From Organelles to Organ Systems: It's all connected

(Time Frame: 3-4 weeks)

Authors

Caitlin Berta

Morgan Oyster

SUBJECT/GRADE LEVEL

Subject Area: Science

Grade Level: Middle School

Materials

- Styrofoam Cups
- Pencil
- Computer/Chromebook
- Poster Paper
- Markers/Art Supplies
- Buckets/Baskets
- Large paper (11 x 14 paper)

Folder of resources

STANDARDS

Next Generation Science Standards

- MS-LS1-1: From Molecules to Organisms: Structures and Processes: Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
- MS-LS1-2: From Molecules to Organisms: Structures and Processes: Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.
- MS-LS1-3: From Molecules to Organisms: Structures and Processes: Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

English Language Arts Standards | Common Core State

- CCSS.ELA-Literacy.RST.6-8.4: Determine the meaning of symbols, key terms, and other domain specific words and phrases as they are used in a specific or technical context relevant to grades 6-8 texts and topics.
- CCSS.ELA-LITERACY.RST.6-8.8: Compare and contrast the information gained from experiments, stimulations, video, or multimedia sources with that gained from reading a text on the same topic.

LESSON OBJECTIVE(S)

Students will be able to

1. Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.
2. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
3. Use arguments supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

CAREER CONNECTION(S)

Mentor Background: Dr. Dylan Fudge is a research biologist within the threat agent sciences division at DEVCOM CBC. Dylan received his bachelors of science in biochemistry and his doctorate in molecular and cellular biophysics from the University of Denver in 2011 and 2020 respectively. Following his Ph.D. he worked as a postdoctoral fellow in an immunotoxicology lab at the University of Colorado Anschutz medical campus and through the Oak Ridge Institute for Science and Education at DEVCOM CBC as a molecular toxicology postdoctoral researcher. His research background includes molecular biology, biophysics/chemistry, and toxicology. Dylan's current research aims to benefit the modern day war fighter faced with biological and chemical threats by utilizing and advancing organ-on-a-chip (OOC) technology.

STEM Careers: Primary Care Provider, Pathologist, Molecular biologist, Medical laboratory scientist, Nurse, Researcher, Biologist, Chemical researcher.

ENGAGEMENT

Brief Description: Introduction, assessing students' prior knowledge, and foundations of cells. Students will have the opportunity to dive into the specific cell organelles. In the first task, students will be constructing a paper cell as well as taking notes on the organelles. If time permits throughout the lesson, students will be able to play various organelle games. Students will have a homework assignment that builds upon organelles. Students will be tasked with going home and finding a common object that represents the function of the organelle. Later on, students will compete for the best organelle in a mayoral race. Lastly, students will put it all together by assessing what they know in a quiz.

Procedures:

1. The teacher will pass out a KWL chart. The topic that they will start with is a Cell. Students will be asked to fill out a KWL Chart as individuals. The students will fill out what they know, what they want to know, and what they have learned. The students and teacher will fill out a KWL chart as a whole. This will allow for discussion of the unit.
    a. After filling out, students will watch a brief video to help spark their curiosity.

b. Students will start with learning what a cell is and what a cell is composed of. Students will take notes on Cell Organelles and their functions. The teacher will be following along and modeling to students the notes as well as creating a construction paper cell. The teacher will be following a Powerpoint Slide.
c. Students will have time to supplement their learning by playing a variety of games: game 1, game 2, and game 3. This will allow early finishers to help supplement their learning in a gamification way.

2. **Organelle Assignment:** To build upon organelles, students will be tasked with going home and finding a common object that represents the function of the organelle. The object can not represent the appearance of the organelle.
    a. The teacher will place students in groups of 3-4. Students in each group will be assigned a different organelle. Other students/groups will not know each other's organelle. When students come to class, they will get out their object. Students will describe the object and allow their group members to guess on their object. At the end, students will reveal their object to their group members. This ensures that students are making correct connections from their everyday object and their assigned organelle. If a student makes an incorrect correlation, group members will be able to discuss what organelle that their object would best correlate with.
    b. After discussing with their groups, students will participate in a gallery walk to view other objects. Students will have the opportunity to make educated guesses on other groups' objects. At the end of class, students will turn in their papers. Students will then be able to share with the class what their object is and what it represents in the cell.
3. Groups will then be entered in a "Cell Organelle Mayoral Campaign" with one chosen organelle.
    a. Your team will be hired to run an organelle campaign. Students will be tasked in convincing others that their organelle is most suited to run the cell. Students will create a campaign poster, a pamphlet, positive campaign, smear campaign, speech, and rebuttal & final statements. At the end, students will vote for one organelle other than their own based on their campaign.
4. Students will then be assessed on their ability to describe the function of the cell as a whole. Students will have a formal assessment to assess their understanding of the cell organelles.

EXPLORATION

Brief Description: Students will use prior knowledge and understanding of cell organelles to explore diseases and how they affect the cell in various ways.

Procedures:

1. Students will have previously gone over the functions of each of the major cell organelles. The teacher will start class off by having the students define the following organelles using just one word: golgi body, ribosome, chloroplast, mitochondria, vacuole, cytoplasm, nucleus, lysosome, cell wall, cell membrane, nuclear envelope, cytoskeleton, centrioles, smooth endoplasmic reticulum.

a. Students will be placed in groups to think about their responses. After 15 minutes, the teacher will ask for responses. If students have struggled with one word, the teacher will allow students to expand to two words.

2. Students will be tasked to use their knowledge of organelles to determine how malfunctions cause health impairments. Students will start their studies by completing the "Little Girl Lost Case Study." The case study allows students to read and complete reflection questions.
    a. After completing the case study, students will be assigned a disorder that involves one of the many cell organelles. The students will be completing a cell organelle research guide for their organelle.
        i. Students will be tasked with researching the given disorder and organelle. They will relate their symptoms to the function of the cell organelle it is caused by. Students will be creating a mini poster detailing information about the disease. Students will have a detailed rubric to help guide their research and project.
3. At the end of their research, students will have the opportunity to share what they have learned. Students will create a one page google slide to show their understanding and importance of their assigned organelle. On the slide, students must include what was found on their cell organelle research guide. Students will take notes over other groups' slides.
4. Students will complete a CER with the following writing prompt, "Which of the following Organelles is most important". This prompt will align with the research, case study, and google slide. The teacher will have the opportunity to choose the best template for each class. If time permits, the teacher will have the option to write a final C-E-R argument into paragraph form.

EXPLANATION

Brief Description: The explain portion of this lesson cycle will consist of two different parts. The first portion will have students put it all together for cell organelles, where they will complete a card sort to relate cell organelle function with diseases that affect these organs. Students will also learn about the different levels of organization associated with life, the journey from organelles to organ systems by first exploring objects of different sizes and arranging them in appropriate size order. Then, students will learn about the major organs and organ systems of the human body and their functions. Students will take notes using a graphic organizer and will also complete a card sort as an assessment to match organ systems with their organs and functions.

Procedures:
Organelles_Ailments Card Sort

1. Put it Together- Students will be given a card sort to match organelles, functions, and related diseases. This assignment will link with the explore portion. However, these diseases may have not been shared in the explore portion. Students will have to use prior knowledge and context clues.
    a. Teacher Note: Students will be able to answer how the various diseases affect the specific organelle. If students become overwhelmed by the number of cards, the teacher may

provide the organelle name and picture first for students to match. After checking for accuracy, the teacher may provide the disease/patient cards. Teachers can highlight key words in the patient cards.

2. Level of Organizations
    a. Bellringer: Students will be given a list of objects. They will use the words to place from smallest to largest: letter, word, sentence, paragraph, book, book series.
        i. Teachers will monitor class discussion after giving a few minutes for students to place from smallest to largest. Teachers will allow students to create their own list. The teacher will ask what we call this when we do this. The teacher should get various words like organize, classify, categorize, or arrange.
    b. Students will be given various cups with the level of organization on them. Students will be asked to try to place the cups in order from smallest to largest.
3. Level of Organization Packet
    a. Read- Students will be reading a passage. Students will place the main idea in each cloud.
    b. Graphic Organizer- Students will work in groups to fill out the graphic organizer below.
        i. Teacher Note: Encourage students to fill out the middle oval first.
    c. Which Level?- Students will complete the questions that correspond to the level of organization.
    d. Analogies- Students will practice what they have learned independently. They will compare levels of organizations to appropriate descriptors.

Organ Systems

1. Teachers will display and show the Human Body Systems video by the Amoeba Sisters linked here. As students watch, students will also answer these questions while they watch.
    a. Teachers should pause the video at the specified points to allow students time to write down the information as well as discuss any information that needs to be clarified for your specific set of students.
    b. After viewing the video and answering student questions about the organ systems, have students complete the organ system card sort linked here.
        i. Teachers should prepare the card sort cards for students prior to the lesson.
        ii. It is suggested that these cards be laminated for future use.
        iii. You can have students work in pairs or individually.
        iv. The file is organized so that the original slides are like an answer key, which can be used to check student work.
        v. Teachers should monitor student progress while they are working and help them make adjustments to their sortings as necessary.
2. Using the provided notes and presentation linked HERE have students fill in the information on this notes page
3. Assess student knowledge using the exit ticket linked here

ELABORATE

Brief Description: During the Elaborate portion of this lesson, students will dive a little deeper into the interactions within the human body. Using the knowledge gained about the organ systems in the Explain portion of the lesson cycle, we will now construct an understanding of how these organ systems work together to function and maintain homeostasis in the body. This will begin with a think-pair-share activity where students will try to connect different systems together in how they assist one another in functioning. Then, students will continue to learn about these interactions and complete the graphic organizer/notes that were started in the Explain portion. Once these key ideas are written down and discussed, students will then play the organ system relay game where they will work together to act as their assigned organ system and connect their system to the other organ systems it has main interactions with. Students will then construct their own flow chart, infographic or other graphic organizer to show these connections between the organ systems and to make their connections visible.

Procedures:

1. **Think Pair Share: Organ Systems**
    a. Teachers will need to display the prompts for the think-pair-share and have a way to collect student answers for discussion.
        i. Some suggestions include:
            1. Chart paper posted around the room and student groups have different colored markers where they add something to the paper and put check marks next to things they agree with
            2. Digitally record student answers using a platform like Padlet or PollEverywhere where students digitally enter their answers so the whole class can see responses.
            3. Record answers on the whiteboard
            4. Create a document where answers are typed as the conversation occurs.
            5. Create a google form where students record their responses to the prompt and answers can be seen.
    b. Conducting the Think-Pair-Share
        i. Use the prompts linked here
        ii. Have students work in pairs, or groups of 3 to come up with answers to the prompt.
        iii. All answers should be recorded for discussion as a class.
        iv. Discuss with students and ask additional questions to see if they can come up with additional connections.
2. **Organ System connection Notes**
    a. Using the notes collected in the Explain lessons, and the new ideas of connectedness, complete the Human body systems notes linked here. Key found here
    b. Teachers should focus on the idea that all the organ systems can not work properly without being interconnected to another and that all are necessary for homeostasis of the organism.
3. **Organ System Relay Game**
    a. Teachers should prepare the cards, buckets and other materials listed in the game instructions linked here prior to this portion of the lesson.
    b. Teachers should group students into groups to ensure that you have enough groups to accommodate the included organ systems.

c. Teachers will place buckets or baskets around the room labeled with the organ system names and have student teams stand near the bucket of their assigned system.
    i. It is suggested that desks be moved out of the way if possible to allow for student movement around the room. Potentially this could be done outside or in a large space like a gym or cafeteria if available.
d. Teachers will distribute the system cards to each student group.
    i. Students by the digestive system will be given the digestive system cards, respiratory will be given respiratory, etc.).
e. Students will line up, like for a relay and the first person in the line will select a card out of their systems stack and will read it with their group. The group will decide which system the card indicates their system is interacting with and will deliver that card to the corresponding system basket/bucket.
f. Once the card has been delivered, the student will return to their team, go to the end of the line and the process will repeat until all cards have been delivered.
g. The first team to finish "wins".
h. After all cards have been sorted, go through each basket and as a class ensure that the cards are where they should be.
i. If cards were put in the wrong baskets, then return that card to the appropriate group (backs have original system labels) and have groups try again with assistance from classmates.
    i. Ask questions like, are any organs listed? Can you think of what system those organs are associated with?

4. **Organ System Connections Infographic**
    a. Students will create an infographic or a graphic organizer that shows the connections between the organ systems.
    b. This can be done on paper, or digitally. Digital platforms that can be used are be listed below. Choose digital tools your students will have access to and you have knowledge of
        i. Google Slides (templates can be found online)
        ii. Google Draw (templates can be found online)
        iii. Canva
        iv. Picktochart
    c. Students will use this rubric to know what the expectations are for the product they are making.

EVALUATION

Brief Description: The evaluation portion of this lesson will have students research diseases associated with human body systems and choose one of two ways to explain their learning in the Amazing Human Body Project. Students will also have the chance to read and respond to an article that reviews the Organ-on-a-Chip technology for students.

Procedures:

1. Students will choose between one of two options for a final project for this unit(5-8 60 minute class periods). Their choices will be the Human Body Battle Royale or Comic. Regardless of the chosen option, students should research:
    a. Major organelles and their functions.
    b. The chosen body system and its organs.
    c. A specific disease related to the chosen system.

2. Students will present their project to the class, explaining their creation and the connection between organelles, systems, and diseases.

Optional activity: This activity is optional, however, this is the research that this unit is based off of. Teachers could use this at any point of the unit to tie the concepts together, or at the end as it is here so that students can understand the purpose of the unit in research today.

3. Students will also Explore the organ-on-a-chip technology (1-2 class periods). For this, there are a couple of options that were generated using Diffit.
    a. The purpose of these activities is to connect this to the research that is going on in labs today.
    b. Teachers can use either activity or both. The reading is scaled for a 6-8th grade reading level and is intended to be introductory.
    c. Activity 1
    d. Activity 2
    e. Activity 3 is based off of this video that can be used to introduce students to the concept of organ-on-a-chip technology and body-on-a-chip technology. This utilizes hexagonal thinking to have students make connections to the vocabulary in the reading and video.

REFERENCES

- https://www.hmhco.com/blog/free-kwl-chart-graphic-organizer-template
- https://www.youtube.com/watch?v=0JDCViWGn-0
- https://vetmed.tamu.edu/peer/wp-content/uploads/sites/72/2020/04/Organ-systems-working-together.pdf
- https://orise.orau.gov/resources/k12/documents/lesson-plans/organelle-ailments.pdf
- https://www.researchgate.net/figure/Diseases-associated-with-specific-cell-organelles-Abbreviations-CDG-congenital_fig3_253339956
- https://carolinaseveriche.me/diseases-associated-specific-cell-organelles/
- https://youtu.be/8tlHd5pYHOY?si=VBZeRMWjvPe82rbc
- https://link.springer.com/article/10.1007/s13206-022-00087-8