Investigating Cell Structure and Function

Unit: Systems of specialized cells within organisms help perform essential functions of life. **BIO.2.2**	**Utah SEEd Standard / NGSS Performance Expectation:** **BIO.2.2: Obtain, evaluate, and communicate information** to determine how (a) the *structure and function* of cells, (b) the proportion and quantity of organelles, and (c) the *shape* of cells result in cells with specialized *functions*. Examples could include mitochondria in muscle and nerve cells, chloroplasts in leaf cells, ribosomes in pancreatic cells, or the shape of nerve cells and muscle cells. (LS1.A)	**Time:** **Two 70 min classes**

Anchor Phenomenon	Students will line up in pairs opposite to one another and stretch their arms out in front of them to simulate the structure of CILIA. Using their outstretched arms, they will attempt to pass an object (like a ball) down the row of students and back to the start. Once the ball is returned, the students will change the cilia structure by bending their arms so that only their elbows stick out. They will attempt, once again, to pass the object down and back.
Driving Question(s)	How does structure affect function? What happens to the function if the structure of an object changes? How did changing the shape of the cilia affect your ability to pass the ball?
Performance Task	- Students will be able to explain how structure affects function through kinesthetic activity (arms = cilia), visual representation (bicycle tires), and their personal experience (favorite sport or activity). - Students will research an assigned disorder and determine the organelle that is connected with the disorder. - Students will relate changes in cell organelle structures to their functions and the possible disorders that occur as a consequence.

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Lesson Summary:			
	Time	**Guiding Question / Learning Objective**	**How are students answering the guiding question or meeting the learning objective?**
 **Engage**	15 - 20 minutes	Spending plenty of time with students is important to help them understand the relationship between structure and function. This portion of the lesson introduces this concept and gets students to relate structure and function to their experiences.	Students will have multiple opportunities through teacher-led discussion, partner discussion, whole group discussion, and individual sense-making to understand the relationship between structure and function.
 **Explore**	25 – 30 minutes	Students will use a prepared case study to determine the relationship between the structure of an organelle and the organelle's function. The case study helps students determine how a change in the organelle's structure will change its function, leading to a disorder.	Students work in groups to understand the case study and the structure and function of the organelle. They will then contribute to a slideshow to give a synopsis of the case study.
 **Explain**	25 – 30 minutes	Students will present their information to the class.	Student groups share their information with the class. As they do, the rest of the class takes notes on their Student Document Sheet.
 **Elaborate**	15 – 20 minutes	Students will use their understanding of the concepts and skills they have developed on how the structure will determine function and apply them to a similar phenomenon: the development of tumors in lung cancer.	Students investigate the cause of tumors in lung cancer and will describe how the change of the cell's structure will result in a tumor's growth.
 **Evaluate**	20 – 30 minutes	There are several options here: 1) Use the lung cell activity on slides 10 –13 of the teacher presentation (see also extension activity below); 2) Use the final analysis in the Student Documentation Sheet; 3) use the document Assessment of Cell Structure and Function. The goal here is to have a summative assessment of student learning.	Student learning of structure and function of specialized cells and cell organelles is assessed.

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Three Dimensions Focused on in This Lesson		
Disciplinary Core Idea: **NGSS Appendix E** Systems of specialized cells within organisms help perform essential functions of life. Any one system in an organism is made up of numerous parts. Feedback mechanisms maintain an organism's internal conditions within certain limits and mediate behaviors.	**Science and Engineering Practices:** **NGSS Appendix F** **Obtain, evaluate, and communicate** Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.	**Crosscutting Concept:** **NGSS Appendix G** **Structure and Function** Students investigate systems by examining the properties of different materials, the structures of different components, and their interconnections to reveal the system's function and/or solve a problem. They infer the functions and properties of natural and designed objects and systems from their overall structure, the way their components are shaped and used, and the molecular substructures of their various materials.
Learning Objectives 1. Students will recognize that the structure (shape) of a cell and cell organelles determine the function of the cell and cell organelles. 2. Students will recognize that when the structure of a cell and cell organelles change, the associated function also changes.		
Related Knowledge and Skills from Prior Grades		
Disciplinary Core Idea: **NGSS Appendix E grades 6-8** All living things are made up of cells. In organisms, cells work together to form tissues and organs that are specialized for particular body functions.	**Science and Engineering Practices:** **NGSS Appendix F grades 6-8** Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).	**Crosscutting Concept:** **NGSS Appendix G** In grades 6-8, students model complex and microscopic structures and systems and visualize how their function depends on the shapes, composition, and relationships among its parts. They analyze many complex natural and designed structures and systems to determine how they function. They design structures to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

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Materials

Link to all materials on the 3DRST website (3drst.byu.edu): https://3drst.byu.edu/bio-2-2-cell-function
Link to all materials on Canvas Commons: https://tinyurl.com/3DRSTbiology

Handouts	Other Resources
Student Documentation Sheet Case Study Files Assessment of Cell Structure and Function	Teacher PowerPoint Investigating Cell Structure and Function Rubric Case Study Slides Teacher's key (diseases)

ENGAGE

- Give students a copy of the Student Documentation Sheet.
- Place the pictures of the bike (**slide 2**) with square wheels and normal round wheels on the board and have students use row 1 of Table 1 to record their observations.
- Teacher says: "Be ready to discuss your observations in 30 seconds."
- After one minute, say: "If you haven't written anything down, now is the time."
- After two minutes, collect responses and redistribute them to the students. Have students use them to do a Pair-Share with the student next to them. *They can share their own answer or the new one with their partner.*
- Show **slide 3,** and have students relate how the structure and function of the normal and abnormal egg might be different.
- Use **slides 4 and 5** to prime students to determine a structure and function idea based on something that they are involved in. Have them record their ideas on row 2 of Table 1, then share them with the class.

Teacher Tips

If your class is small, you can call on specific students you have talked to.

Walk around the class to read what students have written during their writing time.

Give nonverbal cues to have students write something down.

Variations: Use sticky notes, Padlet, convert slides to Nearpod, or use a jamboard for student responses.

EXPLORE

- Show **slide 6**. Each picture represents a biological structure and function. Discuss with students what they are observing. Get them to identify the structure and function.

Investigative Case Studies. Show **slide 7**.

- Place students into groups of 1-3 (or separate into 12 equal groups)
- Give each group a case study that they will be required to read and identify what organelle is causing the dysfunction. Have them record their information in Table 2.
- Give students the link to the slide show so they can add the following:

Teacher Tips

When giving out the link to the slide show, make different files for each class you teach and share that link-specific link.

Move from group to group to ensure they are on the right track. Some organelles are hard to find, so help students think of keywords for them to use in their searches.

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- Give a quick synopsis of what their case study is about. - What the organelle is. - Explain the normal structure and function of the organelle. - Explain how the change in the structure of the organelle changes the organelle function and how that leads to the associated disease.	Be purposeful about who you put into groups. For IEP/504, make sure they are placed in groups that can help them learn and include them in those groups.

EXPLAIN

PRESENTATION OF INFORMATION. Show **slide 8**.

- After students complete their slide show portion, each group will need to share their portion so other students can record the information on Table 3 of the Student Documentation Sheet. Students will:
  - Give a quick synopsis of what their case study is.
  - Explain the structure and function of their organelle.
  - Explain what their organelle does.
  - Explain how the structure of the organelle changes and how this change will affect the function of the organelle.

ELABORATE

- Show **slide 9**. This slide aims to have students use their understanding of the concepts and skills they have developed about how structure determines function and apply them to a similar phenomenon. The phenomenon here is the development of lung tumors.
- Remind students that in the case studies, they were given information to help them determine the disease. Then they researched the information to determine which organelle was malfunctioning due to a change in its structure.

Help students to understand that their task is similar, but they are now given the disease (lung cancer). They are to determine a) signs and symptoms, b) prognosis, c) who it affects, d) affected organelle, e) normal function, f) change in structure, and g) change in function (see student document).

EVALUATE

- Give students a copy of the Assessment of Cell Structure and Function handout to assess their learning. - Have students select a cell type or assign them to students. - Students will work independently or with a partner to answer the questions about cell structure and function.	**Teacher Tips** - Decide if you want to assign a cell type or assign the cell type to have a variety throughout the class. - Determine if the assessment should be on their own or with a partner. - Students will need access to either technology or written resources for research purposes. - Suggested time may vary per class (20-25 min.)

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POSSIBLE EXTENSION / ALTERNATIVE ADAPTATIONS

Possible Extension Activity

Cilia Activity (Balloon)

Materials needed per station:
- 1 balloon
- Masking tape
- Several ping pong balls
- Long table/smooth floor
- Straws

1. In this activity, students will blow up a balloon representing the LUNG and secure it to the table/floor with tape.
2. One student will use the ping pong balls (foreign unwanted particles: dust, allergens, etc.) and try to hit the balloon (LUNG)
3. While the student in #2 attempts to hit the balloon (LUNG), two to three students with straws (representing CILIA) try to prevent the ping pong balls from hitting the balloon.
4. Using the CER method, students will report the BEST method of using the straws (CILIA) to protect the balloon (LUNG).

If using this as an extension, the students can determine the BEST way to protect the balloon (LUNG) from the ping pong balls (foreign particles) using the straws (CILIA)
****Note: Answers will vary with each group*

Alternative Adaptations
1. Provide translated versions of case studies to ELL students. (Teacher key).
2. Scaffold for students with IEPs.
3. Provide ongoing support.

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