Unit 6.6 Cells and Systems

Content Area: **Science**
Course(s): **Science 6**
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Essential Questions

Unit Question- How do things heal?

Lesson 1 What happened in the students footso they could walk again?

Lesson 2 What do our bones, skin, and muscles do for us?

Lesson 3 How can medical images and diagrams help us figure out more about the structures in the body?

Lesson 4 Why is there blood in all of these places in the body?

Lesson 5 What do nerves do, and why are they in different parts of the body?

Lesson 7 Are all things made of cells?

Lesson 8 What happened as the skin on top of the foot healed?

Lesson 9 What is happening at the site of an injury to fill the gap?

Lesson 10 What do cells need to grow and make more of themselves?

Lesson 11 How do cells get what they need to grow?

Lesson 12 How do the structures and systems in the body work together to heal the injury?

Lesson 13 How is the process of growing similar to healing?

Lesson 14 How can shifting our perception of ability and disability allow us to be more thoughtful about how we make our environments more accessible?

Big Ideas

Unit Summary and Storyline

This unit launches with students hearing about an injury that happened to a middle school student that caused him to need stitches, pins, and a cast. They analyze doctor reports and develop an initial model for what is going on in our body when it heals. Students investigate what the different parts of our body are made of, from the macro scale to the micro scale. They figure out parts of our body are made of cells and that these cells

work together for our body to function.

Once students have figured out what their bodies are made of and how the parts of their body work together to be able to move, they wonder how the parts of our body heal. They start by watching a timelapse of a knee scrape and notice that over time the part that was scraped is filled in with new skin cells. Students investigate what happens when cells make more cells, what cells need to make more cells, and how cells get what they need to make more cells. Students return to the healing timeline they made at the start of the unit and apply what they have figured out about the interactions between the different systems in the body to explain the various events of healing that took place for the injury at the start of the unit. Finally, they apply their model for healing to explain growth at growth plates in children's bodies as they become adults.

Anchoring Phenomenon

The anchoring phenomenon of this unit is a case study of a middle school student who suffered an injury in PE class when he dropped a weight on his foot. The impact of this injury resulted in two bones in his foot breaking. Due to this injury, the student had pins put in his foot to line up the bones, stitches to close up the skin that had broken open, and a cast to support the foot as the bones healed. It took four months for the student's injury to heal which included physical therapy once his cast was off to support strengthening his foot and leg.

Students are experts in their lived experiences which makes these experiences educational resources for the science classroom. Students' experiences with their own healing of common childhood injuries, such as scraping a knee on a sidewalk, allow students to engage in the anchoring phenomenon of healing and to describe the healing process they witnessed. While students may not initially describe all of the components and interactions of healing, their macroscopic understanding of personal healing can be leveraged to motivate the need to understand the microscopic structures and multi-system and subsystem components and interactions of healing, that might not be directly visible from the outside of the body with just their eyes.

Each OpenScied unit's anchoring phenomenon is chosen from a group of possible phenomena after analyzing student interest survey results and consulting with external advisory panels. We chose this case study around an injury that heals over time as the anchoring phenomenon for this unit for these reasons:

- The PE bundles for this unit center around cells, connections between cell and cell parts and their functions, and thinking about the body as a system of interacting parts. To fully explain the healing process the body goes through, all of these ideas are necessary components of this story.
- An injury of a broken bone is not foreign to most students, whether they experienced one themselves or saw a classmate or peer who had experienced one.
- We want students to develop the understanding through investigations at different scales that the body is made up of very small parts before naming these parts cells. In working to figure out how the body heals, this idea is accessible for students.
- In analyzing and investigating the different parts of the body involved in this injury and the healing process, students will need to figure out the body is a system that is made up of other systems within it. These systems interact and work together during the healing process. The smallest of these systems is the cell.
- In addition, they will figure out that cells can make more cells when provided food particles that are moved around the body through the blood vessels and therefore, systems need to interact for the student's body to be able to heal and more generally so that all our bodies can heal and function.

Enduring Understandings

NGSS Performance Expectations

- MS-LS1-1. 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.* Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
- MS-LS1-3.* Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
- MS-LS1-8.* Gather ~~and synthesize~~ information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or ~~storage as memories~~.

Disciplinary Core Ideas

The unit expands students' understanding of cells, systems, and structure and function which include these Grade 6-8 DCI elements:

- LS1.A: All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).
- LS1.A: Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.
- LS1.A: In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions
- LS1.D: Information Processing. ~~Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as~~ signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors ~~or memories~~.
    - Other aspects of this PE are developed in additional OpenSciEd units, beginning their initial work on MS-LS1-8 in the One-way Mirror Unit. The current version of this unit, OpenSciEd Unit 6.6: How do living things heal? (Healing Unit), primarily addresses the role of nerve cells in sending signals to the brain. Students will revisit and expand on their understanding of this DCI in later units in the OpenSciEd program, including returning to it in the OpenSciEd Unit 7.1: How can we make something new that was not there before? (Bath Bombs Unit) unit in 7th grade and the Sound Unit unit in 8th grade.

Crosscutting Concepts

- Scale, Proportion, and Quantity: This crosscutting concept is key to the sensemaking in this unit. Students use different spatial scales to observe and make sense of phenomena, from macroscopic (parts of the body, systems within the body) to the microscopic (cell level). They also consider different temporal scales (4 months of healing for the student in Lesson 1 to the quick timelapse in Lesson 8) to figure out what the body is made of and how the different structures in the body are interconnected (ie: cells are part of tissues).
- Systems and System Models: This crosscutting concept is key to the sensemaking in this unit. Beginning in Lesson 2, the class develops a poster titled, Our Body as a System. Students incrementally revise and extend the systems model poster in the next four lessons as they figure out

more about the different systems and subsystems within our body ranging from our body as a whole down to the system of the cell.
- Structure and Function: This crosscutting concept is key to the sensemaking in this unit. As students figure out how parts of the body heal, they investigate the way different parts are structured, how these parts function and how the way these parts are structured is related to the function of the part. Students look at structures both macroscopically in the body as well as microscopically down to the cell. Students figure out that the different parts of the body are made of cells that are unique in shape and composition to that part of the body and that the structure of the cell is related to the structure and function of the part of the body the cell comes from.

- The following crosscutting concepts are also key to the sensemaking in this unit:
    - Patterns
    - Cause and Effect

Cross-Curricular Integration

Additional Mathematics and ELA integration can be found within each lesson plan.

Mathematics Integration

In Lesson 3 students will collect light sensor data under very specific measurement conditions in which any deviation from the protocol could result in measurement error. Even given the detailed protocol students follow, the light sensor will not consistently report a single value, so students will need to determine a range that seems as accurate as possible given the measurement conditions. When they rank order the materials by transmissivity and reflectivity, they will use ranges that could overlap for some materials, and students may need to estimate the central tendency within the range of values to help them determine their rankings. This work is largely done as a whole group and can be more or less guided by you. However, the following math concept may be helpful:

CCSS.Math.Content.6.SP.A.2: Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. Additionally, students collect these data using base tens (x10 lux).
The following math concept will be useful in explaining why they are selecting this setting on the light sensors.

CCSS.Math.Content.5.NBT.A.1: Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.

Diversity Integration

Cultural significance of light and matter
Light in symbolism and spirituality: Explore how light is viewed in different cultures and religions, including concepts of enlightenment, divinity, and purity.
Traditional uses of materials: Investigate how different cultures have utilized various materials for tools, art, and ceremonies, understanding their properties and significance within those cultural contexts.
Light in traditional practices: Explore how light plays a role in traditional practices like Scandinavian "Hygge" or Japanese "Shinrin-yoku" (forest bathing), according to Luminette.
Matter and identity: Consider how material culture reflects and shapes individual and group identities in diverse societies.

Exploring light and matter through diverse lenses
Legends and myths: Discuss myths and legends about natural phenomena like the aurora borealis from different cultures, comparing scientific explanations with traditional narratives.
Art and architecture: Examine how light has been used in art and architecture across different cultures and periods, analyzing the symbolism and cultural context.
Cultural uses of light and color: Explore how different cultures use and interpret colors in their art, clothing, rituals, and ceremonies.
Diverse scientific contributions: Highlight contributions to the study of light and matter from scientists of various backgrounds and cultures throughout history.

Labs and Resources

Scientific Inquiry

Exploring Light and Matter

Objective:
Students will investigate how light interacts with different materials to understand the concepts of reflection, refraction, and absorption.

Reflection Questions:
What happens to light when it hits a mirror?
Describe how light changes direction when it passes through water.
How does the brightness of light change after passing through water?
Assessment:
Students will submit a lab report with drawings and descriptions of their observations.
Include measured angles of reflection and refraction.
Answer reflection questions with detailed explanations.

Science and Engineering Practices

- **Developing and Using Models: Developing and Using Models:** This unit intentionally develops this practice. While students engage in aspects of the modeling practice they have explored in prior units,

this is a different context. This is the first biological system context that students investigate in the program, and their first experience tying physical mechanisms to phenomena that occur in living things. Beginning in Lesson 1, students are developing a model for healing. They revise this model throughout the unit, and use their elaborated model to explain how the body heals from an injury (Lesson 12). In Lessons 2 – 6, the class develops a model of the structure and function of the different parts of the body. In Lesson 8, students apply what they have figured out about the different parts of the body to develop a model for how skin heals from a scrape at the cellular level. In Lessons 9 – 11, students continue to revise the healing model to include what is happening at the cellular level

- **Planning and Carrying Out Investigations**: This practice is key to the sensemaking in this unit. Students plan and carry out investigations across multiple lessons to help figure out how healing occurs. Students watch a demonstration of a chicken wing dissection in Lesson 2. They brainstorm how they would revise this dissection to "injure" the chicken wing in a similar manner to the injury the student in Lesson 1 had incurred. In Lesson 4, students carry out an investigation using microscopes to look at a blood sample. In Lesson 7, students plan for an investigation that could provide evidence as to whether other things in our world are made of cells. In Lesson 11, students carry out an investigation to figure out if things, like food particles, can get into an onion cell.
- **Analyzing and Interpreting Data:** This unit intentionally develops this practice. While students have engaged with this practice in earlier units, in this unit students analyze different kinds of data (including images at different scales) in a different type of context, living things. Students identify the macro-level functions of skin, bone, and muscle, and figure out that the microscopic structures (cells) in blood and nerves support the functions of those body parts. Students analyze and interpret observational data, videos, and images to provide evidence that cell growth occurs. Students analyze second-hand data from an investigation of E.coli to collect evidence that the bacteria need food to make more cells and the more food the bacteria are provided, the more the bacteria make more cells.
- **Engaging in Argumentation:** This practice is key to the sensemaking in this unit. Students engage in argumentation many times throughout the unit as they explain what is happening in the body for it to heal. In Lesson 2, they argue orally for the interactions between the bone and muscle and skin for a part of the body to function. In Lesson 7, students argue from evidence whether the living things they analyzed are made of cells or not. In Lesson 10, students argue for what human cells need to grow and make more cells and argue for what bacteria need to grow and make more of themselves. In Lesson 12, students argue from evidence for what caused the different healing events on the Healing Timeline from Lesson 1. In Lesson 13, students argue for whether the healing process is similar or different from the growth process and why.

- The following practices are also key to the sensemaking in the unit:
    - Asking Questions and Defining Problems
    - Constructing Explanations and Designing Solutions
    - Obtaining, Evaluating, and Communicating Information

Science and Society

Christiaan Huygens: In the 1670s, Huygens proposed that light is a wave and developed the Huygens' principle, suggesting that each point on a wavefront acts as a source of secondary spherical waves.
Thomas Young: Young's double-slit experiment in 1801 involved passing light through two slits, creating an interference pattern on a screen, which strongly supported the wave theory of light.
Augustin-Jean Fresnel: Fresnel built upon Huygens' work, developing a mathematical framework for the wave theory and successfully explaining phenomena like reflection, refraction, interference, and diffraction.
James Clerk Maxwell: Maxwell's equations, published in 1865, revealed that light is an electromagnetic wave,

a form of energy that travels through space by the interaction of electric and magnetic fields.

Isaac Newton: Newton, while initially favoring a particle theory of light, explored light's interaction with prisms and developed ideas about how different colors of light are absorbed, transmitted, or reflected, according to the Science Learning Hub.
Albert Einstein: Einstein's work on the photoelectric effect in the early 20th century showed that light can also behave as particles (photons), leading to the concept of light's wave-particle duality.
Justus von Liebig: Liebig, a German chemist, developed a method for coating glass with a thin layer of silver, revolutionizing mirror production by making them more accessible and affordable, says Live Science.
Ibn al-Haytham: This 11th-century Arab scholar, also known as Alhazen, made significant contributions to optics, including studies on reflection and refraction, particularly with lenses and mirrors. He also authored treatises on visual perception and the nature of light from celestial bodies.
John Hadley: Hadley is credited with inventing mirrors for reflecting telescopes.

CSDT Technology Integration