Lab 4:
Prokaryotic and Eukaryotic Cells

Bio-
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for AP® Courses

In this lab, you will learn

- how to make wet mounts of bacteria, plant and animal cells and view them under the microscope
- how to observe and identify differences between cells and cell structures under low and high magnification and record your observations
- how and why microscope stains are used when viewing cells under the microscope

Activity 1: Pre-Assessment

1. What is the difference between the cells of a bacterium and the cells of your own body?
2. Compare and contrast the structures of prokaryotic and eukaryotic cells.
3. Discuss the answers to questions 1 and 2 with a partner and then the class.

Activity 1: Observation of *Anabaena or Nostoc*

Prokaryotes, unicellular organisms lacking a nucleus, include cyanobacteria (formerly blue-green algae. This name is now considered inaccurate because algae are eukaryotes. Cyanobacteria, like those shown in Figure 4.1, are **photoautotrophs**—organisms that carry out **photosynthesis** by using light energy, water, and carbon dioxide from the air and converting to sugars, and providing oxygen to the atmosphere as a waste product. Cyanobacteria contain pigments capable of capturing light energy but do not contain chloroplasts. Cyanobacteria are single-celled organisms, but some can form colonies with differentiated cell types. For example, some species can form specialized cells called **heterocysts—**structures containing enzymes which can take atmospheric nitrogen (**nitrogen fixation**) from the air and convert into usable molecules for DNA, RNA, and protein synthesis. Nitrogen fixation involves converting nitrogen gas (N_2) from the atmosphere to ammonia (NH_3). Ammonia is a form of nitrogen that can be used to build other molecules, including DNA, RNA, and proteins. Oxygen, a waste product of photosynthesis, interferes with a key enzyme in nitrogen fixation. Thus, only a few cells in a colony (about 1 in 10) become heterocysts. Resources, such as ammonia and sugars from photosynthesis, are then shared between cells. These cells range from 1–40 micrometers in size. Not all bacteria can carry out photosynthesis there are many species of heterotrophic bacteria living virtually everywhere on Earth. These cells are much smaller ranging from 0.5–8 micrometers. Eukaryotic cells have many more features and organelles and range in size from 10–500 micrometers.

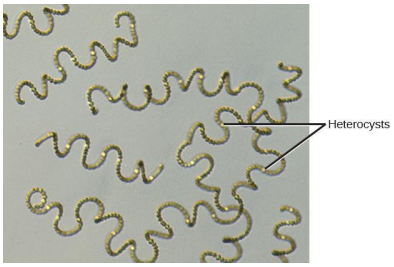

Figure 4.1: Cyanobacteria *Nostoc* with larger heterocysts.

Safety Precautions

- Be careful when handling glass slides, the edges may be sharp.
- Observe proper use of the microscope; avoid handling the electric cord with wet hands.
- Do not use the coarse adjustment knob of the microscope at higher magnifications
- Inform your teacher immediately of any broken glassware, as it could cause injuries.
- Wash your hands with soap and water after handling live organisms.

For this activity, you will work *in pairs*.

For this activity, you will need the following:

- Light compound microscope (10×, 40×, 100×)
- Lens paper
- Prepared slide of *Anabaena* or *Nostoc* or images of *Anabaena* or *Nostoc*
- Special slide with micron ruler or clear millimeter ruler (you can photocopy ruler on overhead transparency, then cut and tape to microscope slide)

Structured Inquiry

Step 1: Estimate the size of the field of view at all the magnifications of your microscope by placing a clear millimeter ruler on the stage of the microscope. This will allow you to estimate the sizes of cells. Convert your millimeter estimates to micrometers for this activity.

Figure 4.2: Example of a millimeter ruler taped to a microscope slide.

Step 2: Hypothesize/Predict: In your notebook predict (draw) what you would expect to see in the microscope. How big do you predict the cells will be? What features do you expect to see? Do you expect to see organelles or a cell wall?

Step 3: In your notebook, create a detailed drawing, with a sharp pencil, of the structure of the cyanobacterium. An example of a detailed drawing is seen in Figure 4.3. Record the estimated size of the cells at the magnification used. Use color in your drawings if appropriate. Identify the colors used and label any obvious structures. Note the shapes or organization of the cells.

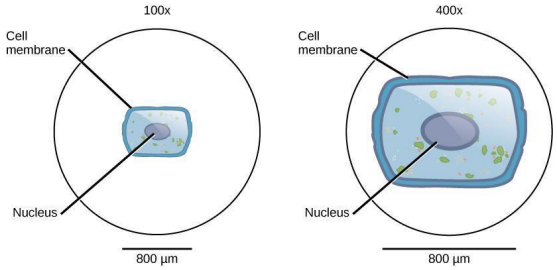

Figure 4.3: Example of a student drawing including labels and magnification.

Step 4: Critical Analysis: Think about the cell types you observed. Do your observations match your expectations? For example, given that the cyanobacteria is photosynthetic, was the color what you expected? Why? Did you expect the cells to have organelles? Did they? Did they have a cell wall? Did you find heterocysts? Discuss with your partner and write your answers in your notebook.

Assessments

1. Create a diagram of a general prokaryotic cell and a general eukaryotic cell. Label the cell structures that differ between the two cell types.
2. How would internal membrane-bound structures, such as chloroplasts and mitochondria, allow chemical reactions to occur more efficiently in cells?

Activity 2: Pre-Assessment

1. What new structures would you observe in *Elodea* cells which are not present in a cyanobacterium cell?
2. Which of those structures would you expect to observe in an onion skin cell? Can you explain why some structures will be present in an *Elodea* cell but not in an onion epidermal cell?
3. Discuss the answers to questions 1 and 2 with a partner and with the class.

Activity 2: Comparing Plant Cells

Plant cells are eukaryotic; they have subcellular organelles. Like the bacteria, they have a **cell wall** to help keep the cell rigid—in plants, the cell wall is composed of a complex carbohydrate called *cellulose*. Plant cells, like that shown in Figure 4.4, also have a **nucleus** with DNA, a **large central vacuole** full of water and other important substances for maintaining life such as carbohydrates, non-nutrients, wastes, and help maintain cell pressure.

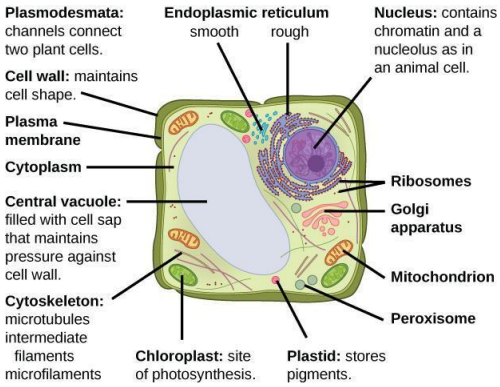

Figure 4.4: Structures found in a typical plant cell.

Safety Precautions

- Be careful when handling glass slides, the edges may be sharp.
- Dispose of used cover slips in a glass disposal box.
- Observe proper use of the microscope; avoid handling the electric cord with wet hands.
- Do not use the coarse adjustment knob of the microscope at higher magnifications.
- Inform your teacher immediately of any broken glassware as it could cause injuries.
- Wash your hands with soap and water after handling live organisms.

For this activity, you will need the following:

- *Elodea anacharis*, moss or *Spirogyra* green algae
- Light compound microscope
- Clean microscope slides and cover slips
- Lens paper
- Water and dropper
- Yellow onion
- Forceps
- Iodine solution (optional)

For this activity, you will work *in pairs.*

Guided Inquiry

Step 1: Hypothesize/Predict: What features do you expect to see in the plant cell *Elodea* and the onion skin under low and high magnification? Draw and label your prediction in your notebook.

Step 2: Student-led Planning: Prepare wet mounts of *Elodea* and the onion skin. View with water only, and again in iodine solution (biological stain). Record your observations as drawings. Use color if present, label the magnification, and estimate the size of the cells in your notebook. Each partner is expected to prepare one sample. Each person should view, draw, state the size and magnification, and label each sample.

Step 3: Critical Analysis: What differences are you expecting to see between *Elodea* and the onion? What similarities? If you used iodine as a stain, did that reveal any other differences in either plant? Why would these organisms have anything in common based on your prediction in Step 1?

Assessments

1. Were the features you predicted to see in *Elodea* cells and the onion cell visible at low and high magnification? Which structures in Figure 4.4 can you identify in the *Elodea* cells? What about the onion cells? Why do you think this is the case?
2. What are the similarities and differences between cyanobacterium and a plant cell?

Activity 3: Pre-Assessment

1. **Answer the following question in your notebook:** How do plant cells and animal cells differ? Why would these differences likely evolve in plant and animal cells?
2. **Answer the following question in your notebook:** What microscope techniques could help us see more structures within cells?
3. **Discuss the answers to questions 1 and 2 with a partner and then the class.**

Activity 3: Observe Animal Cells and Identify their Components

Animal cells are eukaryotic and possess subcellular components in common with the plant cells you observed in Activity 2. Organelles that plant and animal cells share in common include the nucleus, **Golgi apparatus**, **mitochondria**, **ribosomes**, and the **endoplasmic reticulum.** These are all participants in protein synthesis. An illustration of an animal cell is shown in Figure 4.5. There are some exceptions to these general components. For example, mature red blood cells (**RBC**) which have ejected their nuclei to have more room for **hemoglobin**, the protein that carries oxygen around the body. One of the easiest eukaryotic cells to obtain in the lab is the **squamous epithelial** cell (your cheek cells). These cells are arranged in a flat layer and are easy to remove and observe.

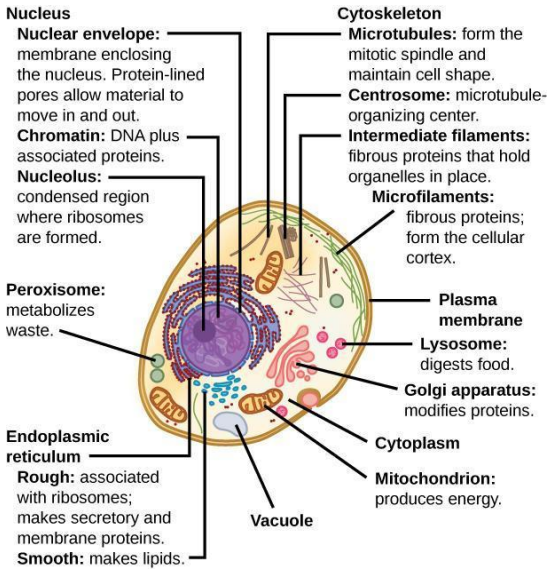

Figure 4.5: Diagram of the parts of an animal cell.

Safety Precautions

- Be careful when handling glass slides, the edges may be sharp.
- Dispose of used cover slips in a glass disposal box.
- Observe proper use of the microscope; avoid handling the electric cord with wet hands.
- Do not use the coarse adjustment knob of the microscope at higher magnifications.
- Inform your teacher immediately of any broken glassware as it could cause injuries.
- Used cotton swabs are considered biohazard; dispose of swabs in the biohazard trash container as soon as you have used them.
- Methylene blue is a dye; be cautious not to ingest methylene blue.
- Wash your hands with soap and water after handling live organisms.

For this activity, you will need the following:

- Prepared slide of red blood cells
- Light compound microscope
- Clean microscope slide, cover slip
- Clean cotton swab
- 0.5–1 percent methylene blue solution
- Dropper or pipette
- Small squares of paper towels

For this activity, you will work *in pairs.*

Guided Inquiry

Step 1: Hypothesize/Predict: Predict the different features you expect to see in the animal cell versus the plant cell. Predict the differences you will see between animal cells and prokaryotic cells under low and high magnification. Include in your prediction the size differences between a cyanobacterium, plant cells, and animal cells. Create a table in your notebook to draw and label your predictions in your notebook.

Step 2: Student-led planning: Observe the red blood cell prepared slide. Record your observations (draw and label any visible parts, use color if visible, include magnification and size of cells) in your notebook. Both partners should view, draw, state the size and magnification, and label each sample.

Step 3: Prepare your cheek cell slides as shown in Figure 4.6 and Figure 4.7 and outlined below.

a. Take a clean cotton swab and gently scrape the inside of your mouth.

b. Smear the cotton swab on the center of the microscope slide for 2 to 3 seconds.

c. Add a drop of methylene blue solution (a dye) and place a coverslip on top.

d. Remove any excess solution by allowing a paper towel to touch one side of the coverslip.

e. View the slide at all magnifications.

f. Record your observations as drawings. Use color if present, label the magnification, and estimate the size of the cells in your notebook. Record your observations (drawings, color if present, labels, magnification, and size of cell) in your notebook.

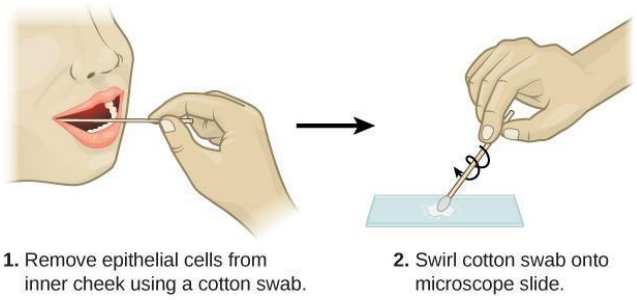

Figure 4.6: How to prepare a cheek swab.

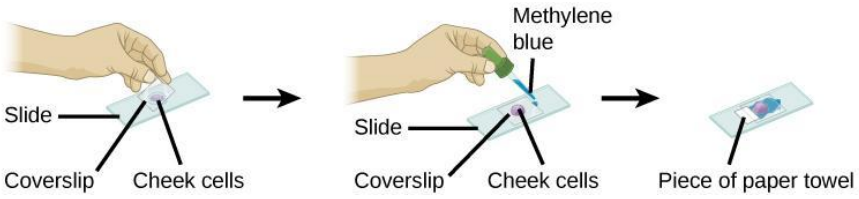

Figure 4.7: How to stain cheek cells with methylene blue dye.

Step 4: Critical Analysis: Were differences observed between the RBC and the cheek cell? What does the methylene blue stain reveal in the cheek cell? There should be small blue dots visible on the cheek cells much smaller than the nuclei. Hypothesize what those blue dots might be? How does the animal cell compare to the plant cells in Activity 2 and the cyanobacteria in Activity 1? Record the answers to these questions in your notebook.

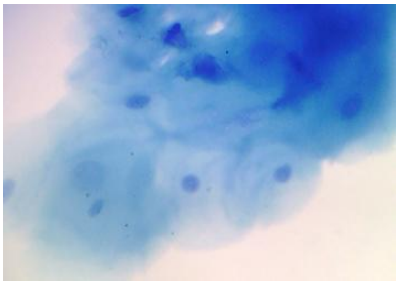

Figure 4.8: Cheek cells stained with methylene blue dye.

Assessments

1. Based on the staining technique you performed in this activity, how could you distinguish stained prokaryotic cells from stained eukaryotic cells?
2. What do all cells have in common, whether prokaryotic or eukaryotic? What major differences would you expect to find?
3. Identify whether the following images (Figure 4.9a, Figure 4.9b, and Figure 4.9c) show an animal cell, a plant cell, or a prokaryote cell. Explain how you know the difference.

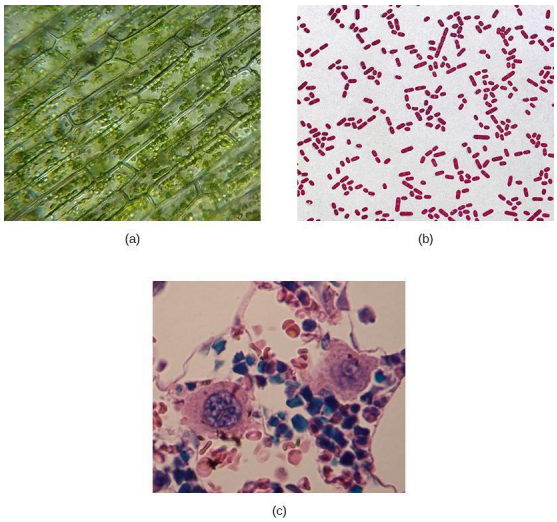

Figure 4.9: This figure shows three photos of different cell types. The photo in part (a) shows green cells with smaller organelles within. The photo in part (b) shows numerous tiny oval-shaped cells. The photo in part (c) shows a complex arrangement of different types of cells, some with a nucleus.