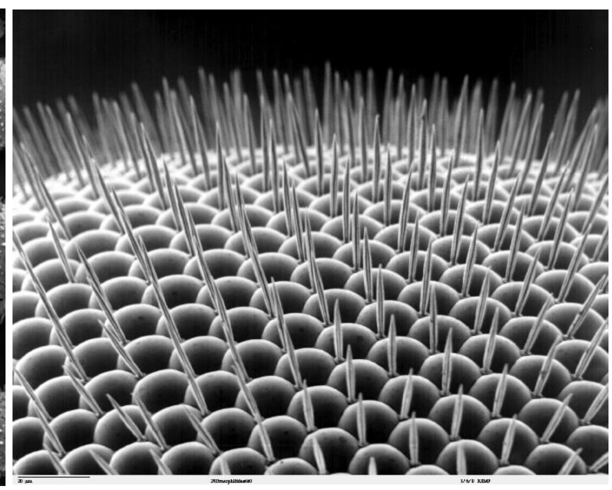
Field diameter = 4500 µm

Therefore, when estimating the size of a specimen, you need to specify whether you are measuring its length or width.

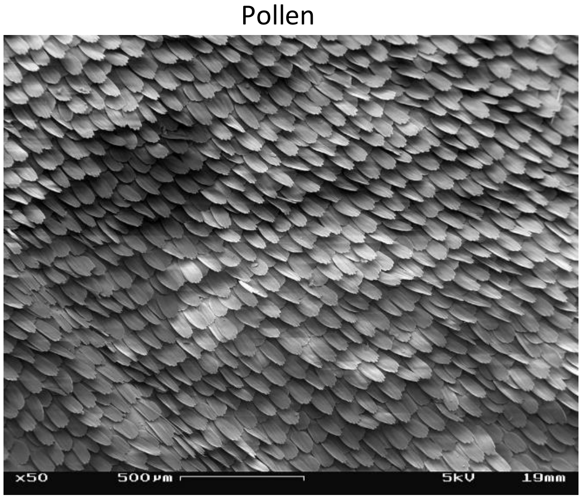
Electron Microscope Images



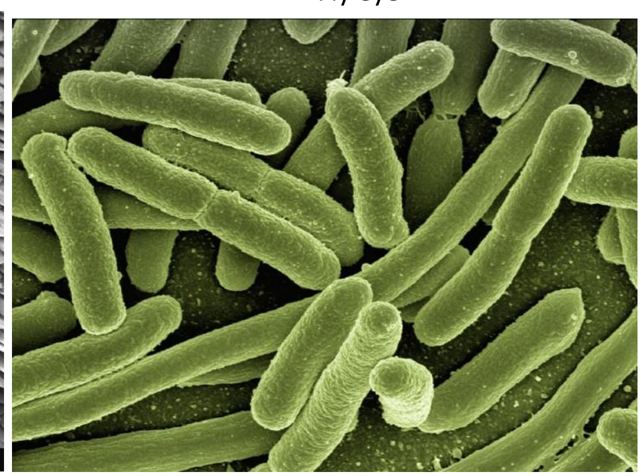
Pollen



Fly eye



Butterfly wing



Bacteria

For your interest:

- Virtual Electron Microscope
- National Geographic Microscopy Images

You are now ready to complete Part C of the First Assignment