Cell Inquiry: A 5e Learning Cycle Lesson

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One dilemma science teachers face every day is balancing the content demands of state and federal testing requirements while providing opportunities for inquiry. Using the 5E learning cycle is a realistic, constructivist way to address this dilemma. The 5E learning cycle leads students through a sequence of learning in which they become engaged in a topic, explore that topic, are given an explanation for their experiences, elaborate on their learning, and are evaluated. This article outlines a 5E learning cycle introducing middle/high school students to the cell.

Key words: biology, cell, constructivism, inquiry, learning cycle

The learning cycle approach has its origin in an elementary curriculum project sponsored by the National Science Foundation in the 1960's (Karplus and Their 1967). As it was first developed, the learning cycle involved three stages: Exploration, Concept Introduction, and Concept Application, which simulate the quest for science knowledge. Research over the past four decades has documented the effectiveness of this teaching approach (Beisenherz and Dantonio 1996; Colburn and Clough 1997; Marek and Cavallo 1997; Marek and Methven 1991; Musheno and Lawson 1999). The learning cycle sequence is also compatible with research on how students learn (Lawson 1988; Odom and Kelly 1998).

The Exploration stage of the learning cycle activity involves students in concrete experiences allowing them to construct knowledge. During the Concept Introduction stage, the concepts that underlie the exploration are formally introduced and given a name. Students then apply this knowledge in the Concept Application stage. Colburn and Clough (1997, p. 33) state that “Research supports the learning cycle as an effective way to help students enjoy science, understand content, and apply scientific processes and concepts to authentic situations.”

As the learning cycle has been used, researched, and refined over the years, some practitioners have extended the three stages into five, known as the 5E learning cycle: Engagement, Exploration, Explanation, Extension, and Evaluation (Trowbridge et al. 2000). The Engagement phase is used to motivate students by creating some mental disequilibrium or tapping into familiar real-life situations. The interest generated leads students into the Exploration stage in which they use direct concrete experiences to make observations, collect data, test predictions, and refine hypotheses. This information enables them to begin...
answering questions initiated in the Engagement phase. During the Exploration stage, the teacher should facilitate safe, guided or open inquiry experiences and questioning so students might uncover their misconceptions about the concept. During the Explanation stage, the teacher uses students’ observations and data to create a scientific explanation for their results. At this time, appropriate scientific vocabulary is introduced and is related to the students’ experiences. The Elaboration stage is designed to give students additional problems, which allow them to apply their new knowledge, propose solutions, make decisions and/or draw reasonable conclusions. This is often in the form of another inquiry activity or extension of the Exploration phase activity. The Evaluation stage is essential to determine if students obtained a scientifically correct understanding of the concept and if they were able to generalize to other contexts. This may be done formally or informally.

The following activity uses the 5E learning cycle to present an introductory lesson on cells. This lesson has been conducted in a high school Biology I class in an eighty-minute block format. It could easily be broken down into stages to conform to shorter teaching periods. The lesson addresses the National Science Education Standards (NRC 1996) in two areas: teaching and content. Teaching Standard A states that “teachers of science plan an inquiry–based science program for their students” (NRC 1996, p. 30). Both Content Standard A and C are targeted. Content Standard A requires that students develop the skills to do scientific inquiry. Content Standard C states that “as a result of their activities, all students should develop an understanding of the cell” (NRC 1996, p. 181).

**Objectives**

1. Students will be able to define the basic building block of life as the cell.
2. Students will be able to describe the differences between plant and animal cells.
3. Students will be able to identify plant and animal cells.

**Materials (2 per group for microscopic work and 4 per group for discussion and sharing):**

- Blob (see Teacher Resources)
- 2 slides per student
- 2 cover slips per student
- Toothpicks (1 or 2 per student)
- Slivers of onionskin
- Dropper (1 per student)
- Water
- Prepared specimen slides showing plant and animal cells
- Drawing paper
- Drawing pencils

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**Procedure**

**Engagement**

1. Give each group of students a “blob.” These are commercially available from ETA Cuisenaire (refer to Teacher Resources) or you can make your own (directions are provided at the end of the article). Allow students 5–7 minutes to manipulate it and to individually hypothesize what this blob represents. Students should record their hypothesis and then share it with their group.
2. Have groups share their hypotheses with the class and record these on the board.
3. Collect the blobs for observation later since they could provide considerable distraction during the remainder of the lesson.
4. Inform the students that they will engage in a laboratory activity to help them test their hypotheses.

The blobs provide a source of confusion to stir students’ curiosity during the engagement stage.

Students study the blobs during the engagement stage.
Exploration

Students need the prerequisite skills of preparing a wet mount and using a compound microscope. See Figure 1 for activity sheet used to record observations.

5. Using the slides, cover slips, and toothpicks, have students individually make a wet mount of their cheek cells by lightly scraping the inside of their cheek (see Discussion and Findings for safety precautions). They should observe this slide under the microscope and make a detailed drawing of their observations. The teacher should not use the term cell at this point in the learning cycle.

6. Next, students should make a wet mount of a small, thin piece of onionskin. Direct students to make careful observations and detailed drawings of this slide.

7. In their small groups, students should then prepare a list of any similarities and differences in the two slides.

8. Students should clean up their work areas before going on to the next stage.

Explanation

9. Ask the students: “Did your observations of the samples give you any clues to what the mystery blob may represent?” Elicit the response “cell” from the students.

10. Have the students describe their observations from the Exploration activity by using the term “cell.”

11. Provide the definition of cell as the basic building block of life.

12. Have the groups share their observations of the two slides by having them draw on the board or post their drawings in the room. Ask students to determine how other groups’ drawings are similar or different from their own. Discuss the reasons for potential differences in the drawings.

13. Then ask the groups to share the list of similarities and differences between the cells that they prepared in the Exploration stage. Lead a discussion to determine why the two types of cells look different.

14. Explain that they were looking at different types of cells. Detail the differences in plant and animal cells. Plants cells have a roughly rectangular shape due to the cell wall and are arranged in an orderly pattern or row. Plant cells include greenish chloroplasts and contain large vacuoles. Animal cells are irregularly shaped, often clumped. They do not have the greenish chloroplasts or large vacuoles. Both plant and animal cells have a cell membrane, although the cell membrane on the plant cell is difficult to see due to the cell wall. Both plant and animal cells have observable nuclei and endoplasmic reticulum. Although plant and animal cells share other similar organelles, they probably won’t be observable with a compound microscope.

15. Now ask the students if they would classify the “blob” as a plant or animal cell. Ask them to give reasons for their answers.

16. Explain that the next activity will help them apply their knowledge of plant and animal cells to other real specimens.

Elaboration

This next activity can be structured as a challenge inquiry in which the groups (not individuals) compete against each other to correctly identify slide specimens.

17. Have students examine unidentified prepared slides showing various plant and animal cells. The specimens should be from familiar organisms. As students examine each slide, instruct them to classify each sample as plant or animal.

18. After all students have examined six to eight different slides, have them discuss their classifications with group members and come to a consensus on the classification. Classification should be based on the differences between plant and animal cells outlined in the Explanation stage.

19. Then have groups share their results. At this point, the teacher verifies their results and determines the winner of the challenge.

Evaluation

To complete this evaluation effectively, students must know the procedure to produce concept maps.

20. Have students individually construct a concept map using the words cell, plant, animal, irregular shape, chloroplasts, nucleus, cell membrane, and cell wall (see Figure 2).

Discussion and Findings

The one safety issue that needs to be considered is the use of live cheek cells. The following safety precautions should be used to alleviate some of the concerns:

- Students handle only their cells throughout the entire activity—scraping, viewing of slide, cleanup, and disposal of specimen.
- During cleanup, the cover slips are disposed as a biohazard. Slides are sterilized before re-use.
- The workspace and microscope stage are cleaned with an antiseptic compound such as diluted bleach solution.
- All students should wash their hands thoroughly before and after collecting the specimen.

As with all learning experiences, this lesson has some strengths and weaknesses. A consistent problem is student skills in using the microscope. In order for effective learning
Are There Similarities and Differences in Plant and Animal Cells?

Complete the following activity and questions to answer the question above.

1. Take a piece of the thin onionskin smaller than your fingernail and place it on a microscope slide with a drop of water on it.
2. Put the cover slip over the onionskin—carefully!
3. Look at your slide through the microscope. Get a bright field in your microscope. Get a dark field in your microscope. Do some parts of the specimen stay light and shiny more than others?
4. In the circle, sketch what your specimen looks like.

   a. How would you describe the shape of the things you see?
   b. Are the blocks all exactly the same?
   c. Are they about the same size?
   d. Are they all exactly the same shape?
   e. What do you see inside?

5. Try the stain, methylene blue, on a piece of onionskin on a slide. With the toothpick, add a bit of stain. Then add a drop of water and the coverslip.
6. Now look carefully through the microscope at your specimen for a while. What do you now see inside?
7. Place a small drop of clean water on a clean slide.
8. Take a clean toothpick. Use the blunt, flattened end to gently scrape the inside of your cheek. You do not need to scrape hard.
9. Touch the material collected on the toothpick to the drop of water on the slide.
10. Add a small drop of methylene blue. Cover with a cover slip.

(Figure 1 continues)
11. You may not be able to see anything of your specimen until you look at it through the microscope. If you cannot see anything then, try again.

12. Sketch below what you see through your microscope.

   ![Sketch](image)

   a. How would you describe the shape of the things you see?

   b. Are the shapes all the same size?

   c. Are they all exactly the same shape?

   d. What do you see inside?

   e. Describe the difference in the two types of cells you viewed.

13. Using a Venn diagram, describe the similarities and differences in the two different types of cells you viewed.

   ![Venn Diagram](image)

Figure 1. Continued.
to occur in both the Exploration and Elaboration stages, it is very important that students can accurately focus the microscope to observe the different cell structures clearly. Consequently, these skills may need to be taught, refreshed, and/or reviewed before starting this lesson.

There are several strengths to this lesson. The primary strength lies in the fact that a traditional laboratory activity sequence is rearranged to structure inquiry and constructivist learning. The “blobs” are very effective in creating disequilibrium. Most students have no idea what they represent. By not telling the students what the blobs are and by directing them to do the Exploration activity to help them find out, you provide motivation for students to complete the activity well. Many students, especially those strong in the visual/spatial multiple intelligence, enjoy recording their data through drawings. The challenge aspect of the Elaboration activity again helps motivate students to find correct answers rather than convenient answers. The concept map as an evaluation allows you to determine if students really understand the difference between plant and animal cells. Odom and Kelly (1998) suggested that this combination of the learning cycle and concept mapping is required for meaningful learning to take place.

**Cross-Curricular Applications**

- **Arts and Humanities**—Students record their data through drawings. Collaboration with the art teacher could provide pointers on effective drawing, examples of famous scientific drawings, etc.
- **Mathematics**—Size of each of the cell specimens could be determined to reinforce the concept of ratio and proportion. Students could then determine if cell size is correlated with the different types of cells.
- **Technology**—The concept map may be drawn using appropriate software such as Inspiration. During the explanation phase, a video microscope can be used to point out structures evident in cheek and onion cells.

**Conclusion**

By restructuring traditional learning activities into a 5E learning cycle sequence, students are motivated to answer questions originating in the Engagement stage. The challenge activity in the Elaboration stage provides additional motivation for students to apply their knowledge correctly. This 5E sequence automatically structures constructivist, inquiry–based learning while addressing content required by high school students.

**Blob Construction**

To make a “blob,” use a small white or clear balloon. Fill it with a clear, viscous liquid such as unflavored gelatin or corn syrup until the balloon is about two inches in diameter. Then insert into the liquid various small objects that would represent cell parts. For example, you can include beads for lysosomes, short pieces of plastic lacings for endoplasmic reticulum, and jelly beans for mitochondria. Tie the end of the balloon securely.
Teacher Resource


References