CEREAL CITY SCIENCE by BCAMSC

Teacher Guide and Student Journal
Sample Activity and Planning Pages

Body Systems for Growth and Repair
MSLNG2

A Middle School Unit supporting Next Generation Science Standards

Body Systems for Growth and Repair

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A middle school unit supporting **Next Generation Science Standards** developed and written by the Battle Creek Area Mathematics and Science Center for

CEREAL CITY SCIENCE™
by BCAMSC

Body Systems for Growth and Repair

Pre-Activity Information Pages

Activities

Appendix

NEXT GENERATION SCIENCE STANDARDS

DISCIPLINARY CORE IDEAS/PERFORMANCE ASSESSMENTS	Activity
LS1.A: Structure and Function • 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). (MS-LS1-1) • Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2) • 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. (MS-LS1-3)	1,2,3,4,5,6
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.	1,2,3
MS-LS1-2. 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.	2,3
MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	2,4,5,6
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. (MS-LS1-8)	4
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.	4
ETS1.B Developing Possibly Solutions • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2)	3
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	3

NEXT GENERATION SCIENCE STANDARDS

SCIENCE AND ENGINEERING PRACTICES/PERFORMANCE ASSESSMENTS	Activity
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and use a model to describe phenomena. (MS-LS1-2) • Develop a model to describe unobservable mechanisms. (MS-LS1-7)	1,2,3,4,6
MS-LS1-2. 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.	1,2,3,4,6
Planning and Carrying Out Investigations Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. • Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. (MS-LS1-1)	2,4,5
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.	2,3
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3)	1,2,3,4,6
MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	4,5,6
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods. • Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS1-8)	1,2,3,5,6
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.	4,6

NEXT GENERATION SCIENCE STANDARDS

CROSSCUTTING CONCEPTS/PERFORMANCE ASSESSMENTS	Activity
Cause and Effect • Cause-and-effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8)	1,4,5,6
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.	4,5,6
Scale, Proportion, and Quantity • Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1)	2,3
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.	2,3
Systems and System Models • Systems may interact with other systems; they may have subsystems and be a part of larger complex systems. (MS-LS1-3)	1,2,3,4,5,6
MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	4,5,6
Structure and Function • Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/ systems can be analyzed to determine how they function. (MS-LS1-2)	1,2,3,4,5,6
MS-LS1-2. 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.	1,2,3

NEXT GENERATION SCIENCE STANDARDS—GUIDING QUESTIONS

DISCIPLINARY CORE IDEAS

LS1.A: Structure and Function

- 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). (MS-LS1-1)
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)
- 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. (MS-LS1-3)
  - How can we investigate what living things are made of?
  - How can we develop models of structures that are too small to see?
  - How can we obtain evidence that living things are made of cells?
  - How can we determine how the systems in multicellular organisms interact?

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. (MS-LS1-8)
  - How can we obtain information to figure out how the brain receives signals and the body reacts?

ETS1.B Developing Possibly Solutions

- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2)
  - How can new scientific technology help the body heal and sustain the healing over time?

NEXT GENERATION SCIENCE STANDARDS—GUIDING QUESTIONS

SCIENCE AND ENGINEERING PRACTICES

Developing and Using Models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-LS1-2)
- Develop a model to describe unobservable mechanisms. (MS-LS1-7)
  - How can we develop a model to explain a broken bone and how it heals?
  - How can we develop a model to describe the cell and cell parts?
  - How can we develop a model to explain how body systems interact?

Planning and Carrying Out Investigations
Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.

- Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. (MS-LS1-1)
  - How can we conduct an investigation to give evidence that living things are made of cells?

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3)
  - How can we construct an argument, using evidence that explains that the body is a system of interacting subsystems composed of groups of cells?

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.

- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS1-8)
  - How can we obtain, evaluate, and communicate information that explains how sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories?

NEXT GENERATION SCIENCE STANDARDS—GUIDING QUESTIONS

CROSSCUTTING CONCEPTS

Cause and Effect

- Cause-and-effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8)
  - How can we demonstrate a cause-and-effect relationship between an injury and messages sent to the brain and repair?
  - How can we use cause-and-effect relationships between receptors and messages sent to the brain to predict healing of an injury?

Scale, Proportion, and Quantity

- Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1)
  - How can we obtain evidence that living things are made of cells?
  - How can we determine how the systems in multicellular organisms interact?

Systems and System Models

- Systems may interact with other systems; they may have subsystems and be a part of larger complex systems. (MS-LS1-3)
  - How can we develop a model to describe the cell and cell parts?
  - How can we develop a model to explain how body systems interact?

Structure and Function

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS1-2)
  - How can we develop a model to describe the cell function and how the parts interact?
  - How can we analyze microscopic structures and systems to determine how they function?

UNIT AT A GLANCE

Activity	Time to Complete	Lesson-Level Learning Goals	Phenomena/ Challenge	Summary: Students will…
1. **The Broken Summer**	Preparation: 15 minutes Activity: 3 classes Lesson 1A: 55–60 min. 2 classes Lesson 1B: 55–60 min.	Develop initial before, during, and after models of how the body heals a broken bone. Raise questions about how the body heals itself.	The story *The Broken Summer* The class will try to figure out how the body heals itself after an injury. (broken bone)	• Take notes about the key ideas and questions based on the story *The Broken Summer*. • Raise questions about how the body heals. • Develop an initial model of early ideas of how the bone heals.
2. **Looking at Cells**	Preparation: 20 minutes Activity: 4 classes Lesson 2A: 55–60 min. Lesson 2B: 55–60 min. 2 classes Lesson 2C: 55–60 min.	Conduct investigations to provide evidence that all living things are made up of cells, which is the smallest unit that can be said to be alive. Make observations to determine that cells are not all alike and are made up of different parts.	The story *The Broken Summer* The class will try to figure out how the body heals itself after an injury. (broken bone)	• Use a microscope to make observations of plant and animal cells. • Compare and contrast plant and animal cells. • Use a microscope to make observations of cell structures. • Compare onion skin cells to cheek cells. • Watch informational videos about cells and cell structures. • Communicate what they have figured out in groups and as a class.
3. **The Role of Cells in How the Body Heals**	Preparation: 30 minutes Activity: 6-7 classes Lesson 3A: 55–60 min. 2–3 class periods Lesson 3B: 55–60 min. 2 class periods Lesson 3C: 55–60 min. 2 class periods	Obtain information about bone structures and the specialized cells in bones that interact during the healing process. Investigate new science technology that is used when remodeling broken bones.	The story *The Broken Summer* The class will try to figure out how the body heals itself after an injury. (broken bone)	• Present previous revisions to their models based on evidence. • Make observations of bone cells. • Obtain information through different media and demonstrations. • Obtain and evaluate information from text. • Make decisions based on evidence and gained knowledge.

UNIT AT A GLANCE

Students Figure Out How to:	Practices/Crosscutting Concepts	Assessment
• Determine the central ideas of a text. • Cite textual evidence to support analysis of key ideas. • Develop a model of their initial thinking about how broken bones heal. • Categorize questions based on similarities.	**Asking Questions and Defining Problems** **Developing and Using Models** **Engaging in Argument Based on Evidence** **Systems and System Models**	**Formative Assessment** initial models group models Activity Page Science Talk
• Make wet-mount slides to observe cells under the microscope. • Use stains on wet-mount slides to observe different organelles. • Obtain, evaluate, and communicate information from multiple sources about cells. • Take notes from video and text.	**Planning and Carrying Out Investigations** **Asking Questions and Defining Problems** **Developing and Using Models** **Obtaining, Evaluating, and Communicating Information** **Scale, Proportion, and Quantity** **Systems and System Models**	**Formative Assessment** Activity Page Journal Entry Science Talk revised models
• Engage in argument from evidence. • Make revisions to models and their thinking based on evidence. • Provide evidence that different tissues and organs are made of different kinds of cells. • Take notes from informational text. • Determine common components among different models and explain why the components are important in understanding the model. • Use a model to explain how specialized cells are constantly working to maintain a healthy body. • Analyze new scientific technology to make decisions.	**Engaging in Argument Based on Evidence** **Developing and Using Models** **Obtaining, Evaluating, and Communicating Information** **Systems and System Models** **Scale, Proportion, and Quantity** **Structure and Function**	**Summative Assessment** revised models Science Talks Journal Entries Activity Pages group discussions presentations

UNIT AT A GLANCE

Activity	Time to Complete	Lesson-Level Learning Goals	Phenomena/ Challenge	Summary: Students will…
4. Raising Questions About Body Systems	Preparation: 30 minutes Activity: 7-8 classes Lesson 4A: 55–60 min. Lesson 4B: 55–60 min. 2–3 class periods Lesson 4C: 55–60 min. 2 class periods Lesson 4D: 55-60 min. 2 class periods	Conduct investigations and develop models to obtain information about how body systems interact with other body systems to maintain a healthy organism.	The story *The Broken Summer* The class will try to figure out how the body heals itself after an injury. (broken bone)	• Ask questions based on text from *The Broken Summer*. • Follow written directions to develop a model of an arm. • Conduct an investigation into the effect of exercise on heart rate and respirations. • Conduct an investigation into the body's response to hot and cold stimuli. • Obtain and evaluate information from informational text.
5. Developing a Plan for Research	Preparation: 30 minutes Activity: 2 classes Lesson 5A: 55–60 min. Lesson 5B: 55–60 min	Conduct research to obtain information about a selected body system and how it interacts with other body systems to maintain a healthy organism.	The story *The Broken Summer* The class will try to figure out how the body heals itself after an injury. (broken bone)	• Collaborate with group members to choose a body system to research. • Develop a Product Descriptor of the essential information to obtain through research.
6. Obtaining Information Through Research	Preparation: 30 minutes Activity: 8–11 classes Lesson 6A: 55–60 min. 2 classes Lesson 6B: 55–60 min. 3–4 classes Lesson 6C: 55–60 min. 2–3 classes Lesson 6D: 55–60 min. 1–2 classes	Conduct and present research to obtain information about a selected body system and how it interacts with other body systems to maintain a healthy organism.	The story *The Broken Summer* The class will try to figure out how the body heals itself after an injury. (broken bone)	• Take notes on informational text and informative videos. • Present findings to the class. • Contribute ideas to develop a consensus model. • Compare models from different classrooms that were developed to explain the same phenomenon.

UNIT AT A GLANCE

Students Figure Out How to:	Practices/Crosscutting Concepts	Assessment
• Use information in the storyline of *The Broken Summer* to raise questions related to how the bone heals. • Explain how the model is a demonstration of how the skeletal system and muscular system interact. • Plan and carry out an investigation into the effect of exercise on heart rate and respirations. • Develop a model on how sensory receptors interact. • Carry out an investigation and draw conclusion about sensory receptors.	**Obtaining, Evaluating, and Communicating Information** **Developing and Using Models** **Planning and Carrying Out Investigations** **Engaging in Argument from Evidence** **Systems and System Models** **Cause and Effect**	**Formative Assessment** student-generated questions Activity Page What We Think chart Science Talk revised models
• Determine the essential information that will help figure out how body systems interact to heal the bone and keep the body well.	**Planning and Carrying Out Investigations** **Obtaining, Evaluating, and Communicating Information** **Structure and Function**	**Formative Assessment** class discussion Activity Pages Science Talk
• Conduct research through text and video. • Develop a research plan. • Analyze relevant information. • Present findings and make connections among systems and how they interact. • Analyze the merits and limitations of models of the same phenomenon. • Develop a scientific explanation for the plausibility of a model based on evidence.	**Obtaining, Evaluating, and Communicating Information** **Developing and Using Models** **Engaging in Argument from Evidence** **Constructing Explanations and Designing Solutions** **Structure and Function** **Systems and System Models**	**Summative Assessment** Activity Pages Product Descriptor presentations question and answers visual effects Science Talk Journal Entry

Dear Parent,

Your student is beginning a science unit created by the Battle Creek Area Mathematics and Science Center. This unit was designed to promote science and engineering literacy and integrate reading and writing skills into high-interest science content. During the next several weeks your student will be actively involved with the *Structure and Function for Growth and Repair* unit. This unit is geared for middle school students and focuses on the structure and function of organisms and how cells, tissue, and organs work together for survival. The unit includes the following areas of study:

- Animal body systems and processes work together to perform life's functions.
- Selected organ systems work together within an animal body.
- Each selected organ system has a general function.
- Cells within each organ system have a general function.
- Cells come in different shapes and sizes depending on the function of the cell.

In this unit of study, students will become engaged in trying to figure out how the body heals. They will plan investigations to figure out that living things are made up of cells and that cells come in many shapes and sizes and different functions. They will conduct research to obtain information about the function of the different body systems and develop an explanation of how each body system plays a role in the everyday function of the body as well as growth and repair.

The unit concludes with the students working in teams to apply what they have learned from investigations and research into specialized cells, cell function, and organ function to a different injury.

Suggestions for activities to do at home are included with this letter. These activities will reinforce the concepts taught during this unit of instruction.

We hope you enjoy discussing the concepts involved in *Structure and Function for Growth and Repair* with your student. Let us know if we may be of assistance.

The Outreach Staff
Cereal City Science by the Battle Creek Area Mathematics and Science Center
(269) 213-3905 or (269) 213-3908

ACTIVITIES TO DO AT HOME

1. The unit begins with the topic of cells and cell organelles. If you have access to a microscope, encourage your student to examine different objects under the microscope at different magnifications.
2. In this unit, your student is also working with a team to conduct research to gather information about an assigned human body system. Visit the local library and check out books that may help the research team. Possible book titles:
   - *Knowledge Encyclopedia, Human Body: Brain and Nervous System*
   - *Knowledge Encyclopedia, Human Body: Heart and Circulatory System*
   - *Knowledge Encyclopedia, Human Body: Lungs and Respiratory System*
   - *Knowledge Encyclopedia, Human Body: Stomach and Digestive System*
   - *Knowledge Encyclopedia, Human Body: Skeletal and Muscular System*
   - *Smithsonian: Human Body!*
   - *The Nervous System: Our Body's Command Center (The Human Body Systems for Young Scientists)*
   - *The Circulatory System (A True Book: Health and the Human Body)*

The Broken Summer

Activity Overview
The unit begins with a story, *The Broken Summer*, that introduces the phenomenon of a broken bone from a fall. The storyline in the following lessons is to try to figure out how the bone repairs itself, answering the overarching question of how the body heals. The students develop models of their initial thinking, share their ideas, and raise questions.

Engage the Learner
The initial phase of the Learning Cycle is intended to introduce and activate prior knowledge about the human body and how it works to facilitate growth and repair. The unit begins with the story about an injury on the soccer field and continues with the study of the process of healing. Students develop initial models, raise questions, and determine how to investigate their ideas. Students' ideas are recorded on the What We Think chart. The chart becomes the driving question board and storyline as students investigate, obtain information, and construct explanations to figure out the answers to their questions. The chart is referred to and updated throughout the lessons, providing students with a venue to make conceptual changes regarding their understanding of how the human body facilitates growth and repair.

Lesson 1A: The Broken Summer

Advance Preparation
Make copies of the Parent Letter and Activities to Do at Home to be sent home with each student.

Prepare a space for Science Talk so all students are standing or sitting in a circle and can make eye contact with one another. (See Science Talk and Developing Effective Questions in the appendix.)

Pre-read the story *The Broken Summer* and determine the reading strategy that is best for your class. For this lesson, students will only read part one of the story.

Write the following headings at the top of four pieces of chart paper:

- Asking a Clarifying Question
- Asking a Probing Question
- Adding to an Idea
- Respectfully Disagreeing with an Idea

ESTIMATED TIME
Lesson 1A: 55–60 min.
2 classes
Lesson 1B: 55–60 min.

LESSON-LEVEL LEARNING GOALS
Develop initial before, during, and after models of how the body heals a broken bone.

Raise questions about how the body heals itself.

MATERIALS NEEDED
For each student:
student pages
booklet, *The Broken Summer (part one)*
For each group of 4:
X-ray Card
Teacher provides:
whiteboards/chart paper
markers
sticky notes

LS1.A: STRUCTURE AND FUNCTION
- 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). (MS-LS1-1)
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)
- 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. (MS-LS1-3)

LESSON 1A

READING SCIENCE AND TECHNICAL SUBJECTS—Grades 6–8
Key Ideas and Details
RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.
RST.6-8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge and opinions.
Craft and Structure
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 scientific or technical context relevant to grades 6–8 texts and topics.
Integration of Knowledge and Ideas
RST.6-8.9: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
Range of Reading and Level of Text Complexity
RST.6-8.10: By the end of grade 8, read and comprehend science/technical texts in grades 6–8 complexity band independently and proficiently.

Research to Build and Present Knowledge
WHST.6-8.8: 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.
WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research.

In this lesson, students will be adding to their group models based on the information learned in this lesson. Please refer to the completed exemplar models in the assessment tab of your teacher guide. Take note of the different elements added in this lesson and utilize it to help prompt student thinking as they reflect on the information learned.

Procedure

Engage the learner.

Introduce the lesson by asking students to share their experiences with injuries. Has anyone needed stitches? Broken a bone? Scraped a knee or elbow? Or suffered a burn? Allow time for students to share their stories freely at this time. Listen for possible questions about the injury and how it healed.

Introduce the story *The Broken Summer* to the class. Distribute the booklet to each student and ask them to read the story and record their ideas on the chart in the Student Journal.

As you read part one of the story The Broken Summer *with your group, take notes and write ideas on the chart below. Include questions about key terms, and ideas that you think are important in understanding the problem the class is trying to figure out.*

Observations	Questions

Divide the class into groups of four. Ask students to share their observations and questions from the story. Encourage students to add to their own ideas with ideas from their classmates.

Facilitate the sharing of ideas by circulating among the groups and listening to their initial responses to the story. To help students elaborate on their explanations, ask:

- What are you wondering about after reading the story?
- What do you think caused the bone to break?
- What effect does a broken bone have on the body?
- Are there some similar observations or ideas that the group has discussed? Why do you think they are important in finding out more about bones, how they break, and how they mend?

- What do you think we could see if we had a special instrument and could "zoom in" on the bone where it is broken and an area that is not broken?
- Do the rest of you agree? Why or why not?
- Can someone build on _____'s idea?

As a class, share common ideas and observations from the story. Listen for ideas and questions about bones, what they are made of, how they break, and how they heal. Establish a driving question that will carry the investigations and research throughout the unit. Samples:

- How does the body heal?
- How will the broken bone heal or repair itself?
- What happens when the body is injured, and how does it repair itself?
- What caused the bone to break? Can someone explain it in terms of forces and motion?

Have the students work individually at first and develop a model in their Student Journals of their initial thinking about the injury in the story and how it will heal. Give students sufficient time to use their initial ideas and the ideas from the class discussion. Encourage students to use their observations and questions from the reading as a reference for their models.

1. *Use the space below to develop a model of your initial ideas about the broken bone. Your model should include three different stages of the broken bone. Include your ideas of how the body reacts and works to repair the injury.*
   a. Include what you know about forces and motion to explain Alex's motion and what caused the bone to break.
   b. Include your ideas of how the body reacts and works to repair the injury.
2. *Write a list of questions you have about the injury and how it heals.*

Explore the concept.
After the students have had the opportunity to develop their initial models, divide the class into groups of four students and have them share their initial models. To help inspire their thinking and discussion, distribute an *X-ray card* to each group.

Ask students to be prepared to work as a group to develop one

ENGAGING IN ARGUMENT FROM EVIDENCE
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).
- Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3)
- Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts.
- **Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.**

CAUSE AND EFFECT
- Cause-and-effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8)

DEVELOPING AND USING MODELS
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop and use a model to describe phenomena. (MS-LS1-2)
- Develop a model to describe unobservable mechanisms. (MS-LS1-7)

SYSTEMS AND SYSTEM MODELS
Systems may interact with other systems; they may have subsystems and be a part of larger complex systems. (MS-LS1-3)

PS2.A: FORCES AND MOTION
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it.

STRUCTURE AND FUNCTION

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/ systems can be analyzed to determine how they function. (MS-LS1-2)

Example charts:

RESPECTFULLY DISAGREEING

- I agree with…but…
- I disagree with…because…
- I agree with part of your model but disagree with this part…
- I respectfully disagree because…
- I understand where you are coming from but have a different idea.
- I agree with you but also think…
- I see your reasoning but disagree with some of the ideas because…

ASKING A CLARIFYING QUESTION

- What do you mean by…?
- Can you be more specific about…?
- What makes you think that?
- What evidence do you have the supports that?
- How do you know?
- Can you say more about…?
- What do you mean by…?
- So are you saying…?

ASKING A PROBING QUESTION

- What do you mean by…?
- What makes you think that?
- If that were true, then wouldn't _____ be true?
- Where did you get this idea?
- How did you come up with…?
- What is your evidence?
- Why is _____ important in your model?
- Can you say more about…?

ADDING TO AN IDEA

- I agree with you, but also…
- I would like to add…
- I agree, but I also think…
- I agree with this part, but would it be helpful to add…?
- Do you think adding _____ would make it more clear?
- I agree but have an idea that might add more clarity or information.
- Would it be more clear if you added…?

model that reflects the thinking of the group. Remind students that this is their initial thinking and that there are no wrong ideas at this time. Explain that if the group has different ideas, they should add the different ideas to their model, and that it is not necessary for a complete consensus to be reached at this time.

When the groups have decided how they want their models to represent their collective thinking, distribute chart paper or whiteboards and markers for them to develop a model to share with the class. Group models must include three parts: before, during, and after the bone heals. Encourage groups to write questions that come up during the model development. Distribute sticky notes to each group and encourage students to write questions about the healing of the bone on them (one question per note). Have the students attach the questions to their models.

Circulate among the groups to monitor their progress and listen to their exchange of ideas. Do not offer suggestions or information at this time. Make a note of key ideas and questions to revisit during Science Talk.

Facilitate the group brainstorming activity by circulating among the students, listening to their ideas and exchanges. To check group progress and help students raise questions and hypothesize, ask:

- Can someone explain what caused the bone to break?
- What do you mean when you say _____?
- Can someone explain what you have discussed in figuring out how the broken bone heals? Can someone add to that idea?
- What are your initial thoughts about what might be happening inside the body to heal the bone?
- How can you represent your ideas in the model?
- What components will you include in your model? How might you represent how they interact?

After the groups have had the opportunity to complete their initial models, ask them to display their models around the room.

In order to conduct friendly, nonthreatening critiques, as a class establish some guidelines and rules for critiquing methods.

As a class, create four anchor posters that will guide the class

throughout the unit when sharing ideas. Display the four charts with the questioning and critiquing categories. Encourage students to propose ways to initiate a question that prompts a group to provide clarification, dig deeper, express disagreement, or add to an existing idea. It is important for success in student-to-student interactions for the anchor charts to be developed by the students. (See example charts.)

After the completion of the anchor questioning charts, conduct a gallery walk. Allow time for each group to make observations of the different models. Encourage students to look for common components that appear in each of the models.

Explain the concept and define the terms.

Science Talk

After the groups have completed their gallery walk, ask them to bring their models and form a circle for discussion and sharing. Ask each group to explain their model, and as a class, look for common ideas, unique ideas, and questions. To help the students elaborate on their explanation of their models, ask:

- _____, I heard you use the term _____. Can you tell us more about that?
- Can anyone add to that idea?
- Do the rest of you agree? Disagree?
- What common component(s) do we see among all or most of the models? Why do you think that component is important to the model?
- Are there any components that show up in the models of others or a single group that you would like to add to your own model?
- What makes you think that would be a useful addition?
- What questions have we raised about how the injured bone will heal?

Encourage groups to revisit their models and take time to make revisions based on the class sharing experience.

Assessment: Formative

Use the initial models and group models to assess the students' initial ability to develop models to reflect their thinking. (Developing and Using Models)

OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.

- 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).

SCIENCE TALK

Science Talk is a conversation among students that allows them to have the opportunity to orally express their ideas and listen to the ideas of others. During Science Talk students may engage in argumentation, raise more questions, and construct explanations. The purpose of gathering in a circle is so that students face one another and address one another. No student has their back to a classmate. The teacher serves only in the role of facilitator and record keeper. As they take turns discussing their ideas, they should address one another and not discuss ideas through the teacher. Good, effective Science Talk should develop as students become more comfortable with collaboration.

Allow sufficient time for each student to express ideas and opinions. Encourage student-led conversation in the classroom.

Science Talk is a meaning-making and pre-writing strategy used throughout the unit.

Lesson 1B: Initial Ideas

Advance Preparation

Prepare a space for the What We Think chart that includes the driving question and an activity summary table. Plan to have the chart visible throughout the activities.

What We Think About How the Human Body Repairs an Injury

What We Think	Questions We Have	What We Did	What We Figured Out	How Does That Help Us to Understand the Phenomenon?

Procedure

Explore the concept.

Introduce the What We Think chart to the class. Explain that the chart will be used to keep track of their initial ideas and new understandings as they try to figure out how the bones heal. Take this time to have students use their ideas from their notes, initial models, and group models to make a list in the What We Think column. Distribute sticky notes and the X-ray card to each group and ask them to write one initial idea per note. Tell students to use the X-ray card as a visual aid to help their thinking. Ask groups to come up with at least 3 or 4 ideas about how the bone will heal.

Continue with the Questions We Have column and invite students to share the questions that came up when they were developing their models and engaging in conversation. To help students collectively raise questions, ask:

- What questions do we need to answer to figure out how the bone will heal?
- What do you think about what _____said?
- Does anyone have questions that relate to _____'s question?

It may be helpful to have students return to their groups and collaborate to form more questions. Distribute sticky notes to each group. Ask each group to generate at least four or five questions to share with the class (one question per sticky note). When the groups are satisfied with their questions, ask one group to share a question and place it on the Questions We Have column of the What We Think chart. Ask if anyone has a similar question and ask them to post it on the chart. Then invite all similar questions to be posted on the column in proximity to one another. Continue to post questions on the chart, looking for similarities and differences.

MATERIALS NEEDED

For each student:
student pages
booklet, *The Broken Summer*

For each group of 4:
X-ray Card

Teacher provides:
whiteboards/chart paper
markers
sticky notes

ASKING QUESTIONS AND DEFINING PROBLEMS

Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

Ask questions:

- **that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.**
- to identify and/or clarify evidence and/or the premise(s) of an argument.
- to determine relationships between independent and dependent variables and relationships in models.
- **to clarify and/or refine a model, an explanation, or an engineering problem.**
- **that require sufficient and appropriate empirical evidence to answer.**
- **that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.**

TEACHING TIP

Encourage students to use their ideas from the What We Think column of the chart to help them generate questions about how the body heals and *The Broken Summer* story.

STRUCTURE AND FUNCTION
- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/ systems can be analyzed to determine how they function. (MS-LS1-2)

LS1.A: STRUCTURE AND FUNCTION
- 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). (MS-LS1-1)
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)
- 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. (MS-LS1-3)

As a class, categorize the questions and write categories on the chart where questions are clustered. Categories for the students' questions about the phenomenon of the broken bone may include:

- Healing
- Bones
- Time
- Blood Tests
- Anemia
- Cells
- Nutrition
- Other Injuries

Your students may have questions similar to and different from those on the sample Questions We Have chart (next page). Raising and categorizing questions as a class is an important process for students to undertake to gain the sense that they are investigating what is real and relevant to them. The chart is merely a sample to help guide your questioning techniques to draw ideas from the students. Your students' questions may include many more questions and questions that relate to their own injuries or injuries of people they know.

Remind the class that the chart is going to remain visible for the remainder of the unit and as new questions and categories develop, they will be added to the chart. Explain that as the lessons progress, the class will periodically review their initial questions, add new questions, and decide which questions have been answered and what questions remain to be investigated.

Take this opportunity to develop with the class the overarching driving question that will drive the following lessons. The driving question should be broad enough that individual questions can be incorporated into the bigger question. The driving question may include questions similar to the following:

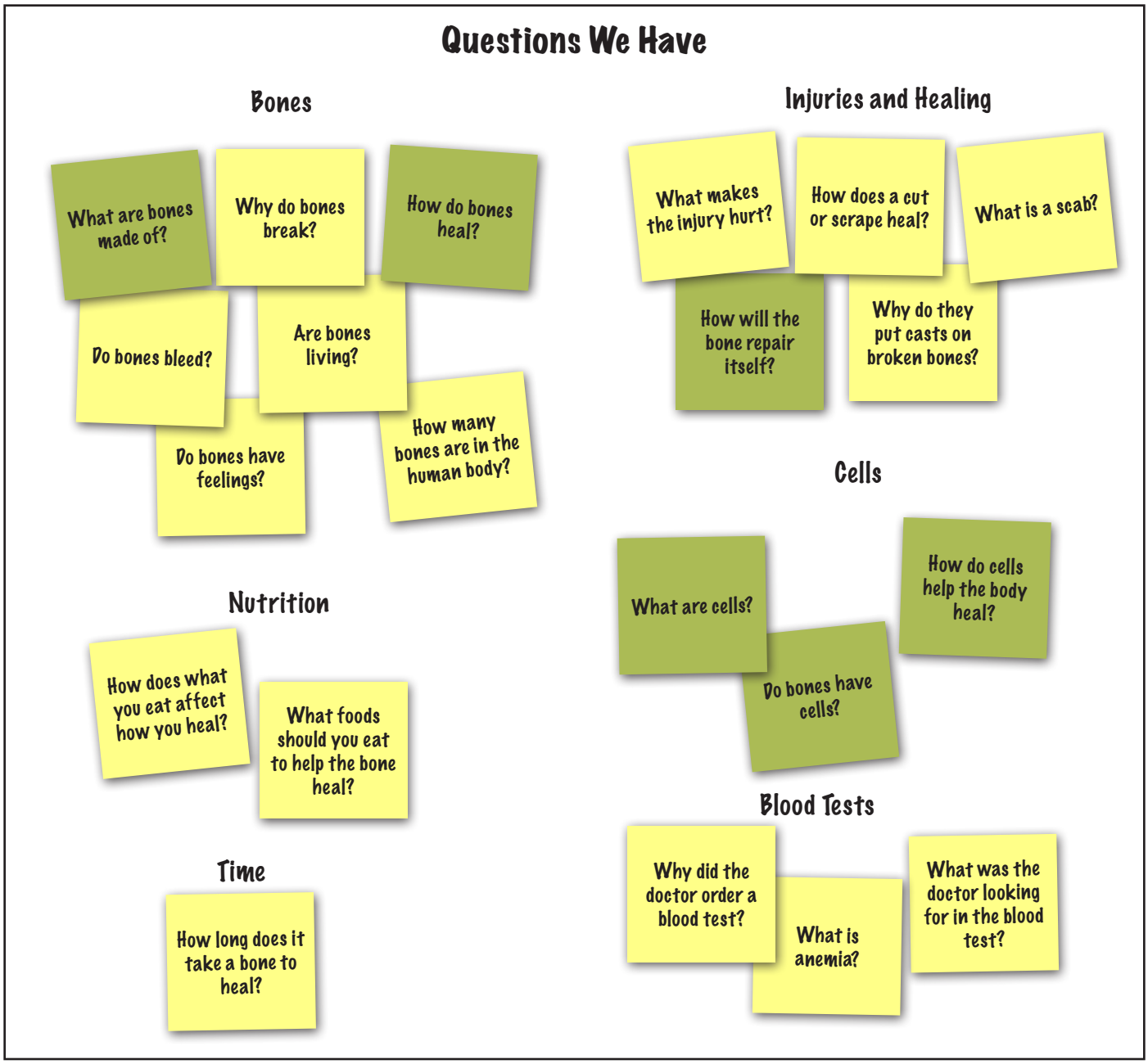
- Why does the injury hurt, and how does the body heal?
- What happens inside the body when it is injured? How does the body know there is an injury?
- How does the body heal?

At the conclusion of the lesson, allow time for students to review the chart and their initial models and reflect on how the questions relate to the injury in the story and beyond. Ask the class for their ideas of how they can investigate some of the questions and revise their models based on evidence. Ask:

- How can the class conduct investigations to answer some of the questions on the chart?
- Where do you think we should start our investigation?
- What makes you think that?
- Can anyone add to that idea?

Congratulate the class for the effort in sharing their ideas and raising questions.

Assessment: Formative
Use the students' initial models, group models, Activity Page, and Science Talk to assess their initial understanding of how the body is made up of cells, tissues, organs, and body systems that are specialized and work together to perform life's functions. (LS1.A: Structure and Function)



Looking at Cells

Teacher Background Information

A good place to start when trying to figure out how the body heals after an injury is to take a look into cells. Students were introduced to cells in MSLNG1: *Stability and Change in an Ecosystem*. They carried out investigations into pond water, soil microbes, and plant cells. They have been introduced to the difference between plant and animal cells. They recognized chloroplasts within the plant cell as the defining feature of plants and other photoautotrophs.

Cells are often called the building blocks of life. All living things are made up of cells. Organisms may be one single cell or many different specialized cells. These are the microscopic units of structure of the body, just as bricks may be the units of structure of a building. But cells are much more than mere building blocks. Each cell is an independent functioning unit, and the processes of the body are the sum of the coordinated functions of cells. The cellular units vary considerably in size, shape, and function. The smallest organisms have bodies made of a single cell. Others, such as a whale, giant sequoia tree, or human, are composed of countless billions of cells fitted together. Unicellular and multicellular organisms need food, water, a means of disposing of waste, and a suitable environment to carry out functions of growth, repair, and survival.

Some living things are single-celled organisms; some are more complex organisms, from apples to zebras, that are made of many cells. Living things are made up of many different kinds of cells, and each kind has a different job to do.

The human body systems have the ability to interact to form a healthy, active human and promote growth and repair. In order to figure out how this happens in the body, students begin by taking a look at cells. All humans begin when sperm and egg unite to form a single cell called a zygote. The cells begin to divide rapidly, with one cell becoming two cells, then four cells, until the body contains more than thirty trillion cells! These cells differentiate and specialize so that the body is no longer a mass of cells but instead a being that contains cells of many different types with different functions.

Plant and animal cells differ. Plant cells, unlike animal cells, have a cell wall, vacuole, and chloroplasts. Animals are multicellular, containing many cells. Animal cells are the basic structural units of animal tissues and organs. Animal cells contain organelles surrounded by a cell membrane. Organelles work together to enable the cell to perform a specific function. The organelles are surrounded by cytoplasm.

ESTIMATED TIME
Lesson 2A: 55–60 min.
Lesson 2B: 55–60 min., 2 classes
Lesson 2C: 55–60 min.

LESSON-LEVEL LEARNING GOALS
Conduct investigations to provide evidence that all living things are made up of cells, which is the smallest unit that can be said to be alive.

Make observations to determine that cells are not all alike and are made up of different parts.

MATERIALS NEEDED
For each student:
student pages
For each group of 4:
booklet: *The Broken Summer*
prepared slides:
plant cells
animal cells (liver cells)
Word Sort Card Set (plant cells, animal cells, chloroplasts, chlorophyll, photosynthesis, food, survival, function)
Prepared Slides card set
plant cells
animal cells (liver cells)
For the class:
microscopes
Teacher provides:
microscopes
For the teacher:
booklet: *Prepared Slides Key*

LS1.A: STRUCTURE & FUNCTION
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). (MS-LS1-1)
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)
- 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. (MS-LS1-3)

TEACHING TIP
If this is the first time your students have used microscopes, take time to demonstrate how to focus the microscopes using the *How to View Your Specimen* handout. Demonstrate how to make slides using the *Microscope Know-How* handout. Both can be found in the Handouts section.

PLANNING AND CARRYING OUT INVESTIGATIONS
Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.
- Conduct an investigation to produce data to serve as the basis for evidence that meets the goals of an investigation. (MS-LS1-1)

TEACHING TIP
If your class has already completed the unit *Stability and Change in an Ecosystem*, they should be familiar with observing the onion skin through a microscope and have had the opportunity to gather evidence that the onion is made up of cells.

DEVELOPING AND USING MODELS
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop and use a model to describe phenomena. (MS-LS1-2)
- Develop a model to describe unobservable mechanisms. (MS-LS1-7)

SCALE, PROPORTION, AND QUANTITY
- Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1)

The function of the cell is to give structure to the body, absorb nutrients, and enable movement, growth and repair. The cells also contain the genetic makeup of the organism and can reproduce themselves.

This lesson begins with a review of the difference between plant and animal cells from *MSLNG1: Stability and Change in an Ecosystem*. Students review that within the plant cell lies the chloroplasts that play a key role in how plants make and store their own food for growth, repair, and survival. The animal cell does not have chloroplast or a cell wall. Students may ask how animal cells achieve growth, repair, and survival for the organism.

For more information about cells and their structures, check out Chapter 3: Your Cells and Tissues in the *Anatomy and Physiology Made Easy* book in your kit.

Explore the Concept
During this phase of the learning, students explore and investigate cells and cell organelles through microscopic observations and research. They continue their exploration into body systems and their interactions. Students gather information through observations and a variety of resources.

Lesson 2A: Looking at Cells

Advance Preparation
Preview the prepared plant-cell and liver-cell slides. The liver cell slide will serve as the animal cell for this lesson.

Arrange for your class to have at least 8 microscopes for this and the following lessons. Ideally, students working in pairs with one microscope allows for all students to engage in an exchange of ideas and observations in the investigation into cells. Students will be making observations of different types of cells and cell structures. There are 8 sets of the prepared slides in each kit.

Procedure
Engage the learner.
Review the What We Think chart and students' initial ideas and questions they have about the story *The Broken Summer* and how the broken bone might heal. Ask students for their ideas of where or how they might start their investigations to answer their questions.

Review any questions about cells and ask if that might be a good place to start. Give students the time and opportunity to consider their ideas of cells and how knowing the role that cells play in the body might help them figure out how the broken bone will heal. Ask students for their ideas of how they can

investigate their ideas to provide evidence to support their thinking. Explain that the class is going to investigate cells using microscopes. Take time to find out if the class has had previous experiences with investigations using microscopes. Refer to the *Microscope Know How* in the handouts section of the Teacher Guide to review how to use a microscope. Discuss the use of the microscope to learn about things that are too small to be seen.

Explore the concept
Divide the class into groups or pairs depending on the number of microscopes you have for your class. Ask the class if they think they can find out more about how the body heals by examining cells under the microscope. Ask students what they think they will find out.

Distribute the prepared animal (liver) cell and plant cell slides. Explain that the first step in learning about different kinds of cells is to differentiate between plant and animal cells. Ask students to refer to their Student Journals to record their observations.

With your partner, study the differences between the plant and animal cells under the microscope.

1. *Place the animal cell slide under the microscope. Draw what you see.*
2. *Place the plant cell slide under the microscope. Draw what you see.*
3. *Discuss your observations with your team. Write what you think is the significance of recognizing that there is a difference between plant and animal cells. What does that tell you about plants and animals?*

Facilitate the microscope activity by circulating among the students, observing their drawings and listening to their ideas. To help students deepen their reasoning and rely on their previous understandings, ask:

- Why do you think it is necessary to use the microscope to observe cells? What does that tell you about cells?
- What differences do you see between the plant cell and the animal cell?
- What do you recall about the green part of the plant cell and its function in the survival of the plant?
- How is that different from the animal cell? (Listen for students to suggest that plants have chloroplasts and chlorophyll that provide them with what is necessary to make their own food. Students should recognize that animals must hunt and gather their food).

TEACHING TIP
As you circulate among the groups, take notes of key ideas and components students are using in their discussions to use during the Science Talk.

If your class is working in teams of two to four students, have the students prepare their cheek slides one at a time. While the first slide is soaking up the dye, the next student can be preparing another slide with their own cheek cells.

HISTORY/SOCIAL STUDIES, SCIENCE, AND TECHNICAL SUBJECTS WRITING STANDARDS—GRADES 6–8
Text Types and Purposes
WHST.6-8.1: Write arguments focused on discipline-specific content.
WHST.6-8.1.C: Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons and evidence.
WHST.6-8.2: Write informative/explanatory texts, including the narration of historic events, scientific procedures/experiments, or technical processes.
WHST.6-8.2.A: Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
WHST.6-8.2.B: Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
WHST.6-8.2.C: Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
WHST.6-8.2.D: Use precise language and domain-specific vocabulary to inform about or explain the topic.

Production and Distribution of Writing
WHST.6-8.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
WHST.6-8.7: 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.
WHST.6-8.8: 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.
WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing
WHST.6-8.10: Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

- So, what I hear you saying is…
- How does knowing that plants make their own food for survival and animals must gather food help in our investigation into how the body heals?
- What more do we need to understand about cells?

Allow time for the microscope groups to complete their observations and discuss their ideas. Return to the What We Think chart and ask students if they have new ideas or questions to add to the chart. Discuss if they have figured anything out and what further inquiries they need to pursue. Ask:

- How might learning more about cells and cell function help us to answer the question about how the body heals?

Pre-Writing Strategy: *Word Sort Card Set*
Divide the class into their microscope groups and distribute the *Word Sort Card* set. Ask them to discuss the terms on the card set and then collaborate to complete the written response in the Student Journal.

Journal Entry
Your class has been trying to figure out how the body heals and how Alex's leg will heal. Write how the study of cells and how they contribute to how the body functions might give us answers to the question.

Assessment: Formative
Use the Activity Page and Journal Entry to assess the students' initial ideas and their ability to make connections between cells and how the body heals.

Lesson 2B: Taking a Closer Look at Different Kinds of Cells

Lesson Overview

In this and following lessons students take a closer look into cells and cell structures and their functions. At this level students are not responsible for knowing the details of the function of the structures within the cell, but only to recognize that each structure has a role to play in the function of the cell, organ, tissue, and well-being of the organism.

This lesson provides students with the opportunity to observe prepared slides and slides they have prepared themselves. They will make wet-mount slides of plant and animal cells to observe with the microscope.

Advance Preparation

Keep the What We Think chart visible and active throughout the unit.

Microscopes are required for this and following lessons. Arrange for your class to have at least 8 microscopes for this and following lessons. Ideally, students working in pairs with one microscope allows for all students to engage in an exchange of ideas and observations in the investigation into cells. Students will be making observations of different types of cells and cell structures. There are 8 sets of the prepared slides in each kit.

Prepare methylene blue solution.

The methylene blue that comes in the kit has a concentration of 1.0%. To make the 0.05% solution called for in the lesson, you will need to do the following:

- Using a graduated cylinder, measure out 19ml of water and pour it into the 4 ounce bottle.
- Using a pipette, remove 1ml of methylene blue (MB) solution from the 1% stock solution that came with the kit. Transfer the 1ml of solution from the pipette into the 4 ounce bottle.
- Seal the bottle and shake gently to mix.
- Once you have your solution made for the class, fill enough pipettes with a small amount MB solution so that each group has their own to use for staining their onion cell and cheek cell slides.
- Do not use a more concentrated solution of methylene blue because the cells will be stained a solid blue and details such as the nucleus will be difficult to observe.

Cut up onion into chunks using a knife and cutting board.

MATERIALS NEEDED

For each student:
- student pages
- toothpick
- safety goggles

For each group of 4:
- booklet: *The Broken Summer*
- prepared slide:
  - onion root tip cells
- pipette, 2
- slides, 6
- slipcovers, 6
- forceps, 1
- *Prepared Slides* card set
  - onion root tip cells

For the class:
- bottle, 4oz.
- microscopes
- toothpicks (flat style, box)
- methylene blue solution (see Advance Preparation)

Teacher provides:
- onion
- water
- microscopes
- cutting board
- knife
- safety goggles

For the teacher:
- booklet: *Prepared Slides Key*

TEACHING TIP

Demonstration videos for Microscope Know-How, Onion Specimen Preparation, and Cheek Cell Preparation are available at https://cerealcityscience.org/curriculum-updates.

TEACHING TIP

The solution is light-sensitive, so only make what you need for the day. The recipe is a 1:19 ratio. You can even have students make their own solution by mixing 1 drop of the 1% MB solution with 19 drops of water. Or you can scale it up!

LESSON 2B

LS1.A: STRUCTURE AND FUNCTION
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). (MS-LS1-1)
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)
- 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. (MS-LS1-3)

PLANNING AND CARRYING OUT INVESTIGATIONS
Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.
- Conduct an investigation to produce data to serve as the basis for evidence that meets the goals of an investigation. (MS-LS1-1)

ANALYZING AND INTERPRETING DATA
Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis
- Analyze and interpret data to provide evidence for phenomena.

SCALE, PROPORTION, AND QUANTITY
- Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1)

Practice separating the fleshy layers of the onion and peeling off the thin skin in between. This skin is a single layer made up of cells. You may want to put the cut-up onion in a plastic bag to help control the odor.

Procedure
Elaborate on the concept.
Review the What We Think chart and discuss what the class has figured out so far. Look for ideas that reflect an understanding that living things are made up of different kinds of cells. Ask:

- How might understanding the different kinds of cells help us to figure out how the body heals?
- What makes you think that?
- Can anyone add to that idea?
- Do the rest of you agree? Disagree?

Listen for initial ideas that relate to previous experiences. If your class has completed the unit *Stability and Change in an Ecosystem*, ask what they recall about what they discovered about plant cells and the role of chloroplasts in the plant cell. Explain that the class is going to first take a look at the skin of an onion and compare it to the skin inside the cheek using a microscope.

As a class, review the *Microscope Know-How* handout. Allow sufficient time for students to learn how to adjust the view, make wet-mount slides, and describe observations.

Begin the microscopic observations with the onion skin to help students to establish that the onion plant is made of cells. Hold up an onion and ask:

- What is the onion made of?
- What do you think you will see if you look at the surface of the bulb of the onion through a microscope?
- Why do you think it is necessary to use the microscope? What do you mean when you say _____?
- Can anyone add to _____'s idea?
- What do the different magnifications mean?

Demonstrate how to separate the fleshy layers of the onion and peel off the thin skin in between. Have the groups follow the procedure in "Looking Closely at an Onion" in the Student Journal. Students will prepare one onion skin cell slide per group. Have students work together to discuss and record their findings.

Looking Closely at an Onion

1. *Take a small piece of thin onion skin and use forceps to place it on the microscope slide.*
2. *Place a drop of water on the specimen.*
3. *Place the coverslip over the onion skin, being careful not to get bubbles under the coverslip.*
4. *Look at the slide through the microscope. Adjust the light to help you see the onion skin.*
5. *Record your microscopic observation.*
    a. *Describe the shape of the things you see.*
    b. *Do they have anything in them? Describe what you see.*
6. *Draw and label a model of what your specimen looks like.*

Students will create another onion skin cell slide and add the methylene blue solution. Having a slide without and a slide with the methylene blue solution will help students make comparisons.

Looking Closely at Onion Cells Using Methylene Blue Solution

1. *Take a small piece of thin onion skin and use forceps to place it on the microscope slide.*
2. *Place a drop of methylene blue solution on the specimen.*
3. *Place the coverslip over the onion skin, being careful not to get bubbles under the coverslip.*
4. *Look at the slide through the microscope. Adjust the light to help you see the onion skin.*
5. *Record your microscopic observation.*
    a. *Describe the shape of the things you see.*
    b. *Do they have anything in them? Describe what you see.*
6. *Draw and label a model of what your specimen looks like.*

Facilitate the microscope activity by circulating among the groups, listening to their descriptions and assisting with microscope adjustments as needed. Ask:

- Can someone describe what you are seeing when you look at the onion skin under the microscope?
- What do you think that is? What makes you think that?
- What shapes do you see? What do you think they are?
- Do they remind you of anything you have seen before?

SAFETY TIP
Goggles should be worn when dispensing methylene blue. Avoid skin contact. For more information, refer to the MSDS section.

DEVELOPING AND USING MODELS
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop and use a model to describe phenomena. (MS-LS1-2)
- Develop a model to describe unobservable mechanisms. (MS-LS1-7)

READING SCIENCE AND TECHNICAL SUBJECTS—GRADES 6–8
Key Ideas and Details
RST.6-8.3: Follow precisely a multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks.

HISTORY/SOCIAL STUDIES, SCIENCE, AND TECHNICAL SUBJECTS WRITING STANDARDS—GRADES 6–8
Production and Distribution of Writing
WHST.6-8.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Research to Build and Present Knowledge
WHST.6-8.7: 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.

SCIENCE TALK
Science Talk is a conversation among students that allows them to have the opportunity to orally express their ideas and listen to the ideas of others. During Science Talk students may engage in argumentation, raise more questions, and construct explanations. The purpose of gathering in a circle is so that students face one another and address one another. No student has their back to a classmate. The teacher serves only in the role of facilitator and record keeper. As students take turns discussing their ideas, they should address one another and not discuss ideas through the teacher. Good, effective Science Talk should develop as students become more comfortable with collaboration.

Allow sufficient time for each student to express ideas and opinions. Encourage student-led conversation in the classroom.

Science Talk is a meaning-making and pre-writing strategy used throughout the unit.

- _____, I heard you say that you are seeing cells. Can you say more about that?
- What else have you heard about cells?
- Who can add to that idea?
- Can we make any statements about living things and cells?
- What evidence do we have so far?

After the students have completed their onion skin observations, distribute the toothpicks, slides, slipcovers, and methylene blue. Each student will make their own cheek cell slide. Review the cheek cell procedure with the class. Have students follow the directions in the Student Journal to prepare their cheek cell slide.

Preparing slides of cheek cells for microscopic viewing:

1. *Use the pipette and place a drop of 0.05% methylene blue in the center of a slide.*
2. *Using the flat toothpick, gently scrape some cells from the inside of your cheek.*
3. *Touch the end of the toothpick (with the cheek cells) to the drop of methylene blue on the slide and swirl it gently.*
4. *Discard the toothpick into a trash container. Do Not Share Toothpicks.*
5. *Place the slipcover over the specimen and allow 4 to 5 minutes for the cells to soak up the dye.*
6. *Look at the slide through the microscope. Adjust the light to help you see the cheek cells.*
7. *Record your microscopic observation.*
    a. *Describe the shape of the things you see.*
    b. *Do they have anything in them? Describe what you see.*
8. *Draw and label a model of what your specimen looks like.*
9. *Compare what you observed in the cheek cell slide to the onion slide.*

Facilitate the second microscopic observations by circulating among the groups, listening to their ideas and if they are seeing common components in the cells as well as differences between the cells. Ask:

- Can someone explain what you are observing when you look at the cheek slide under the microscope? Do you think you could observe the cheek cells without the microscope?

- What do you see that makes you think that?
- What shapes do you see? What do you think they are?
- How does this slide compare to the onion skin slide?

The final microscopic observation is the onion root tip cells from the prepared slide. The cells in the prepared slide have been stained to highlight structures inside the cells. Have students pay close attention to "squiggly lines" inside the nuclei. Explain that these are the chromosomes. The root tips of live onions grow. Ask students what happens to the cells within a growing organism. Listen for ideas that the cells are dividing.

- What do you think the cells are doing when something is growing?
- Do you think the cells are growing also? Becoming larger?
- Do the rest of you agree? Why or why not?
- What do we know about cells that makes you think that?

Science Talk

When the groups have completed the observations and entries in the Student Journal, ask them to gather in a circle for a Science Talk and share their observations and ideas that connect to the class driving question (How does the body heal?). Ask:

- I heard some interesting descriptions and ideas that were generated from our microscope observations. Would someone like to start the conversation by sharing an observation?
- Would someone like to share their models of the onion cell and cheek cells? How do they compare?
- Who had the same or a similar observation? What does that tell us about what living things are made of?
- What was the difference between the slide with water and the slide with methylene blue? How did the slide with methylene bllue help you see the cells?
- We have been using the term *cells* in our discussion. Can someone explain what we mean by cells?
- How does understanding cells and what living things are made of help us to better understand how the body heals?

STRUCTURE AND FUNCTION

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/ systems can be analyzed to determine how they function. (MS-LS1-2)

ENGAGING IN ARGUMENT FROM EVIDENCE

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3)
- Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts.
- Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.

- How does that help us to figure out how the body systems work to heal injuries?

Revisit the What We Think chart, add new ideas and questions, and add to the What We Did, What We Figured Out, and Phenomenon columns. Ask the class if they have sufficient information to add to their initial group models of the broken bone injury. Review the story of *The Broken Summer* and ask what further information they need to figure out. Allow time for students to revise their group models from Lesson 1A if they feel they have sufficient information or want to add cells to their models.

Inform the class that they will continue their exploration into cells and how the body heals in the following lessons to try to figure out how Alex will recover from her injury.

Assessment: Formative
Use the Activity Pages, Science Talk, and revisions to students' initial group models to assess their understanding of cells and how cells play a role in the repair of an organism.
(LS1.A: Structure and Function) (MS-LS1-1) (MS-LS1-2)

ENGINEERING DESIGN PROCESS

The Engineering Design Process provides students with a series of steps to guide them as they solve problems and design and test products, models, and solutions. The process is cyclical, yet not necessarily in an order. Students are encouraged to evaluate as they progress through the process, revisit the mission often, and revise thinking and their plan multiple times as the process unfolds.

Engineers do not always follow the Engineering Design Process steps in order, one after another. It is very common to design something, test it, find a problem, and then go back to an earlier step to make a modification or change the design. Engineers must always keep in mind the mission or problem they are trying to solve and the limitations (cost, time, material, etc.) that are part of the solution to the problem. Two key elements in working as an engineer are teamwork and design-test-and-redesign.

Mission

- Defines the problem and what the engineers are trying to design or build.
- Describes the limitations within which the engineers must solve the problem.

Brainstorm Ideas

- Imagine, discuss, and sketch possible solutions.
- Conduct research into what has already been done.
- Discover what materials are available, time frame, and other limitations.

Plan and Design

- Draw and write a plan.
- Design your solution through drawing and manipulating materials.
- Develop a plan or steps and a schedule.

Build

- Construct your engineering device or project.
- Follow your plan.
- Adjust and test along the way.

Test and Adjust

- Test your device to see if it solves the problem within the mission and limitations.
- Make your project better based on tests: Test → Revise → Test.
- Improve based on feedback of others.

Present Your Solution

- Demonstrate how your solution solves the problem.
- Define problems and limitations.
- Describe the challenges and limitations in solving the problem.
- Describe additional revisions that could improve the device or project.

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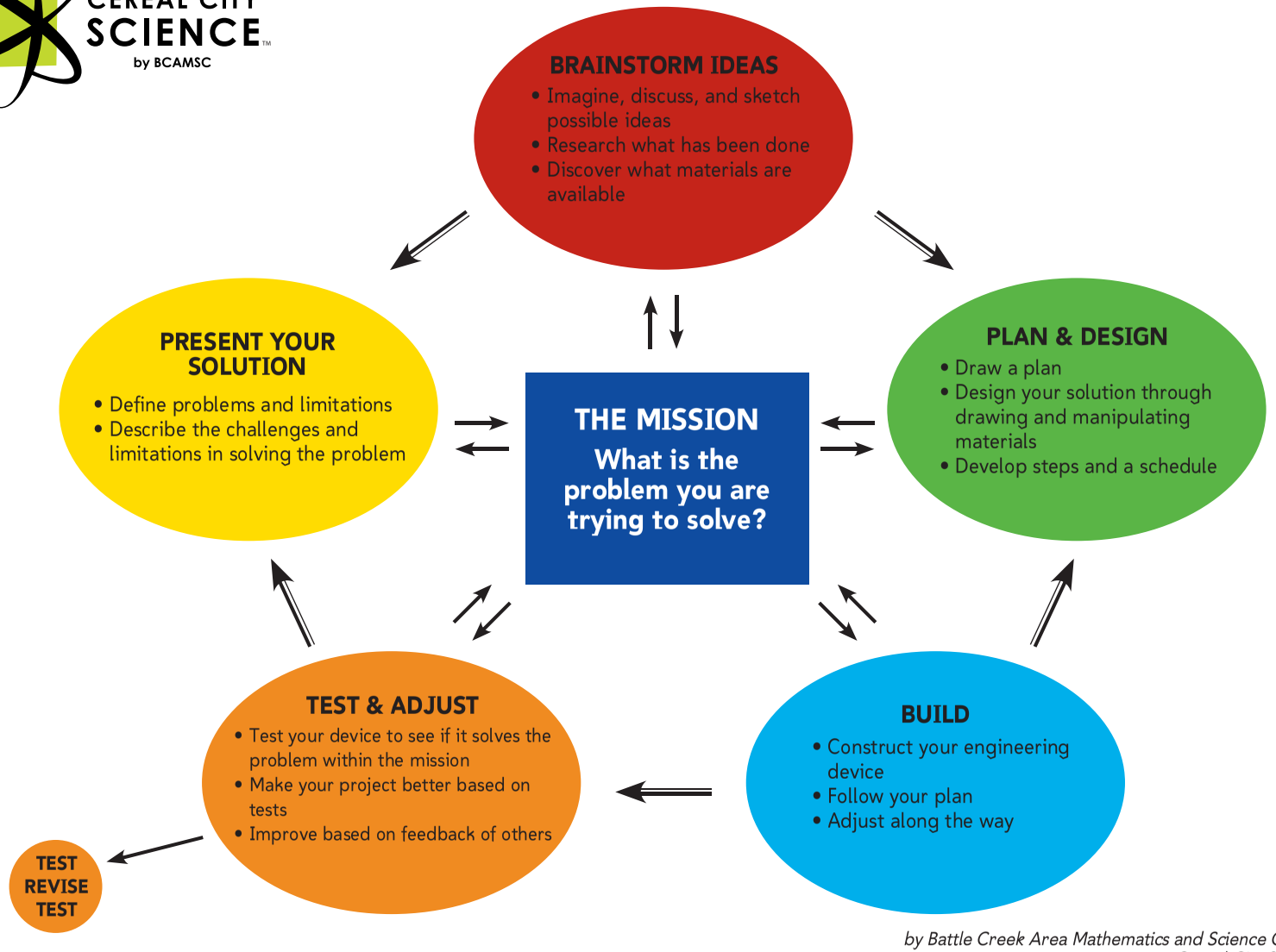
ENGINEERING DESIGN PROCESS



by Battle Creek Area Mathematics and Science Center
Cereal City Science
Adopted from the Carnegie Mellon Robotics Academy

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Student Journal
MS.LS.NGSS

Body Systems for Growth and Repair MSLNG2

A Middle School Unit supporting the Next Generation Science Standards.

Name:

ACTIVITY **1A**

The Broken Summer

Name:_____

Date:_____

As you read part one of the story *The Broken Summer* with your group, take notes and write ideas on the chart below. Include questions about key terms, and ideas that you think are important in understanding the problem the class is trying to figure out.

Observations	Questions

Name: _____

Date: _____

1. Your model should include three different stages of the broken bone. Include your ideas of how the body reacts and works to repair the injury.
   a. Include what you know about forces and motion to explain Alex's motion and what caused the bone to break.
   b. Include your ideas of how the body reacts and works to repair the injury.

Impact (when the bone breaks)

Name:_____

Date:_____

Recovery (while the bone is healing)
Renewal (when the bone is healed)

Name: _____

Date: _____

2. Write a list of questions you have about the injury and how it heals.

Name:_____

Date:_____

ACTIVITY **2A**

Taking a Closer Look at Different Kinds of Cells

With your partner, study the differences between the plant and animal cells under the microscope.

1. Place the animal cell slide under the microscope. Draw what you see.

Name: _____

Date: _____

2. Place the plant cell slide under the microscope. Draw what you see.

Name:_____

Date:_____

3. Discuss your observations with your team. Write what you think is the significance of recognizing that there is a difference between plant and animal cells. What does that tell you about plants and animals?

2A JOURNAL
Taking a Closer Look at Different Kinds of Cells

Name: _____

Date: _____

Your class has been trying to figure out how the body heals and how Alex's leg will heal. Write how the study of cells and how they contribute to how the body functions might give us answers to the question.

Name:_____

Date:_____

Looking Closely at an Onion

1. Take a small piece of thin onion skin and use forceps to place it on the microscope slide.
2. Place a drop of water on the specimen.
3. Place the cover slip over the onion skin, being careful not to get bubbles under the coverslip.
4. Look at the slide through the microscope. Adjust the light to help you see the onion skin.
5. Record your microscopic observation.
    a. Describe the shape of the things you see.

    b. Do they have anything in them? Describe what you see.

Name: _____

Date: _____

6. Draw and label a model of what your specimen looks like.

Name:_____

Date:_____

Looking Closely at Onion Cells Using Methylene Blue Solution

1. Take a small piece of thin onion skin and use forceps to place it on the microscope slide.
2. Place a drop of methylene blue solution on the specimen.
3. Place the cover slip over the onion skin, being careful not to get bubbles under the coverslip.
4. Look at the slide through the microscope. Adjust the light to help you see the onion skin.
5. Record your microscopic observation.
    a. Describe the shape of the things you see.

    b. Do they have anything in them? Describe what you see.

Name: _____

Date: _____

6. Draw and label a model of what your specimen looks like.

Name:_____

Date:_____

Preparing Slides of Cheek Cells for Microscopic Viewing

1. Use the pipette and place a drop of methylene blue in the center of a slide.
2. Using the flat toothpick, gently scrape some cells from the inside of your cheek.
3. Touch the end of the toothpick (with the cheek cells) to the drop of methylene blue on the slide and swirl it gently.
4. Discard the toothpick into a trash container. Do Not Share Toothpicks.
5. Place the slipcover over the specimen and allow 4-5 minutes for the cells to soak up the dye.
6. Look at the slide through the microscope. Adjust the light to help you see the cheek cells.
7. Record your microscopic observation.
    a. Describe the shape of the things you see.

    b. Do they have anything in them? Describe what you see.

Name: _____

Date: _____

8. Draw and label a model of what your specimen looks like.

Name:_____

Date:_____

9. Compare what you observed in the cheek cell slide to the onion slide.

K E Y T E R M S

Name: _____

Date: _____