The Cell

The cell is the smallest unit that can perform all the functions necessary for life. All forms of life consist of one or more cells. There are two types of cells: prokaryotic cells and eukaryotic cells. All prokaryotes belong to the domains Bacteria or Archaea. All organisms in these groups are single-celled. All organisms in the domain Eukarya consist of eukaryotic cells. They can be either single-celled or multi-cellular organisms.

List three differences between prokaryotic and eukaryotic cells:
1.

2.

3.

In this lab, you'll be examining both prokaryotic and eukaryotic cells using a microscope, the most widely used tool in microbiology. Microscopes work by passing light through an object and then through a series of lenses that bend the light, magnifying the image of the object.

While we do not have time for a full microscope techniques lab, your lab instructor will show you the basics. Refer to the labelled photo of a microscope and the table describing its parts at the end of this lab as necessary. Also, ask for help anytime, as learning to use a microscope effectively is not an intuitive or rapid endeavor.

Procedure 1: Examine prokaryotic cells
Obtain a microscope and a prepared slide of *Oscillatoria*. These bacteria, as well as *Gloeocapsa*, which you will examine next, belong to a group of prokaryotes called **cyanobacteria**: photosynthetic bacteria. Being prokaryotes, these organisms do not have chloroplasts, the organelles of photosynthesis that some eukaryotes like plants have. Rather, cyanobacteria have infoldings in their plasma membranes that function in photosynthesis.

The importance of cyanobacteria to life on Earth cannot be overstated: roughly one-third of the oxygen produced by the process of photosynthesis on the planet comes from cyanobacteria, which live largely in the oceans and other aquatic environments.

Examine the *Oscillatoria* slide, asking for help with the microscope as needed.

Oscillatoria is a colony-forming organism; in this case, the cells aggregate into filaments. At 400x magnification, you should notice what look like ridges in the filaments. Each ridge represents one individual bacterium.

In the space below, draw what you see at 400x.

Do you see any organelles? (think about it…)

Next, obtain and examine a prepared slide of *Gloeocapsa*. Note that it also forms aggregations of cells inside of a clear, mucilaginous sheath. At 400x magnification, the tiny blackish dots you see are individual cells.

Draw what you see at 400x in the space below

Return the objective to low power (40x), focus the image, then, leaving the microscope adjusted for the next procedure, remove the slide and return it to the proper slide tray.

Procedure 2: Examine plant cells

Plants, like animals, fungi and a group of organisms collectively known as protists, consist of eukaryotic cells. One of the characteristics that distinguish plants from animals, fungi, and many protists, is that they can carry out photosynthesis: the synthesis of sugar molecules from water and carbon dioxide. The process is powered by energy from the sun and produces oxygen as a by-product.

Select a small, healthy-looking *Elodea* leaf (or other aquatic plant supplied by your instructor) from near the tip of a sprig, and wet mount it on a slide as you did in the microscope lab. Ensure that the top of the leaf is facing up. Examine the tip of the leaf at 40x, 100x and 400x. Can you see individual cells? ____________What shape do they generally have?_____________

Draw what you see at 400x in the space below

By rotating the fine-focusing knob back and forth, you can get different superimposed layers of cells to come into focus. Using this technique, determine how many cell layers there are in your leaf and write this down. Number of cells in the leaf you are looking at:_____________
What is/are the most prominent structures visible inside the plant cells?_________________
Are they static or do they move around?__________________What color are they? What gives them that color?____What is their function?
____

Carefully observe the chloroplasts in your cells. Are any of them moving? _________This kind of movement is called **cytoplasmic streaming** and serves to distribute materials within the cell. It requires the cell to expend energy.

Focus your slide at 40x, leaving the microscope adjusted for the next procedure. Remove the *Elodea* slide and discard it in the beaker provided or the broken glass box.

Procedure 3: Examine animal cells

Cells, while generally microscopic in size, come in many different shapes, depending on their function. Certain nerve cells, for example, have a long cytoplasmic extension that serves to transmit signals between cells. Other cells are more compact. In this procedure, you will examine some of your own cells: epithelial cells from the inside of your cheek.

Obtain a clean slide, cover slip, and a toothpick. Place a dime-sized drop of water on your slide. With the flat side of the toothpick, gently scrape the inside of your cheek. Swirl the end of the toothpick in the water drop and place a cover slip on it. Dispose of your toothpick in the bleach solution provided.

Examine your slide beginning with the low power objective and see if you can find any cells. Can you distinguish any structures inside the cells?

Microscopic images can often be enhanced with stain. To stain your specimen, place a small drop of Methylene Blue at the corner of the cover slip. The stain will mix with the water under the cover slip and be drawn over the cells by capillary action. You can speed this process up a little by gently touching a bit of paper towel to the opposite corner of the cover slip from where you placed the stain. Your instructor will demonstrate the staining technique if necessary.

Draw what you see at 400x in the space below

Procedure 4: Examine protists

"Protist" is a catchall term for eukaryotic organisms that are *not* plants, animals, or fungi. They include multi-cellular algae and many single-celled aquatic organisms like amoebae.

Obtain and examine a prepared slide of *Paramecium*.

Draw what you see at 400x in the space below

If you have access to the Internet in lab, watch the following 35 second video of a Paramecium: https://www.youtube.com/watch?v=a4aZE5FQ284. Note the beating of cilia, the pulsing of the gullet and the contractile vacuoles in action. What functions do you think each of these structures performs?

Obtain and examine a prepared slide of *Amoeba*

Draw what you see at 400x in the space below

Amoebas are single-celled protists. They are irregular in shape and move by means of **pseudopodia** (=false foot), temporary protrusions of the cell. Pseudopodia also surround food particles and create food vacuoles, where food is digested. This is illustrated in the following one-minute video: https://www.youtube.com/watch?v=W6rnhiMxtKU. Amoebas also have contractile vacuoles for expelling water and waste products.

Return your slides to the appropriate slide tray.

Procedure 5: Examine bacteria in yogurt

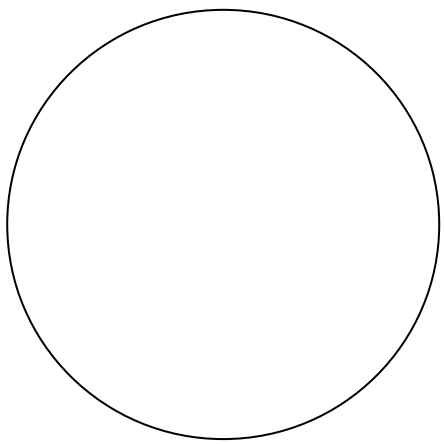
Now that you've had practice examining various eukaryotic cells, try your hand at observing smaller cells: bacteria from yogurt. Yogurt is a nutrient-rich culture of bacteria that feed off the lactose sugar that naturally occurs in milk. The sour taste of yogurt is a by-product of the bacteria's metabolism. The high acid content of the yogurt acts as a preservative, so yogurt can be kept longer than milk without spoiling. Because the bacteria metabolize the lactose in milk, many people find yogurt more easily digestible than milk and milk products.

Remember that bacteria are prokaryotes and on average, 10 times smaller than the eukaryotic cells you've just been examining. That means you should not expect to see individual cells at lower magnifications.

Start with your microscope in sharp focus at 100x on a reference slide (like for example, one of the amoebas you just looked at). Obtain a clean slide and cover slip. Place a dime-sized drop of water on the slide. Take a clean toothpick and obtain a *tiny* (smaller than the pencil-lead in a mechanical pencil) dab of yogurt. This is important, the saying "less is more" really applies in microscopy. Swirl the dab of yogurt in the water droplet and place a cover slip on it. To the naked eye, the slide should look clear; if it is cloudy, it probably means you got too much yogurt and will not be able to see the bacteria clearly. If this is the case, make a new preparation.

Place your slide under the microscope and examine in it first at 100x. Adjust the focus if necessary, then increase the magnification to 400x. You should see grayish blobs of yogurt protein and in between these, tiny quivering dots. The bacteria may look like they're all "swimming" in one direction, but that's an artifact of the water evaporating from under the cover slip. The evaporation is usually uneven, creating this streaming effect.

Draw what you see at 400x in the space below



Discard your bacteria slide as instructed and put the microscope away as follows:

- Rotate the 4x objective back into place and turn the coarse adjustment knob towards you so that the stage is all the way down

- Remove any slide from the stage and dispose of it as instructed or place it back in the slide tray if it is a permanent slide

- Turn the power switch off and wind the cord around the cord winder at the back of the microscope

- Loosen the thumbscrew and turn the body tube around; tighten the thumbscrew. Place the dust cover back on the microscope and return it to the cabinet

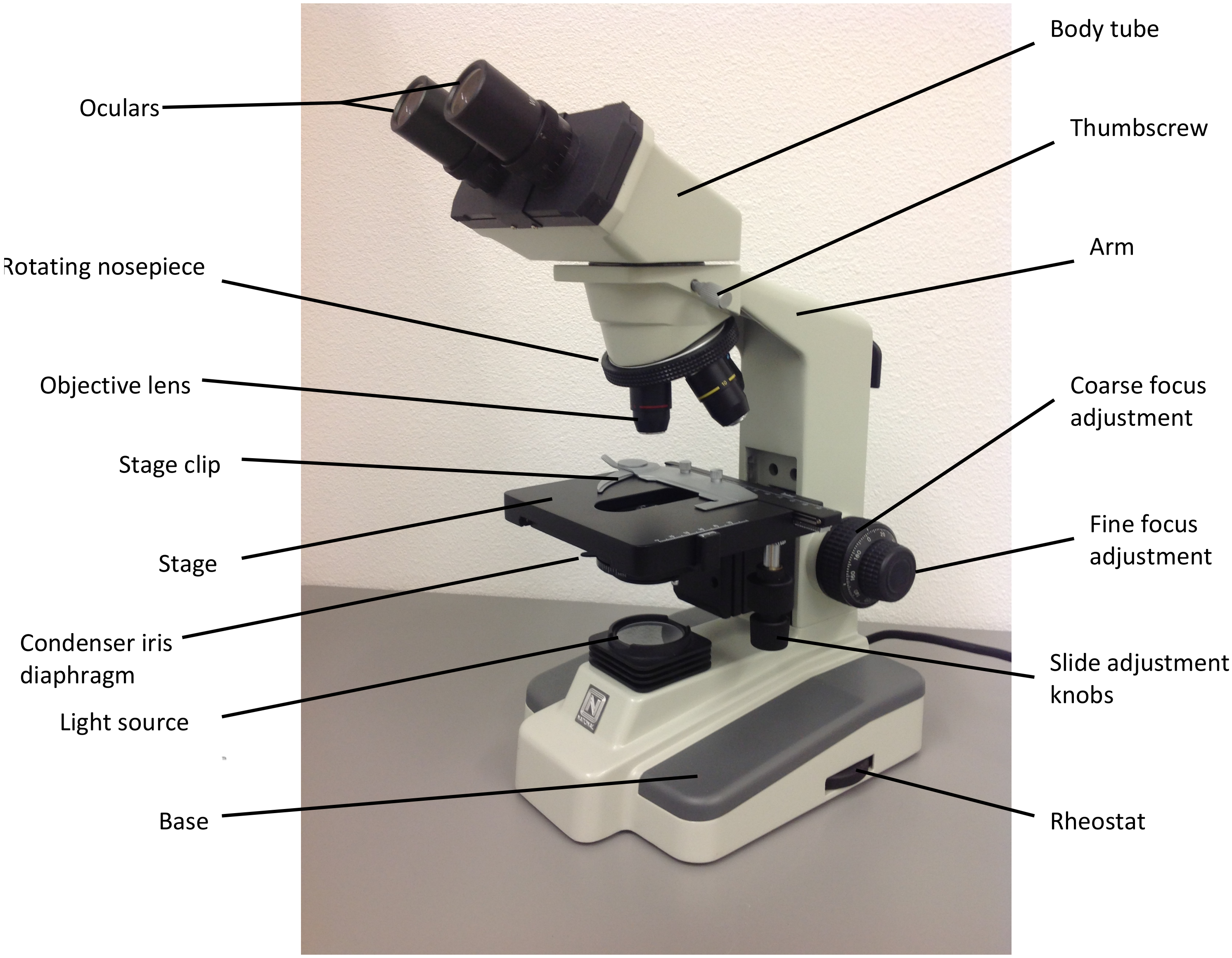


Figure 1. Labeled microscope

Table 1. Microscope parts and their function

Microscope part	Function
Ocular (eyepiece)	The uppermost lens through which a specimen is viewed; usually has a magnification of 10x. There are two oculars in a binocular microscope
Body tube	Holds the nosepiece at one end and the oculars at the other
Arm	Serves as a handle for carrying the microscope
Rotating nosepiece	Revolves and holds the objective lenses; when changing objectives, turn the nosepiece instead of using the objectives themselves; the objectives click into place when properly aligned
Objectives	Also called objective lenses; lower set of lenses attached to the rotating nosepiece; the magnification of each objective is stamped on the housing of the objective
Scanning objective (short, red)	Used for viewing larger specimens or searching for a specimen; the shortest objective usually magnifies 4x
Low power objective (yellow)	Magnifies an object 10x
High power objective (blue)	Magnifies an object 40x
Oil-immersion objective (white)	Uses oil to concentrate and focus light on the specimen; magnifies 100x
Stage	Platform where the slide is placed
Stage clip	Secures the slide on the stage
Slide positioning knobs	Move the slide around on the stage: up-down, left-right
Light source	Illuminates the specimen
Rheostat	Controls the intensity of the light
Iris diaphragm	Regulates light entering the microscope; usually controlled by a mechanical lever or rotating disk
Condenser	A lens system found beneath the stage; used to focus the light on the specimen
Coarse-adjustment knob	Used to adjust the microscope on scanning and low power only
Fine-adjustment knob	Used to adjust the specimen into final focus
Base	Supports the microscope; the part that rests on the lab bench