Cells: The Inside Story

Overview

Description

In this activity, students will research the structure and function of major cell organelles and use an analogy to another system to describe the functions. Students will communicate their understanding in a digital slideshow or scrapbook and a written narrative.

Final Product: Students will either present digital slideshows or create and turn in scrapbooks on the structure and function of major cell organelles and present them to the class. All students will also create a written narrative structured around an analogy to a familiar system.

Subject

Biology

Task Level

Grade 9

Objectives

Students will:

- Understand the role of subcellular organelles in the structural hierarchy of life.
- Develop diagrams and descriptions of cell organelles.
- Demonstrate an understanding of cell organelle function by developing and explaining an analogy to an existing system such as a city, school, or family.
- Compile cell organelle research into a digital slideshow or scrapbook.
- Use original print or digital images or public domain images to illustrate the structure of cell organelles.
- Write a narrative description of cell organelles, using an analogy to structure the narrative.

Preparation

- Read the Instructor Task Information and the Student Notes.
- Prepare copies of the Student Note pages, the *Information Summary Planning Page* handout, and the *Going Further: Cell Organelles* handout.

- Obtain 11 index cards for each student.
- Prepare a sample digital slide on one cell organelle, using a city analogy (described in the Instructional Plan).
- Develop a list of possible resources and references for research. Instruct your students how to use the appropriate citation style for both printed and electronic references. For many biology resources, APA format is preferred.
- Provide students with a list of possible analogies from which to choose.
- It is not necessary for students to have Internet access for this exercise, but the most appropriate Internet resources are those ending in .edu or .gov. Examples are listed below.
  - CELLS *alive!,* http://www.cellsalive.com
  - The Biology Project, http://www.biology.arizona.edu
- Prepare to share the scoring guide with students as they create their slide shows and narratives.

Prior Knowledge

Students should have experience using the Internet for research. Students must be able to locate and download public domain images. Students should have basic understanding of the hierarchical organization of organisms (whole organism, organ systems, organs, tissues, cells, cell organelles, etc.).

Key Concepts and Terms

- Cell membrane (or plasma membrane)
- Centriole
- Chloroplast
- Cilia
- Cytoskeleton
- Endoplasmic reticulum
- Flagella
- Golgi apparatus
- Lysosome
- Mitochondria
- Nucleus
- Organelle
- Ribosome
- Subcellular
- Vacuole

Time Frame

This assignment will require approximately four to six hours of class time.

Day 1: Review the hierarchy of life. Have students conduct initial research about cell organelles using texts, references, and Internet resources.

Day 2: Use an example to explain how analogies can be used to represent cellular functions. Outside of class time, students complete the *Information Summary Planning Page* handout.

Day 3: Students submit the *Information Summary Planning Page* handout for peer review and feedback during class. At this point, introduce the project and show sample(s).

Days 4–5: Outside of class, students complete a table of contents and the first page of the scrapbook or the first slide of the slideshow.

Day 6: Students submit the table of contents and product sample for peer review and editing. Students will have gathered enough information at this point to begin writing their descriptive narrative.

Days 7–10: Students complete the scrapbook or slideshow and descriptive narrative outside of class time.

Day 11: Students turn in their narratives and scrapbooks or present their slideshows. (Students presenting slideshows should also turn in a printed copy of their slides or a thumb drive containing their slides). Students also submit their peer-reviewed *Information Summary Planning Page* handout. Encourage students who often do not present to give presentations.

Days 12: Students complete the *Going Further: Cell Organelles* handout.

This assignment can be modified to meet the needs of different classroom schedules and student ability levels. For example, if the amount of time and independent work required to develop a complete analogy is too much, perhaps students can present just a few elements of an analogy to the class at a much earlier point in the project, leaving the rest of the analogy as fodder for discussion. For instance, one student might present an analogy between mitochondria and an automobile battery, and the class can discuss what this analogy captures, what it fails to capture, and how other parts of an automobile might relate to organelles if the analogy were extended). This saves time by allowing presentations to take place on Day 6, rather than Day 11, and allows for a constructive peer review process before students begin their narratives.

Instructional Plan

Getting Started

Learning Objective

Students will:

- Understand the role of subcellular organelles in the structural hierarchy of life.

Procedure

1. Discuss the hierarchy of life so that students will be familiar with the structural level of organelles within the scope of the biosphere. Then, ask students to write the following terms on index cards and arrange the cards in order from the largest structure to the smallest:

   Biosphere, biome, cell, cell organelle, community, ecosystem, organism, organ system, organ, population, tissue.

2. Discuss the need to understand subcellular organelles. Explain that an understanding of organelles has led to advancements in medicine. For example, studying the structure of cell membrane transport proteins has led to a better understanding of cell signaling and insulin-related glucose uptake.

3. Distribute the Student Notes. Describe the assignment. Share the scoring guide and timeline with students. Clearly establish which components are to be completed during class and which are to be completed outside of class. Provide time for students to develop a task list and completion timeline.

Investigating

Learning Objectives

Students will:

- Develop diagrams and descriptions of cell organelles.
- Demonstrate an understanding of cell organelle function by developing and explaining an analogy to an existing system such as a city, school, or family.

Procedure

1. Distribute the *Information Summary Planning Page* handout. Explain that students should use this handout to record the information they gather. Remind students that academic integrity is important. They should document all sources used. Give examples of how to cite different types of references. Make sure students understand the use of public domain images and how to locate and cite them.

2. Distribute the list you have prepared of possible resources and references to be used for research.
3. Monitor students' work, periodically checking for accuracy and redirecting searches as needed.
4. When students have begun their research, share a sample analogy. Liken the cell to a city. The nucleus, which is the control center of a cell, can be compared to city hall. The city's waste disposal team would be analogous to lysosomes, the power plant analogous to mitochondria, and the post office analogous to the Golgi apparatus. Additional ideas for analogies include a school system, hospital, shopping center, factory, amusement park, and airport.
5. Before students submit their completed *Information Summary Planning Page* handout*s*, they should each make a copy for use as they write their narratives.

Drawing Conclusions

Learning Objectives

Students will:

- Compile cell organelle research into a digital slideshow or scrapbook.
- Use original print or digital images or public domain images to illustrate the structure of cell organelles.
- Write a narrative description of cell organelles, using an analogy to structure the narrative.

Procedure

1. Show students the sample digital slide you have prepared. Note how an analogy has been incorporated in the slide. Assign students to prepare slides or scrapbook pages to explain the functions of six of the twelve cell organelles they have researched.
2. Emphasize the need to plan the contents of a scrapbook or slideshow. Explain the purpose and expectations for the table of contents. Then, explain the purpose of the introductory page. Give the example of students using the titles *Cell City* and *Cytoville* in the introductory slide.
3. Encourage students to be creative in the design of their projects while including all information indicated on the scoring guide.
4. Students work with peers to review their initial slides or pages, including the introduction, table of contents, and first three organelles. Encourage student reviewers to note any items that have been left out or that need more development.

5. Explain to students that the descriptive narratives they will now write will convey their research findings in a different format and will also require citations. Provide time for students to draft their narratives.
6. Schedule time for in-class presentations. Have students turn in their narratives, scrapbooks, and *Going Further: Cell Organelles* handout.

Scaffolding/Instructional Support

With an assignment as complicated and time-intensive as this, it is possible that the optimal time during the course for implementation and the optimal time to introduce the focused content (sub-cellular organelles) may not align. However, the analogical reasoning, peer review, presentation, and writing skills may apply to many topics in biology. This activity could be adapted for discussion of cell differentiation and function, the function of biological molecules, and structures and processes responsible for gas exchange, waste excretion, and reproduction, to name a few.

The goal of scaffolding is to provide support to encourage student success, independence, and self-management. Instructors can use these suggestions, in part or all together, to meet diverse student needs. The more skilled the student, however, the less scaffolding that he or she will need. Some examples of scaffolding that could apply to this assignment include:

- Consider offering students who have underdeveloped time management skills more narrow due dates with smaller-sized interim products. Review their personal timelines to make sure they have set smaller windows of work time. For example, some may need to submit their projects one page or slide at a time. Of course, if the timeline is abbreviated (as described above), the due dates and products will already be better suited for students with underdeveloped time management skills.
- Use techniques such as drawing the cell structure, comparing images from different sources (online, other textbooks, and classroom references), and sketching the analogy. [NOTE: This corresponds to the ELPS.]
- Assign struggling students fewer than six organelles.
- Offer tangible reminders of due dates as needed. For example, continuously post interim product due dates in the classroom.
- Partner English language learners with those who speak English proficiently during the research portion of the project.
- Provide samples of a descriptive narrative to students struggling with the written component of the assignment.

Solutions

The information below is intended to help you assess students' final work products. It may not represent all possible strategies and ideas. The accompanying scoring guide provides specific examples of ways a student might demonstrate content understanding and mastery of cross-disciplinary skills.

Necessary Elements

Students will likely produce presentations in different mediums. Creativity is limited only by the required content. Slideshows or scrapbooks should include an introductory page, legally obtained images, written descriptions that include all information gathered in the *Information Summary Planning Page* handout (except the image), and a Works Cited page.

Key Connections

The student analogy should reflect the concept of interdependence. Although each organelle has specific functions, organelles must all cooperate to keep the entire cell functioning (idea of "teamwork").

Students should demonstrate understanding that the particular frequency of organelles in a given cell type simply represents one example from a broad array of configurations a cell may adopt. Similarly, it is important to understand that there is vast natural variation even among cells of a given type—i.e., even all epithelial cells are not identical, and natural variation and diversity can be observed all the way down to the cellular level.

Common Misconceptions

Some students assume plant cells have only chloroplasts and animal cells have only mitochondria. In fact, while animal cells do have only mitochondria, plant cells have both.

Students may also assume that all cells have cell walls when this is not the case. Alternately, they may think it is the exception to have cell walls when in reality there are more types of cells with cell walls than without.

Some students may assume that if you put a cell under a microscope you will immediately see all organelles clearly. Similarly, they may assume that the nucleus is always in the center of the cell and that it will be "dyed" an obvious color. These assumptions are not true.

Students may not understand that some organelles are found in higher frequency in some cells than in others. In fact, organelle counts are not the same in all cells.

Students may assume that cells are flat and thin and not grasp the concept of a cell as a 3-D structure.

Going Further: Cell Organelles - Sample Solutions

Directions: Answer each of the following questions using your text, library reference materials, and/or Internet resources. (Sample solutions in italics.)

1. Which type of organelle would you expect to be particularly abundant in each of the following types of specialized cells? Explain your answer.

   a. A cell in a gland that is specialized to produce protein hormones

      Organelle: *ribosome*

      Explanation: *Ribosomes are sites of protein production; a cell whose primary role is to produce protein hormones would require more ribosomes in order to meet the increased protein production needs.*

   b. A muscle cell that uses a great deal of energy to contract

      Organelle: *mitochondrion*

      Explanation: *Mitochondria are the "powerhouses" of the cell, and would be required to provide the energy necessary for muscle contraction.*

   c. A liver cell that does extensive detoxification of drugs and poisons

      Organelle: *smooth endoplasmic reticulum*

      Explanation: *Smooth endoplasmic reticulum produces enzymes that are essential for the detoxification of foreign compounds.*

   d. A macrophage cell that engulfs and digests bacteria

      Organelle: *lysosome*

      Explanation: *Lysosomes contain enzymes that are responsible for helping cells break down waste materials and cellular debris.*

2. Predict what would happen if a cell had:

   a. No functional lysosomes

      Cells with no functional lysosomes would not be effective at removing waste products; cellular waste would accumulate to the point that the cell could not function.

   b. Very few mitochondria

      Mitochondria are responsible for providing energy for cellular processes. Cells with very few mitochondria would not produce sufficient energy to meet the energy demands of cellular production and maintenance; if these processes stop, the cell will die.

   c. Extensive rough ER but little smooth ER

      Cells with extensive rough ER but little smooth ER could produce sufficient proteins for cellular function, but would not be able to produce necessary lipids and carbohydrates or remove cellular debris and waste. These cells would also

be deficient in their ability to regulate calcium, which is essential for many important cellular processes.

3. Suppose you are examining a cell from a multicellular organism under a microscope. How could you determine whether the cell was from a plant or an animal?

   The most obvious visible difference is the presence of a large, fluid-filled central vacuole in a plant cell; this organelle can take up as much as 90% of the interior of a plant cell, yet is absent in animal cells. Other distinguishing characteristics that may be visible in plant cells include the presence of a rigid cell wall as the outermost layer as well as the presence of numerous green chloroplasts, which are the organelles where photosynthesis takes place. Both of these structures are absent from animal cells.

TCCRS Cross-Disciplinary Standards Addressed

Performance Expectation	Getting Started	Investigating	Drawing Conclusions
I. Key Cognitive Skills			
A.1. Engage in scholarly inquiry and dialogue.		✓	✓
B.2. Construct well-reasoned arguments to explain phenomena, validate conjectures, or support positions.		✓	✓
D.1. Self-monitor learning needs and seek assistance when needed.	✓	✓	✓
D.2. Use study habits necessary to manage academic pursuits and requirements.	✓	✓	✓
D.3. Strive for accuracy and precision.	✓	✓	✓
D.4. Persevere to complete and master tasks.		✓	✓
E.1. Work independently.	✓	✓	✓
E.2. Work collaboratively.			✓
F.1. Attribute ideas and information to source materials and people.		✓	✓
F.4. Understand and adhere to ethical codes of conduct.		✓	✓
II. Foundational Skills			
A.4. Identify the key information and supporting details.		✓	
B.1. Write clearly and coherently using standard writing conventions.		✓	✓
B.2. Write in a variety of forms for various audiences and purposes.		✓	✓
C.5 Synthesize and organize information effectively.		✓	✓
C.6. Design and present an effective product.			✓
C.7. Integrate source material.		✓	✓
C.8. Present final product.			✓
E.1. Use technology to gather information.		✓	
E.3. Use technology to communicate and display findings in a clear and coherent manner.			✓

TCCRS Science Standards Addressed

Performance Expectation	Getting Started	Investigating	Drawing Conclusions
I. Nature of Science: Scientific Ways of Learning and Thinking			
A.2. Use creativity and insight to recognize and describe patterns in natural phenomena.		✓	✓
D.1. Demonstrate literacy in computer use.		✓	✓
E.1. Use several modes of expression to describe or characterize natural patterns and phenomena. These models of expression include narrative, numerical, graphical, pictorial, symbolic, and kinesthetic.		✓	✓
E.2. Use essential vocabulary of the discipline being studied.	✓	✓	✓
III. Foundation Skills: Scientific Applications of Communication			
A.1. Use correct applications of writing practices in scientific communication.		✓	✓
B.3. Recognize scientific and technical vocabulary in the field of study and use this vocabulary to enhance clarity of communication.	✓	✓	✓
C.1. Prepare and present scientific/technical information in appropriate formats for various audiences.			✓
D.1. Use search engines, databases, and other digital electronic tools effectively to locate information.		✓	✓
VI. Biology			
A.3. Describe the structure and function of major subcellular organelles.	✓	✓	✓

TEKS Standards Addressed

Cells: The Inside Story - *Texas Essential Knowledge and Skills (TEKS): Biology*
112.34.c.2. Scientific processes. The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to: 112.34.c.2.E. plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology; and 112.34.c.2.H. communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.

112.34.c.3. Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to: 112.34.c.3.A. in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student; and 112.34.c.3.E. evaluate models according to their limitations in representing biological objects or events.
112.34.c.4. Science concepts. The student knows that cells are the basic structures of all living things with specialized parts that perform specific functions and that viruses are different from cells. The student is expected to: 112.34.c.4.B. investigate and explain cellular processes, including homeostasis, energy conversions, transport of molecules, and synthesis of new molecules.
112.34.c.5. Science concepts. The student knows how an organism grows and the importance of cell differentiation. The student is expected to: 112.34.c.5.B. examine specialized cells, including roots, stems, and leaves of plants; and animal cells such as blood, muscle, and epithelium.

Cells: The Inside Story

Introduction

The cell is the basic functional unit of life on our planet. The small and seemingly simple cell of a plant or animal is actually a complex system of smaller components called organelles. Each organelle has a unique function and specific structure.

In this activity, you will develop your understanding of the features of subcellular organelles. You will explore the structure of major organelles and become familiar with the role that each organelle plays in the functioning of a normal cell. You will showcase your understanding of subcellular organelles by completing two activities: (1) either creating and presenting a digital slideshow or creating a scrapbook and (2) by writing a narrative based on your research.

Directions

Getting Started

1. Writing each of the following terms on the face of its own index card: *biome, biosphere, cell, cell organelle, community, ecosystem, organ, organism, organ system, population,* and *tissue.* Use your prior knowledge to discuss and sequence the cards into a structural hierarchy.
2. Listen as your instructor describes each component of the project. Review the scoring guide and ask for needed clarifications.
3. Develop a personal timeline that identifies the various tasks you will need to complete for this project. On your timeline, note how you will schedule your time outside of class. Your timeline should include personal target due dates as well as official due dates for the various project components.

Investigating

1. Your instructor will provide a list of 12 organelles. Write their names on the *Information Summary Planning Page* handout.
2. Using at least three sources from the list your teacher provides, research the structure and function of each organelle. Record your research findings on the handout. As you complete your research, look for public domain images of the organelles. Save any public domain images you may wish to use.
3. Record the citations for resources used during your research. These will be included in a bibliography for your project.

4. The class will discuss analogies for the cell and cell organelles. Decide upon an analogy to use for your project. For each organelle, write a description that fits the analogy.
5. Complete the *Analogy* column on the *Information Summary Planning Page* handout using the information gathered during your research.

Drawing Conclusions

1. Design a cover sheet for your scrapbook or an introductory slide for your slideshow. This will include your name, course title, date, and a title that fits your analogy.
2. Select six organelles from your *Information Summary Planning Page* handout that you wish to include in your scrapbook or slideshow.
3. Carefully consider the order in which you will present the organelles in your scrapbook or slideshow, and develop a table of contents.
4. For each of your first three organelles, prepare a preliminary slide or scrapbook page.
5. With a partner, peer review your first three pages. You will use the feedback you receive to revise and complete your presentation.
6. Complete your slideshow or scrapbook, including an introductory cover page, table of contents, six organelle pages or slides, and a bibliography. The bibliography should include all important references and use an appropriate citation style (such as APA), as indicated by your instructor.
7. Use the analogy you have chosen to write a descriptive narrative of the six organelles in your slide show. Again, you will summarize their structures and functions. Be sure to cite your sources properly.
8. Assemble your scrapbook or slideshow to submit or present. If you present a slideshow, print copies of the slides to turn in to your instructor.
9. Complete the questions found on the *Going Further: Cell Organelles* handout.

Information Summary Planning Page

Organelle Name	Structure	Function	Analogy	Sketch	Resources Used

Information Summary Planning Page, continued

Organelle Name	Structure	Function	Analogy	Sketch	Resources Used

Information Summary Planning Page, continued

Organelle Name	Structure	Function	Analogy	Sketch	Resources Used

Going Further: Cell Organelles

Directions: Answer each of the following questions using your text, library reference materials, and/or Internet resources.

1. Which type of organelle would you expect to be particularly abundant in each of the following types of specialized cells? Explain your answer.

   a. A cell in a gland that is specialized to produce protein hormones.

      Organelle:

      Explanation:

   b. A muscle cell that uses a great deal of energy to contract.

      Organelle:

      Explanation:

   c. A liver cell that does extensive detoxification of drugs and poisons.

      Organelle:

      Explanation:

   d. A macrophage cell that engulfs and digests bacteria.

      Organelle:

      Explanation:

2. Predict what would happen if a cell had:
   a. No functional lysosomes.

   b. Very few mitochondria.

   c. Extensive rough ER but little smooth ER.

3. Suppose you are examining a cell from a multicellular organism under a microscope. How could you determine whether the cell was from a plant or an animal?