Exploring Cell Diversity

OBJECTIVES:

- To explore cell structure and morphology in prokaryotes and eukaryotes.
- To gain more experience using the microscope.
- To obtain a better understanding of these terms: prokaryote, eukaryote, cell, cell membrane, cell wall, nucleus, plastids, et al.
- Describe two general characteristics of prokaryotic cells.
- Distinguish among the three morphological types of bacteria.
- Describe the subcellular structure of a typical bacterium.
- Identify cellular structures of a typical plant cell.
- Identify cellular structures of a typical animal cell.

Understanding the nature of cell structure and function is important to an understanding of organisms. All organisms are composed of cells, whether they exist as single cells, colonies of cells, or in multicellular form. Cells are usually very small, and for this reason, a thorough understanding of subcellular structure and function has been possible only through advances in electron microscopy and molecular biology.

There are two general types of cells: prokaryotic and eukaryotic. These two words have their root in the Greek word karyon (nut), which refers to a cell's nucleus. The prefix pro- means "before" or "prior to." Thus prokaryotic means "before having a nucleus." Prokaryotic cells do not have a membrane-bound nucleus and their genetic material (DNA) is only loosely confined to a nuclear area within the cell. Bacteria, including the cyanobacteria (formerly known as blue-green algae), are prokaryotes. All other organisms are eukaryotes. The prefix eu- means "true." The cells of eukaryotes have true, membrane-bound nuclei containing their genetic material.

Prokaryotic and eukaryotic cells also differ in several other ways. Eukaryotic cells are generally larger and contain additional specialized compartments (membrane-bounded organelles) in which cell functions such as energy production may occur. Prokaryotic cells lack membrane-bound organelles; their cell functions are carried out in the cytoplasm.

During this laboratory you will investigate some of the structural of prokaryotic and eukaryotic cells.

PROCEDURE

Part A: Prokaryotic Cells

Part 1: Observing Bacteria

Most prokaryotic cells are extremely small (approximately 1 to 2 µm in diameter). Most are heterotrophic, depending on preformed food, but some are autotrophic and make their own food. Morphologically, bacteria are either round (coccus), rod-shaped (bacillus), or spiral-shaped (spirillum). To view them with the compound microscope, you must use an oil-immersion lens (100X objective). Even then, not much more than their basic shapes will be visible. With the aid of the electron microscope, however, you can study these prokaryotic cells more closely. You can even use special staining techniques to learn about their structure.
Figure 2-1. The cells of many familiar genera of bacteria include the (a) rod-shaped bacillus, (b) spherical coccus, and (c) helical spirillum.

You can use the compound microscope to study bacteria, but only their external features will be distinguishable. It is possible to identify the three morphological types of bacteria (coccus, spirillum, and bacillus) by observing their shape (Figure 2-1). You will also note that bacteria are often found in clusters or in chains.

2. Examine the oil immersion demonstrations of prepared slides of the bacterial specimens set up at the side of the room.
3. Draw simple sketches of these prokaryotes focusing on shape of the cells. Make the sketches in the spaces below. For each, note whether the bacterium is spherical (coccus), rod-shaped, (bacillus), or spiral-shaped (spirillum). Don’t forget to write in the magnification.

Specimen____________                        ____________                        ____________
Magnification ______                        ________                           ________
Shape             ______                      ______              ______

Part 2: Examining Cyanobacteria
1. Make a wet mount of the cyanobacteria species in the lab, as instructed, and observe under high-dry power (400X, the highest power that is not oil immersion).
2. Draw a representative cell in the space below and label the parts which you can identify (but don’t expect to be able to identify too much!!). Don’t forget to include the name of the organism and the magnification.
Part B: Eukaryotic Cells

All eukaryotic organisms are composed of cells, whether they exist as single cells, colonies of cells, or in multicellular form. Your body is composed of billions of cells, most of which are very small, with specialized structures that allow for a diversity of functions.

All eukaryotic cells have their genetic material enclosed by a nuclear membrane, the nuclear envelope. In addition, a variety of subcellular membrane-bound organelles are present. These include plastids, mitochondria, lysosomes, microbodies, and Golgi complexes. Internal membrane systems divide the cell into specialized compartments. Non-membrane-bound organelles, such as ribosomes and centrioles, and a cytoskeleton including microtubules, intermediate filaments, and microfilaments are also present in eukaryotic cells.

During this part of the lab you will investigate the structures of plant, animal, and protistan cells.

Part 1: Examining Plant Cells

The cells of plants are eukaryotic, containing both a membrane-bounded nucleus and membrane-bounded organelles. A cell wall composed of cellulose surrounds the plant cell. A large central vacuole surrounded by a membrane (the tonoplast) is used for storing water, pigments, and wastes. Within the cytoplasm are membrane-bound organelles unique to plants called plastids. In this lab, you will look at various types of plastids responsible for photosynthesis (chloroplasts), for storing starch (amyloplasts or leucoplasts) or for storing accessory pigments (chromoplasts). Chromoplasts contain several types of pigment including carotenoids, which give plants an orange or yellow color.

1. Prepare a wet-mount slide of an Elodea leaf. Observe the thick cell wall, thinner cell membrane, cytoplasm, nucleus, and chloroplasts. A large central vacuole should be apparent. These structures characterize a generalized plant cell.

2. Sketch a representative Elodea cell as observed under high power, and label its parts on your sketch.

   Specimen: ______________________
   Magnification: ______________________
   Shape and Description: _____________
   ___________________________________
   ___________________________________
3. Do the chloroplasts appear to move?  

   If so, describe their movement.

4. **Prepare a wet-mount slide of onion epidermal tissue.** Onions (Allium) have layers of modified leaves (scales) that can easily be separated from one another. Peel off a portion of one layer and examine the concave side of the piece you have obtained. The surface is covered by a thin layer of cells, the epidermis.

5. Remove a small piece of the epidermis (approximately 3 X 8 mm) by breaking the scale gently, leaving the epidermis intact. Peel the epidermis from one of the halves of the scale. Prepare a wet-mount slide of the isolated epidermis.

6. Observe the onion cells using low power (10X objective) and then high power (40X objective).

7. If it is difficult to see the cells, add a drop of Lugol's solution (I₂KI) at the edge of the coverslip. The iodine in the Lugol’s solution will stain starch blue/purple.

   Does this solution stain the cells as it reaches them?

8. Sketch a representative onion cell as observed under high power, and label its parts.

   Specimen: ______________________
   Magnification: ______________________
   Shape and Description: _____________
   ___________________________________
   ___________________________________

9. Compare the onion cell with the Elodea cell. Since they are both plant cells, they should be similar. You will note that onion cells lack one structure (organelle) that is very conspicuous in Elodea cells.

   What is this organelle missing in the onion cells?
10. List the similarities and differences between Elodea cells and onion cells.

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11. **Prepare a wet mount slide of a potato.** Use a razor blade to slice a piece of tissue, as thin as possible, from a potato. Be careful not to cut your fingers! Prepare a wet-mount slide; use a drop of water.

12. Study the slide at low power (10X objective) and then at high power (40X objective). Add a drop of Lugol's solution (I₂KI) to the side of the coverslip and observe the cells as the iodine solution makes contact with them.

   Specimen: ______________________
   Magnification: ______________________
   Shape and Description: _____________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

   How does the reaction of iodine with the potato cells compare with what you observed in your onion epidermis preparation?

   What does this tell you about the differences between the storage products in onions and potatoes?

   Do you see any chloroplasts? ___ Why or why not?

   You will probably see some small oval-shaped blue-black structures. These **leucoplasts** store starch. Why did they turn blue?
13. If a banana is available, scrape a small amount of tissue from its surface and spread it onto a slide. Add a drop of Lugol’s solution and a coverslip. Observe the preparation using high power (40X objective).
   How do these observations compare with what you saw in the potato?

14. **Prepare a wet mount slide of carrot or red pepper.** Use a razor blade to slice a piece of tissue, as thin as possible, from the outer portion of a peeled carrot, or scrape some tissue from a red pepper. Prepare a wet-mount slide using water.

   Can you see the chromoplasts? Sketch them.

   Specimen: ______________________
   Magnification: ______________________
   Shape and Description: _____________
   _____________________________________________________________________
   _____________________________________________________________________

**Part 2: Examining Animal Cells**

Animal cells can be studied using the light microscope, but most of the cellular organelles within the cytoplasm are not visible without the use of special staining techniques. The nucleus and nucleolus, where ribosomes are manufactured, are usually apparent in most cells.

1. **Prepare a wet mount slide of your cheek cells.** You will examine cheek cells obtained from your mouth. Instructions for obtaining and staining the cheek cells will be provided by your instructor. Sketch a few cells, and label the plasma membrane, nucleus, and cytoplasm.

   Specimen: ______________________
   Magnification: ______________________
   Shape and Description: _____________
   _____________________________________________________________________
   _____________________________________________________________________

Do the cells you observe have a cell wall? ____ Plastids? ____ Chlorophyll? ____
List the similarities and differences between the plant cells and the animal cells you have observed.

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List the similarities and differences between the plant cells and the animal cells you could not see but expect to be present.

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**TO TURN IN:** Answer all the questions posed in the proceeding pages. If you need additional space, please use a separate page. Also include all drawings as indicated.