Lesson Plan
Cell Comparisons (6-8)

Estimated Time: Over several days.

Central Benchmark
5C Cells (6-8)#1
All living things are composed of cells, from just one to many millions, whose details usually are visible only through a microscope. Different body tissues and organs are made up of different kinds of cells. The cells in similar tissues and organs in other animals are similar to those in human beings but differ somewhat from cells found in plants.

Objective
Students will be able to describe likenesses and differences among the cells of one kind of living thing and among the cells of a variety of living things.

Advance Preparation
Have an aquarium ecosystem that includes elodea plants set up in the classroom.

List of Materials
For the class:
- Aquarium ecosystem containing goldfish, snails, and elodea plants
- Whole onion plant including stem. (If you can find a whole red onion plant, you can avoid the use of a stain.)
- Several small beakers containing water and a dropper
- Several small beakers of dilute IKI solution for staining slides
- Sentence strip containing the statement, "All living things are made of cells."
- Cube made of detachable Lego toys

For each research group of three:
- Set of prepared slides of human skin cells, skeletal muscle cells, nerve cells, and blood cells
- Set of prepared slides of nerve cells from a frog, a bird, a cat, and a human. (Slides showing muscle cells could also be used.)

For each student:
- Elodea leaf from aquarium ecosystem
- Microscope slides
- Cover slips
- Goggles
- Laboratory Report Sheets #1, #2 and #3
- Crayons

Note: In this lesson it is important for each student to have ample time for leisurely microscopic study and to work without interruption using his or her own microscope. If you do not have enough microscopes for the whole class, rather than having students share microscopes, teach the lesson to part of the class on one day and to the rest of the class on a succeeding day or days.

Motivation
Ask students to focus their attention on the organisms you are going to place before the class. Where they can be seen by all students, place a sprig of elodea from the classroom aquarium ecosystem, an onion plant, and a bowl temporarily containing a goldfish from the aquarium ecosystem. Ask a student to stand next to these organisms.

Say: *Look at these four organisms: the elodea, the onion, the fish, and the human being. Work with a partner to write three statements that are true about* ***all four*** *organisms.*

Have some partners report responses, which may include statements such as

- All are in our classroom.
- All need food.
- All need air (or oxygen).
- All need water.
- All are alive.

Say: *Let's consider parts and wholes as we think about these four organisms. Does each of these whole organisms have parts?* (Respond:) *Yes. Now, name some parts of the human being, the fish, and the onion plant.* Ask the student to sit down, return the gold fish to the aquarium, and set aside the onion plant.

Continue: *Now let's focus on parts of the elodea plant. What parts can you identify?* Accept student responses, which will probably include the idea that one part of the plant is the leaf. Tear off a leaf and Ask: *Do you suppose this leaf has parts that are even smaller?* Accept student responses. Ask: *What do you think we would see if we observe this leaf with a microscope?* Accept student ideas.

Development

1. Observation of Plant Cells.
Elodea Cells: Organize the class into research groups of three. Distribute a microscope, slide, and cover slip to each student. Distribute beakers containing water and a dropper to locations around the room where they are available to all students. Demonstrate how to make a slide using a bit of elodea leaf. Give an elodea leaf to each student. Have each student make a slide and examine it with the microscope. Ask each student also to look at the slides of at least two classmates. Ask each group of three to formulate and write several statements describing what they observed. Caution students that the cells we observe on slides may appear to be two-dimensional, when, in fact, they are three-dimensional.

Have students share findings. Hold up another elodea leaf.
Ask: *Did we find that this kind of leaf has even smaller parts?* If students have trouble perceiving that the roughly rectangular shapes they observed are small parts of the whole leaf, sketch one rectangular part on the board and tell the students each one of these is a part of the whole leaf. Ask students, without using the microscope, to look again at their elodea leaves and determine whether they can see these small, rectangular parts. (They cannot.) Comment: *These parts of the leaf are too small to be seen without the microscope.*

Ask students to describe how the microscopic, rectangular parts they observed are arranged. Ask students what other things are sometimes arranged in this way. (Probable response: Bricks in a wall may be arranged this way.) Ask students whether there was any place on their slide of the elodea leaf where they did **not** see these tiny, roughly rectangular parts. (Probable response: No.)

Tell students that each of the parts they saw is called a cell. Ask: *Can we conclude from our observations that elodea plants are made of cells?* (Probable response: Yes.) Have several students justify this conclusion. Some may wish to limit the generality to the part of the elodea leaf observed.

Onion Cells: Say: *Now let's consider parts and wholes as we look at the second living thing we're focusing on today. Let's identify some parts of the onion plant*. Repeat the identification of parts with the onion plant. Cut apart the onion bulb and give a small cube to each student. Show the students how to pull off the thinnest outside layer of the onion cube and place it on a slide. Explain that, because the onion skin is white, we will stain it with iodine so that we can see more clearly any parts that are present. Remind the students about using the iodine solution with care. Tell them that, as when they are using any chemical, they must wear goggles while working with the iodine. Demonstrate how to stain the specimen and drop the cover slip over it.

As in the elodea investigation, have students examine their onion slides with the microscope. Ask each student also to look at the slides of at least two classmates. Ask each research group to formulate and write several statements describing what they observed.

Have students share findings. Ask students whether they found any small parts in the onion. (Students should agree that they did.) Again, discuss the arrangement of these parts. Ask students whether there was any place on their slide of the onion where they did **not** see these small parts. Comment that the parts the students identified are, as in the elodea plant, called cells. Ask: *What color are the cells of the part of the onion plant we examined?* (Probable answer: Colorless.)

Ask: *Then why do they look yellow?* (Answer: Because we stained them yellow to see them better.)

Ask: C*an we conclude that onion plants are made of cells?* (Students may specify that the part **we examined** is made of cells.)

Ask the student who stood next to the elodea, onion, and fish at the beginning of class to return to that position. Remind the class that we have found that the elodea and onion plants are made of cells. Ask: *If we could examine the fish and the human being with the microscope, do you think we would find they are made of cells, too?* Have students justify their responses to this question. (The fish can now be returned to the aquarium and the student to the class.)

Say: *Scientists tell us that all living things are made mostly of cells.* (Post sentence strip.) *Do we have any evidence that this is true?* (Answer: Our own microscopic observations indicate that this is true for the items we have examined.) *What additional evidence would convince you that this statement is true?* (Probable answer: Microscopic examination of other living things; reading about other scientists' findings.) *What evidence would indicate that the statement is not true?* (Probable answer: Finding a living thing that is not made of cells.) *What do you think is the*

probability that a living thing not made of cells will be found? (Ask students to justify their responses to this question. Explain that all living things observed so far have been found to be made of cells, so that the cell theory seems to be valid.) *Describe cells you have observed or seen pictures of. You will have additional experiences with cells that will help you decide how probable it is that the cell theory will hold true.*

Have students work in their groups to compose a list of at least 10 things that are made of cells and 10 things that are not made of cells. Have each group share its lists with another group.

Have the students conduct a second observation of the elodea and onion cells and complete Laboratory Report Sheet #1. Have students share their findings in their research groups of three. Discuss any differences in the observations and comparisons and possible reasons for them. Then have two groups meet to share findings. Again, discuss discrepancies and possible reasons for them. (If necessary, remind students that the elodea cells naturally have green components, but that the onion slides are not naturally yellow.) You may wish to explain that the tiny green parts inside the elodea cells contain chlorophyll, a green substance that helps the plant use light energy to produce sugar from carbon dioxide and water. The part of the onion plant that the class examined does not contain chlorophyll, although other parts of the onion plant do. In discussing the cell parts observed, comment that these parts help the cells do their jobs, such as getting energy from food and getting rid of wastes. If students ask, you may wish to identify the main parts of the cells, such as the cell wall, the cell membrane, the cytoplasm, and the nucleus. However, do not focus on labeling cell components.

2. Observation of Human Tissue Cells.

Review the fact that the human body contains different systems, each system having particular organs. Explain that these organs are made of different kinds of tissue, which in turn consists of cells. Tell the class we will now examine several kinds of tissue from the human body.

Explain that the slides to be examined will be stained in different colors and that the cells are not naturally those colors.

Distribute the prepared slides of human skin, muscle, nerve, and blood cells. Have students work in their research groups to study the slides and complete Laboratory Report Sheet #2.

Have students share findings within their groups and with another group. Again, discuss differences in findings and possible reasons for these differences. Students will probably note that there were many differences among the human tissue cells. Ask students why they think the cells are different. Briefly discuss the relationship of cell shape and function, asking, for example, why it would be useful for a nerve cell to be elongated.

3. Observation of Nerve Cells from a Frog, a Bird, a Cat, and a Human Being.

Say: *We will now compare cells from the same kind of tissue but from different animals.*

Distribute the prepared slides of frog, bird, cat, and human nerve cells. Have students work in their research groups to study the slides and complete Laboratory Report Sheet #3.

Have students share findings within their groups and with another group. Again, discuss differences in findings and possible reasons for these differences. Students will probably note that there were many similarities among the nerve cells. Ask students why they think this is so.

4. Discussing the Number of Cells in Organisms.
Say: *Different organisms are composed of different numbers of cells. What is the lowest number of cells that can compose a living thing?* (Answer: One.) *What were your experiences observing one-celled organisms and other microorganisms? How many cells do you think there are in a large organism?* (Answer: About a trillion cells.)

Continue: *Write the number one trillion* (1,000,000,000,000). *How many millions is this?* (Answer: One million millions.) *What does this number mean?* Have students work in their research groups to devise a way of demonstrating what is meant by this number. Have groups share their ideas or products and evaluate them for how well they express what is meant by one trillion. Students will probably conclude that it is very hard to understand such a large number.

Summary
Remind students that in this lesson we have looked at how the cells of different organisms are alike and different as well as how cells within one organism are alike and different. Have students name the kinds of cells studied in this lesson.

Have students complete learning journal entries in which they write the five most interesting facts learned today about cells.

Evaluation
A. Say: **Let's examine some analogies about how living things are composed of cells. Show the cube of Lego toys.**
Say: *Let's suppose this cube represents one whole organism.* (Begin to take the cube apart.) *Can the small blocks represent the cells of which a whole organism would be composed? Discuss this analogy with your research group and decide whether this is a poor, good, fair, or excellent analogy and why.* (You may need to remind students that an analogy is a comparison of relationships and that the more alike are the relationships being compared, the more excellent the analogy is.) (Probable response: The analogy is fair, because the small blocks are small parts of the whole thing; however, they are each exactly alike, whereas the cells in a many-celled organism are different.)

Present the class with the incomplete analogy: Cells are related to whole organisms as _____ are related to _____. Ask the research groups to try to complete the analogy. Have the analogies shared, and ask the class to decide which are most valid and why.

B. Have students review their laboratory report sheets on the 10 kinds of cells observed today. Ask students to write paragraphs in response to these questions:

- *Of the 10 kinds of cells you observed today, which two kinds looked most like each other? Support your answer with data.*

- *Of the 10 kinds of cells you observed today, which two kinds looked least like each other? Support your answer with data.*

Say: *If you wish to do so, you may repeat your microscopic observations before answering these questions.*

C. Tell the class that textbooks often include diagrams of "typical" plant and animal cells. Ask each student to write a paragraph explaining why it would be difficult to diagram a typical plant or animal cell.

Extensions

- Give students as many experiences as possible in examining slides of cells from other plants, other human body tissues, and other kinds of tissue from frogs, birds, cats, and humans. Have students decide to what extent these experiences provide evidence for the theory that all living things are made mostly of cells. Note whether students consider it increasingly improbable that living things not made of cells will be observed.

- Have students conduct research to find out how many cells compose various organisms and how these numbers were determined. Students could be asked to develop a graphic representation of the different organisms investigated and the number of cells of which they are composed.

- Have some students read in Paul De Kruif's book, *Microbe Hunters*, about Van Leeuvenhoek's discovery of microorganisms. These students could act out the discovery for the class.