Using a Microscope to See Different Types of Cells

by Drs. Vivianne Nachmias, Lori Spindler, Ingrid Waldron, and Jennifer Doherty, University of Pennsylvania, © 2018

All organisms are made up of cells. Some organisms are single-celled. A single cell accomplishes all the different functions that are needed to live. Name two types of organisms that have only one cell.

In contrast, our bodies consist of trillions of cells with many different cell types. Each of our cell types has its own special function. The different cells communicate and cooperate with each other to accomplish all the functions that our bodies need.

Most cells are very small, so we need to use a microscope to see them. In this lab, we will be using a microscope to look at different types of cells. A microscope (micro = tiny or small; scope = to see) is really just two magnifiers or lenses working together. The ocular lens, inside the cylinder that you look into (it is called the eyepiece, being near your eye) magnifies object 10 times, expressed as 10x. The objective lenses (near the object) are down near the slide. The magnification of the objective lenses can vary from 4x to 100x. To get the total magnification you would multiply the magnification of the ocular lens by the magnification of the objective lens. An object viewed using the 4x objective lens would be magnified 40x total. Together, the ocular and objective lenses are able to magnify an object much more than a single lens can.

If you are not experienced in using a microscope, read "How to Use a Microscope" (pages 7-9) and follow the instructions on **Viewing a Slide Under the Microscope** on page 7.

Part 1: Blood Cells

You will begin with a prepared slide of human blood cells. Human blood consists of red blood cells, white blood cells and platelets, suspended in a liquid called plasma. Red blood cells bind oxygen and carry it to all the tissues of the body. White blood cells protect the body from infection and platelets aid in clotting after an injury.

1. Find the red cells; how abundant are they? Do the red blood cells have nuclei? Draw a red blood cell as it appears to you under the microscope.

2. Now find the white blood cells. They have been treated with stain to make them more visible and will appear purple on the slide. How abundant are they? Do the white blood cells have nuclei? Draw a white blood cell as it appears to you under the microscope.

3. Now look at a slide with frog blood cells. Do frog red blood cells have nuclei? Can you suggest a hypothesis to explain the difference in structure between frog and human red blood cells? Draw a frog red blood cell as it appears to you under the microscope.

4. Next, look at a slide with red blood cells from a person who has sickle cell anemia. A person with sickle cell anemia makes some normal hemoglobin, the protein that carries oxygen within the red blood cell, and some mutated hemoglobin that clumps together and changes the shape of red blood cells. Draw the types of red blood cells that you see on this slide. How does the abundance of normal cells compare to the abundance of sickle shaped cells?

Part 2: Cheek Cells and Bacteria

You will now prepare a slide of your own cheek cells and the bacterial community that lives in your mouth. You will use a toothpick to put the cells on a slide and stain them using methylene blue. Follow the detailed instructions below to make sure you create a good quality slide.

1. Put a drop or two of the 0.85% salt solution on your slide. This will match the concentration of your saliva and prevent your cells from changing shape due to osmosis.

2. Hold a toothpick flat against your inner cheek and scrape the inside of your cheek. This will release some of the cells lining your cheek.

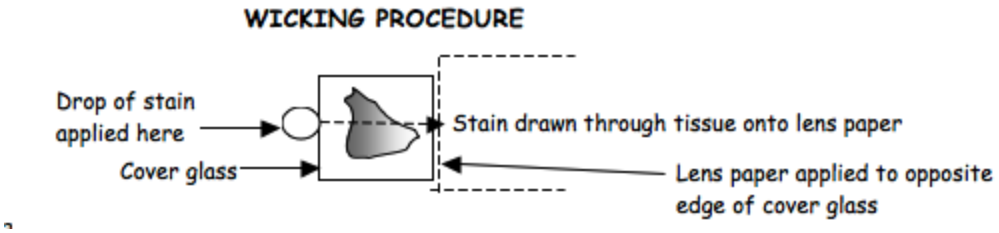
3. Spread the cells on one half of a clean slide by rubbing the toothpick flat against the slide. Make sure you get plenty on the slide so you can easily find them under the microscope; you want to be able to see a kind of smear on the slide with just your eyes.

4. Stick a fresh toothpick between your teeth and wiggle it. To be sure you have a lot of bacteria, repeat 2 or 3 times using different teeth in your mouth.

5. Smear the end of the toothpick on the slide close to your cheek cells.

6. Add a cover slip on top of the cheek and bacterial cells. Place the cover slip starting at an angle to avoid air bubbles. Air bubble look like circles with thick black rings around them.

7. Right against the edge of the cover slip add a drop of the methylene blue stain. Then place thecorner of a paper towel on the other side of the cover slip. As the salt solution is absorbed by the lens paper or a paper towel it will wick a thin layer of methylene blue under the cover slip. Remove any extra stain from the edge of the cover slip with a paper towel.



8. Always put the slide on the microscope stage with the lowest power objective lens facing down. Move the slide around and when you see something that looks like cells focus on it as well as you can. Only then should you go to a higher power.

9. First look at your cheek cells. Look carefully for some pale irregular shapes with a blue circle or oval in the middle. Most cheek cells will show this; the oval is the nucleus of the cell, where the DNA is located. Draw a cheek cell and label the nucleus.

10. Now look at the other half of your slide. Bacteria appear as very, very small blue-stained rods or spheres, which look like circles. These are two different main groups of bacteria. See if you or other members of your group can find both kinds of bacteria. Sometimes the rods are in long chains like tiny necklaces because they grow lengthwise and often stay connected after dividing. You may also see smeary stuff, which is probably your saliva or partially digested food from your teeth.

11. Can you see a nucleus in the bacteria?

12. Go back and look at your cheek cells again. Can you find any bacteria on top of the cheek cells? The human mouth is full of bacteria, and although most bacteria in the mouth are found on or between the teeth, sometimes there are bacteria living right on the cells.

13. What is (roughly) the difference in size between the bacteria and the cheek cell? This is easy to see if you find a bacterium on top of a cheek cell.

14. Why do you think most of the bacteria in our mouth are found between or on our teeth?

Part 3: Single-Celled Organisms

In this section you will be examining single-celled eukaryotic organisms. Eukaryotic means that the cells have a true nucleus, with DNA in chromosomes and a nuclear membrane surrounding the chromosomes. In contrast, bacteria are prokaryotic; bacteria have DNA in a region called the nucleoid, but not a membrane around a nucleus. Another important difference is that eukaryotic cells are much larger than prokaryotic cells, so they are easier to see under the microscope. We will refer to these single-celled eukaryotic organisms as protists. Today, you will look for protists in pond water.

1. Place a few drops of pond or aquarium water on a slide and put a cover slip on top. If possible, include some decaying leaves or bits of plant matter, as they will prevent the protists in the pond or aquarium water from being squashed. Do not use any dye (methylene blue), as it will kill the protists! Look at the slide under your microscope starting at low power. Look near the decaying leaves of the water plants, and try to find living organisms -- if the protists or small animals are moving they probably are alive.

2. Examine the slide under low power first to find moving objects. Then, increase to medium and high power. Try to find a protist moving very slowly and describe how it moves.

Part 4: Plant Cells

Organisms can be made up of many types of different cells. You will now prepare two slides, one that will allow you to see the different types of cells present on the surface of a leaf and another that will allow you see internal structures of the leaf. Most of the cells on the surface of a leaf are epidermal cells which provide a protective barrier between the inside of the leaf and the environment. The surface of a leaf also has pores, called **stomata**, which have a special cell called a **guard cell** on either side. Guard cells can change shape to open or close the stomata. When open, these guard cells allow CO_2 into the leaf for photosynthesis and allow water to leave the leaf.

A. **Leaf Surface Cells**

1. Apply clear nail polish to the underside of a leaf. You do not need to cover the entire leaf. A section 1-2cm long is sufficient.
2. Allow the nail polish to completely dry and harden.
3. Place a piece of tape onto the hardened nail polish. Peel the tape and nail polish off of the leaf. Try not to get any leaf material stuck to the tape.

4. Place the tape on a slide so that the nail polish is sandwiched between the tape and the slide. The tape will act as a cover slip.
5. As you did with the previous slides start to focus on the lowest power and increase to 40x. Observe the arrangement of leaf epidermal cells and stomata with guard cells.
6. Draw a portion of the impression of the leaf surface. Include both epidermal cells and guard cells.

B. **Onion Skin**

The layers of an onion or scallion are actually modified leaves tightly stacked into a structure called a bulb. They lack the green pigment chlorophyll since they grow underground and do not photosynthesize.

1. Place a drop or two of water on a clear glass slide.
2. Remove a small piece of the thin membrane between the layers of an onion or scallion.
3. Place a small piece of the membrane on a glass slide. Use forceps to position it on the slide smoothly with no wrinkles or folds.
4. Place a cover slip on top of the membrane.
5. As you did with the previous slides, start to focus on the lowest power and increase to 40x. Observe the arrangement of cells and draw what you see.

Part 5: Comparisons

1. How does the shape of the red blood cells differ from the shape of the plant cells? How do their shapes relate to their functions?

2. Why do you think sickle shaped cells produced in people with sickle cell anemia cause symptom such as pain and swelling in the hands and feet?

3. How do you think cheek cells and red blood cells get food as compared to the protists you observed?

4. How does the way red blood cells move differ from the way protists move?

5. Why is it important for red blood cells and protists to move? Why don't cheek cells move around?

6. Could cheek cells or blood cells survive as a single-celled organism? Why or why not?

7. The guard cells on a plant's leaves allow their stomata to open and close. Why is it beneficial for a plant to be able to open and close its stomata? Under what conditions would expect plants to open their stomata? Under what conditions would you expect plants to close their stomata?

8. How do the shapes of the cheek cells and onion skin cells differ? What structures in the cells could account for this difference?

How to Use a Microscope

by Drs. Irby Lovette and Linda Robinson, University of Pennsylvania

The compound microscopes you will be using are expensive, delicate instruments. Please treat them with special care.

It is important that you learn to use the compound microscope correctly. Incorrect use could damage the microscope, give you a headache, and prevent you from seeing the materials you are supposed to study.

Some general rules of microscope use that you must always follow include:

1. Never adjust anything without knowing exactly what you are doing.

3. When starting to use a microscope, always start by adjusting the ocular lenses correctly for the width of your eyes.

4. Never remove any lenses from the microscope.

5. Always lift the microscope with both hands, with one hand grasping the arm of the microscope and the other supporting the instrument from underneath.

6. Turn off the light source using the toggle switch before unplugging the microscope. Before plugging in a microscope, check that the previous user turned the light source off correctly. Plugging the microscope in with the light turned on tends to burn out the light bulb.

Viewing a Slide Under the Microscope

You will now practice using the microscope by viewing a sticker on a slide.

1. Place a small sticker on the center of your slide. And write a letter or draw a small, simple picture.

2. Set the stage as close to the objective lens as possible, but be especially careful that you do not rotate the focusing knob in such a way that the objective lens comes into direct contact with–or smashes through–the slide. This will destroy the objective lens. This mistake is particularly easy to make when using the 40x and 100x objective lenses, because these lenses need to be close to the slide for proper viewing.

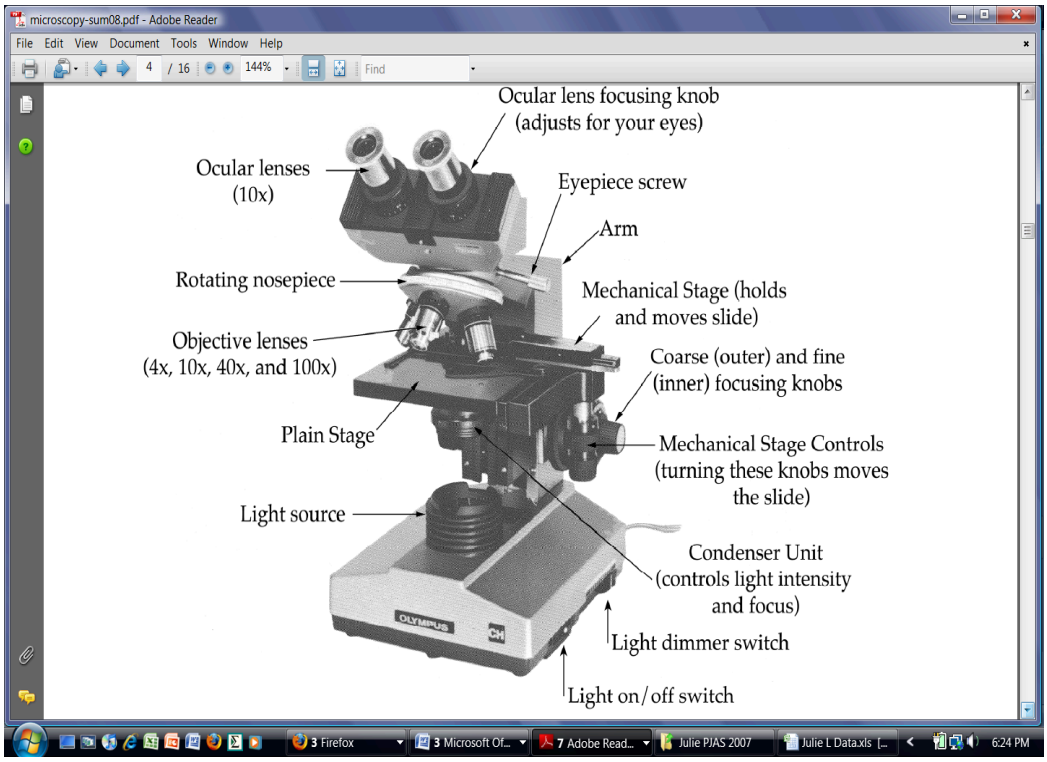
3. Observe your slide under the weakest (4x) objective lens first. Focus using the 4x lens using the course focus knob then the fine focus knob, then flip to the next (10x) lens, and focus it. Then flip to the 40x lens, focus it, etc.

4. How does your letter or picture look under the microscope as compared to when you view it just with your eyes?

5. How does your letter or picture change as you increase the magnification? What details do you see that were not apparent before?

Parts of the Compound Microscope

1. **Ocular Lenses.** Twin 10x lenses housed within the two eyepieces. It is important to adjust the ocular lenses to match your individual eyes, as described below.
2. **Objective Lenses.** A set of four lenses of varying magnification (often 4x, 10x, 40x, and 100x). These are mounted on a **rotating nosepiece**. Always start with the 4x objective and work your way sequentially to the higher power lenses.
3. **Arm.** Always lift the microscope by firmly grasping the arm and supporting the base.
4. **Plain stage.** Supports a slide placed in the mechanical stage.
5. **Mechanical Stage.** A slide clipped into the mechanical stage can be moved by turning the two stage adjustment knobs. See below for a description of how to insert a slide into the mechanical stage.
6. **Focusing Knobs.** The outer knob is used for coarse focusing and the inner knob for fine focusing adjustment. Turning the focusing knobs moves the objective lenses in relation to the slide. While adjusting the focus, be careful not to ram the objective lens into the slide.
7. **Eyepiece screw.** Loosening this screw allows the entire eyepiece assembly to be rotated. For your purposes this is not necessary and the screw should be tightened.
8. **Main light switch.** Turns lamp on and off. Always turn off before storing microscope.
9. **Sliding light switch.** A dimmer switch used to adjust light intensity.
10. **Condenser.** A lens system that concentrates the light on the slide. This is used for improving the contrast of the image. You can adjust the condenser in two ways: with the knob just behind it that raises and lowers the condenser in relation to the stage, and with the small aperture control lever on the front of the condenser unit. Ask your teacher to show you how to adjust the condenser optimally.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Arm
Rotating nosepiece
Mechanical Stage (holds
and moves slide)
Objective lenses
(4x, 10x, 40x, and 100x)
Coarse (outer) and fine
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