Applying the Role of Cells in the Real World

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Unit Overview

In this integrated, seventh-grade biology unit, students learn about the concepts of active and passive transport in cells. In the first half of the unit, students conduct labs and a series of thought experiments to deeply understand diffusion, homeostasis, and osmosis. In the second half of the unit, students apply their knowledge of active and passive transport to design a solution to the real-world question, "How can we solve the potable water crisis in Puerto Rico?" Then, students work together to create a biofuels company. Finally, students take on the role of a medical counselor and work to understand and accurately explain cell diseases.

Standards Addressed

1. **ELA7W3**: Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences
2. **ENGR-STEM 1**: Students will recognize the systems, components, and processes of a technological system
3. **ENGR-STEM 3**: Students will design technological problem solutions using scientific investigation, analysis and interpretation of data, innovation, invention, and fabrication while considering economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints.
4. **ENGR-STEM 4**: Students will apply principles of science, technology, engineering, mathematics, interpersonal communication, and teamwork to the solution of technological problems.
5. **ENGR-STEM 5**: Students will select and demonstrate techniques, skills, tools, and understanding related to energy and power, bio-related, communication, transportation, manufacturing, and construction technologies.
6. **L6-8RST1**: Cite specific textual evidence to support analysis of science and technical texts.
7. **L6-8RST4**: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.
8. **L6-8RST3**: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
9. **L6-8RST7**: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

10. **L6-8RST9**: Compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading a text on the same topic.
11. **L6-8WHST1**: Write arguments focused on discipline-specific content
12. **L6-8WHST7**: Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
13. **L6-8WHST8**: Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
14. **MGSE7.RP.2**: Recognize and represent proportional relationships between quantities
15. **S7L2**: Students will describe the structure and function of cells, tissues, organs, and organ systems.
    - **S7L2a**: Explain that cells take in nutrients in order to grow and divide and to make needed materials.
16. **S7L4:** Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments.

Days 1 – Introduction to Unit & Shipwrecked Sailor Lab, Day One

Standards Addressed: S7L2.a; L6-8RST3; L6-8WHST1

Essential Question: How do levels of salt and water impact cells?

1. Begin class with a "Do Now" in their science notebooks to refresh the class about their knowledge about cells. Refer to slides two and three in the **Cell Transport Unit Slideshow.** After students finish the activity, engage the class in a discussion about what they wrote. Spend a few minutes refreshing students about homeostasis and the parts of a cell.

2. Next, instruct students to read the following case studies individually. Then, instruct students to get into groups and answer the questions on slide five of the **Cell Transport Unit Slideshow**:
    a. Case Study One, Death by Over-hydration?: https://www.washingtonpost.com/news/early-lead/wp/2014/08/13/a-high-school-football-player-dies-after-reportedly-consuming-two-gallons-each-of-water-and-gatorade/
    b. Case Two, Death By Holding It?: http://www.nbcnews.com/id/16614865/ns/us_news-life/t/woman-dies-after-water-drinking-contest/
    c. Case Three, Death by Salt?: https://www.theguardian.com/uk/1999/jul/27/vikramdodd1

SHIPWRECKED SAILOR LAB PREP

To prepare cups, the students will measure and record the mass and length of sections of raw potato, then place each section in a cup of water with a different salt solution. Students will use ratios to calculate the amounts of saltwater and freshwater needed to make solutions with five different rates of salinity: 0.5%, 1%, 5%, 10%, and 20%. Students can use this solution calculator to help them make the solutions. They will need to enter the water volume of your container and the percentage of salt you want and it will tell you how many grams of salt to add. For example, a 1% salt solution is 1-part salt to 100 parts water. To make a 1% salt solution, you could use a 100 ml bottle, add exactly 1 gram of salt (use your electronic balance) to your bottle, and bring the water volume up to 100 ml.

3. When students have had a chance to read the case studies and answer the questions as a group, reconvene the class to discuss the answers on slides six through eight.

4. Next, introduce the students to the Shipwrecked Sailor Lab on slides nine through fifteen. In this lab, students will explore the effects of saltwater and freshwater on cells.

5. On day one, students will complete pre-lab questions related to the case studies, then write a hypothesis with the sentence frame "If the level of salinity in the water increases, then____" (*students predict what will happen and why*). After that they will prepare their cups with various saline solutions and potato slices, then set them aside until tomorrow.

Day 2 – The Shipwrecked Sailor Lab, Day Two

Standards Addressed: S7L2 a; L6-8RST3, 7; L6-8WHST1

Essential Question: How do levels of salt and water impact cells?

A NOTE FROM THE TEACHER

Decide whether you want your students to complete the lab on a lab report (which you will need to print for them) or with their science notebooks (which you will need to

1. Begin class with a brief discussion question to remind the class of the case studies from the previous day: How is it possible for water and electrolytes – things our bodies need – to become toxic? (Slide 17 on the **Cell Transport Unit Slideshow**.)

2. The Shipwrecked Sailor Lab Day Two: Students will retrieve their cups with potato slices and remove the potato segments from each cup, measure the mass and length of each piece, and record their data on the table. Show students slide 18 from the slideshow so they can see an example of a completed table.

3. After they measure and record the data in the table, they will answer the analysis questions, create bar graphs, and write conclusions supported with evidence from their graphs and data chart. The conclusion should include the answer to the question: Based on the data, was your hypothesis supported or not supported? Have students submit their full report in your preferred method.

4. Wrap-up: Students will clean up lab, complete a ticket out the door on a post-it: "What stuck with you about the Shipwrecked Sailor Lab?"

Day 3 – Introduction to the Puerto Rico Water Purification System

Standards Addressed: S7L2.a; ENGR-STEM 1; ENGR-STEM 4

Essential Question: How do I design a water purification system for Puerto Rico following the hurricanes?

1. Begin the day with the following "do now" challenge (slide 22): You and your friends are stranded on a small island. There appears to be a stream, plants, and coconut trees. Fortunately, you have the following items: Clothing, a backpack, a lighter, glass and plastic bottles, plastic garbage bags, and a paracord. How would you use these resources plus any items found on the island to make sure you have a safe source of fresh water to drink? Engage the class in a discussion about their answers. Note to teacher: Possible answers may include solar stills, tying the plastic bag around a tree branch and collecting the water transpiring from the leaves, drinking coconut water, boiling the water from the stream, risking drinking the stream water without boiling.

2. Next, present the next project using slides 23-27. Explain to the class that the U.S. territory of Puerto Rico was devastated by two hurricanes in September 2017. Their water system was

completely destroyed. Much of the country is still without a reliable source of safe drinking water. In the months following the hurricanes, many of the residents relied on water from streams and drainage ditches. As we now know, drinking the seawater that surrounds the island is not an option for them.

3. Give the class the following problem to solve:
    a. What are some possible solutions to the drinkable water crisis in Puerto Rico?
    b. Limiting factors to consider:
        i. Water is around, but may not be clean or salt-free
        ii. Some areas are near the ocean, others far from the ocean
        iii. The amount of materials they have to work with is limited

4. Display and review the engineering design process (EDP) on slide 26. Instruct the students to use the EDP to design a method to capture and purify water with common, inexpensive materials. Here are the directions (slide 27 and sample on slide 28):
    a. Work as a team to create simple design illustrations and instructions.
    b. Create a poster or slides with diagrams and words explaining your plan. Make it clear and easy to understand.
    c. Be prepared for a brief presentation. Provide comments to each team on their design.
    d. Based on the comments of others, improve your design.

5. Finally, display and review the **Creativity & Innovation Rubric**.

Days 4 & 5 – Cellular Transport Stations

Standards Addressed: S7L2.a; L6-8RST3; L6-8RST7

Essential Question: What are the different types of cellular transport?

STATIONS PREP

*Use the instructions for each station from the **Cell Transport and Boundaries Lab Stations** activity sheet. Ensure that you set up the stations prior to class beginning. For larger classes, set up at least two of each station to avoid bottlenecking. Please note, station five will take additional prep time, since it involves eggs.*

1. Begin the class by showing students a video about the frog population and pesticide runoff: https://www.youtube.com/watch?v=nBbkwlGM7X0

2. After showing the video, instruct students to answer the following prompt in their science notebooks: How do you think this issue with pesticides in drinking and natural water sources relates to the general health of the organism? How is this related to health on the cellular level?

3. Next, pass out pages 9-16 of the **Cell Transport and Boundaries Lab Stations** activity sheet; they will use these pages to document their findings from each station. Then, instruct students will rotate through the five lab stations exploring features of the cell membrane, osmosis, diffusion, facilitated diffusion, active transport, and tonicity. At each station, students will record their observations.

4. Students will complete station activities related to active and passive transport, spending 15-20 minutes per station and revisiting, if needed. They will work in teams at their own pace, moving to empty stations as they become available.

5. As students visit each stations, they will complete a summary graphic organizer to demonstrate understanding of the concepts.

6. Following the station work, use the **Cell Transport Formative Assessment**. evaluate students' understanding of the concepts, they will be given a formative assessment on cell transport. The attached document shows the questions; the student version would be online and interactive.

Day 6 – Cell History

Standards Addressed: S7L2 a; L6-8RST9

Essential Question: What is the history of cell research and discovery?

1. Begin the class by displaying slide 29, which shows images of specialized cells. Engage the class in a discussion about their assumptions about the cells' functions based on their structures.

2. Display the following webpage and review the levels of organization in living things: http://peer.tamu.edu/curriculum_modules/Cell_Biology/Module_1/index.htm

3. Provide to the class the **Cells to Systems Formative Assessment** (you can cut the document in half to save paper).

4. Next, introduce cell history by reviewing slides 30-35 with class. You can decide whether you want students to work independently, in groups or pairs, or if you want to conduct the lecture yourself. Instruct students to record notes in their science notebooks.

5. Following the notetaking portion of the class, provide students with the **Cell Theory** activity sheet.

Day 7-9 – Cell Project

Standards Addressed: S7L2.a; ENGR-STEM 5; MGSE7.RP.2

Essential Question: What are the key differences between plant and animal cells?

1. Begin the class by instructing students to get into small groups of three or four. Provide them with the **Plant and Animal Cell Comparison** activity sheet to complete. Engage the class in a brief discussion about the answers they came up with.

2. Next, display slide 36 of the **Cellular Transport Slideshow**. Tell students that they will apply their understanding of cell organelles and cell parts by completing a cell model of their choice. Make sure that you fill in the final project due date. They have several options to choose from; go through the options displayed on the Cell Project Handout.
    a. Option 1: Four Pictures, One word—A picture game using clues to guess organelles
    b. Option 2: 3D Cell Model
    c. Option 3: Cell Video
    d. Option 4: Cell Shirt
    e. Option 5: Cell Song
    f. Note: This is a three-day lesson. Introduce the project on day seven, then give them two complete work days to work on the models.

3. After reviewing the handout, review the rubric on slide 37.

4. Use the rubric to grade student designs.

Day 10 – Photosynthesis & Cellular Respiration

Standards Addressed: S7L2.a; S7L4; L6-8RST1; L6-8RST4; L6-8RST7; L6-8WHST 1.a; L6-8WHST 1.b

Essential Question: What are photosynthesis and cellular respiration?

1. Display the Do Now on slide 38. Ask students to pair up and discuss how plants get energy. Then, pass out the **Leaf Sort Handout** (slide 39) and ask them to pair up with a peer to categorize the leaves based on common traits. Ask them to use Claim-Evidence-Reason written response (slide 40) to write why they categorized the leaves in that way. Finally, engage the group in a discussion about their findings.

2. Next, review photosynthesis and cell respiration with the class (slides 41-50). While you review the concepts, students should take notes in their science notebooks.

Day 11-13 – Creating a Biofuels Company

Standards Addressed: S7L2 a; L6-8RST3; L6-8RST7; L6-8WHST4; ENGR-STEM 1; ENGR-STEM 3; ENGR-STEM 4; ENGR-STEM 5

Essential Question: What are the different types of biofuels?

1. Begin the class by sharing a short video with the students explaining the role of yeast fermentation in producing alcohol and carbon dioxide: https://youtu.be/eksagPy5tmQ. Engage the class in a discussion about the role of alcohol in making biofuels.

2. Provide students with the **Biofuels Challenge Logbook**. Instruct them to follow the procedures for the fermentation lab using part one of the **Biofuels Challenge Logbook** handout. Based on the data, complete the written conclusions.

3. Days two and three involve a design challenge. Present slides 51-55, which covers biofuels. They will need this background knowledge to begin the design challenge.

4. Discuss the biofuel company assignment by going through pages 4-11 of the **Biofuels Challenge Logbook.** The student log is designed to walk them through the steps of the design process.

TEACHER NOTE

Encourage student teams to be creative about how they design their business. For example, if two or more students plan on developing a biofuel from algae they might consider developing companies that focus on different stages of the development process. One student may decide to focus on the growth stage and make a profit from selling the biomass to another company that turns the biomass into fuel. Another student may choose to develop their business around using the residual biomass as a co-product or designing an engineering solution to separate the algae from the water. The main point is that their company does not need to go through the entire process of developing the biofuel from start to finish, there will likely be many different business ideas that focus on different steps along the way.

5. On Day Three, student groups will present their business pitches to the class. Scoring will be done according to the guidelines explained in the log book.

Day 14-18 – Cell Diseases & the Role of the Medical Counselor

Standards Addressed: S7L2.a; ELA7W3

Essential Question: What is the role of the medical counselor?

1. Begin the class by providing students with the **Cell Processes Performance Assessment** handout. Tell students that they will take on the role of a medical counselor. Specifically, students will work in teams to research and present information on a cellular defect related to a specific organelle. Tell students that they will use the GRASP performance assessment to help them navigate the project.

2. The grade will be based on two parts: quality of the oral presentation and individual contribution assessed through completion of research fact sheets.