THE CYCLE OF MATTER AND ENERGY IN HEALTHY ECOSYSTEMS

Grades 3 - 5 Timeframe: 8 Weeks

Overview

This 5th grade unit will take about 8 weeks, 25.5 hours to complete. Students plan and carry out an original investigation in which they observe the effect of different types of matter on the growth of plants. They create their own observable question with prompting such as: "What type of matter do you think will affect plants' growth?" or "Do you think the amount of a particular type of matter will affect how the plant grows?" They observe their experiment over a period of seven days (or longer if time allows). At the conclusion of the investigation, students use their data to explain how plants convert matter (gas and liquid) into plant matter.

Standards and Assessment Anchors

Standards	**NGSS Standards** 5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water. 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. 5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. **Math Standard** CC.2.4.5.A.2 Represent and interpret data using appropriate scale M05.D-M.2.1.2 Display and interpret data **Technology Standards** Standard 5: The effects of technology on the environment Standard 10: The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Desired Learning Objectives

What Essential Questions will be considered?	Students will understand that…
How do we assess and improve the health of an ecosystem?	An ecosystem's health can be assessed by looking at the interaction of abiotic and biotic features in the ecosystem and observing how effectively the matter and energy flow within the system.

	An ecosystem's health can be assessed by looking at how effectively the web of producers, consumers, and decomposers have their needs met and cycle energy and matter. An ecosystem can be made healthier by strengthening the web of producers, consumers, and decomposers. This can be done by increasing the biodiversity of the ecosystem without disrupting the balance or creating instability.

Students will know…	**Students will be able to…**
-Key terms: ecosystem, producers, consumers, decomposers, biodiversity, stability, energy, matter, abiotic, biotic Plants acquire their material for growth chiefly from air and water. Matter is transported into, out of, and within systems. The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. Energy can be transferred in various ways	Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. Support an argument that plants get the materials they need for growth chiefly from air and water. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.

Formative and Summative Assessments

Performance Tasks: Summative Assessment	**Improving the Health of an Ecosystem** In groups, students analyze data (pictures, research, tables) in order to assess the health of a sample schoolyard ecosystem. They then craft three suggestions that would help the ecosystem become healthier. Using the Engineering Design Cycle, students create an explanatory model that predicts how their suggestions would help the ecosystem more fully reach the criteria of a healthy ecosystem. **Improving the Health of Our Schoolyard Ecosystem.**

	Students will gather and analyze data to assess the health of their own schoolyard. They then craft three suggestions that would help the ecosystem become healthier. Using the Engineering Design Cycle, students create an explanatory model that predicts how their suggestions would help the ecosystem more fully reach the criteria of a healthy ecosystem. Students could collect and analyze data on the schoolyard or another nearby public space. Arrange for students to present their suggestions and explanatory model to an audience that may be able to implement their plan (e.g., the school board, park and recreation board, or neighborhood association). See Lesson Sequence 11 for additional information and an optional assignment description.

Other Evidence: Formative Assessment	**Assessing a Forest Ecosystem** Students carefully observe a diagram of a forest ecosystem. They analyze data about the food web depicted in the diagram. Then they construct two arguments. In the first one, they argue how well the ecosystem meets the criteria for a healthy ecosystem. In the second argument, they predict how the health of the ecosystem would be affected if one of the organisms (the white oak tree) was removed. For each argument, they explain whether or not the evidence is sufficient and, if not, what additional evidence is needed. This assessment takes place in Lesson Sequence 11. Throughout the module, students engage in the Science and Engineering Practices (things that scientist and engineers do) by making explanatory models, constructing explanations and engaging in arguments. Students also consistently discuss Crosscutting Concepts, especially matter and energy and systems, to deepen their understanding of content. Routinely, they track their learning in a student science notebook and practice articulating their understanding in Scientists Meetings. **Formative assessments are embedded throughout the unit**.

Student Self Assessment and Reflection:	Self-Assessment: In the beginning of the unit, students will fill out the "what do you know" and "what do you want to know" sections of the K, W, L chart. After each lesson students will fill in the "what did you learn?" section and any questions you still have about recycling and helping our environment. Reflection: Reflect on your group project, "Improving." What did you like about your project? What did you struggle with?

Planned Learning Experiences

Materials:	• Bean seeds • Potting soil • Clear plastic cups • Graduated cylinder • Gallon plastic storage bags • Poster board (x10) • 2 liter plastic bottles • Eyedropper (x 4) • Ball of string • Hand mirrors or compact mirrors (x25) • Electric tea kettle • Sand or sawdust • Hairspray/air freshener

Learning Activities

Overview

Matter and Plant Growth

Students plan and carry out an original investigation in which they observe the effect of different types of matter on the growth of plants. They create their own observable question with prompting such as: “What type of matter do you think will affect plants’ growth?” or “Do you think the amount of a particular type of matter will affect how the plant grows?” They observe their experiment over a period of seven days (or longer if time allows). At the conclusion of the investigation, students use their data to explain how plants convert matter (gas and liquid) into plant matter.

Lesson 1:

Instructional Focus

- Launch unit with an anchoring phenomenon: a Healthy Ecosystem slide show
- Gather students’ background knowledge about healthy ecosystems, food webs, and the cycling of matter and energy
- Start the Criteria for a Healthy Ecosystem anchor chart
- Introduce the student science notebook and Scientists Meeting protocol

Ongoing Assessment

- Student science notebook: Anchoring Phenomenon entry
- Scientists Meeting: Gathering Ideas

Lesson 2:

Instructional Focus

■ Introduce matter as a crosscutting concept
■ Introduce the Concepts Scientists Think About anchor chart and the Scientists Do These Things anchor chart
■ Gather baselines data about a student's ability to construct a scientific argument

Ongoing Assessment
■ Student science notebook: Defining Matter entry
■ Scientists Meeting: Building Understanding

Lesson 3:
Instructional Focus
Note: The Plant Investigation began in this lesson sequence will require a week of observation before students may analyze the data in Section 3 of the lesson sequence. Students may go on to Lesson 4 while they wait for the investigation to finish.
■ Build background on the investigation process and how plants get the matter they need for growth chiefly from air and water
■ Plan and carry out original investigation about the effect of matter on plant growth

Ongoing Assessment
■ Scientists Meeting: Planning Investigation
■ Scientists Meeting: Building Understanding
■ Participation in Back-to-Back and Face-to-Face protocol
■ Student science notebook: Plant Growth entry

Lesson 4
Instructional Focus
■ Build background information on the crosscutting concept of energy and the Law of Conservation
■ Refine an argument by evaluating evidence
■ Synthesize learning

Ongoing Assessment
■ Scientists Meeting: Building Understanding
■ Participation in Back-to-Back and Face-to-Face protocol
■ Student science notebook: Flow of Energy entry

Lesson 3 Revisited
Instructional Focus
■ Analyze data from Plant Investigation
■ Develop model of photosynthesis
■ Synthesize learning about the role of plants in the cycle of matter and energy and the criteria for healthy ecosystems in a Scientists Meeting

Ongoing Assessment
■ Scientists Meeting: Building Understanding
■ Participation in Back-to-Back and Face-to-Face protocol

■ Student science notebook: Plant Growth entry

Lesson 5
Instructional Focus
■ Introduce the Crosscutting Concept of Systems and how the abiotic and biotic parts of an ecosystem work together
■ Create Ecosystem in a Baggie
■ Form expert groups and build background on one of the three forest ecosystems: temperate, boreal, or tropical
■ Begin Ecosystem Explanatory Diagrams
■ Synthesize learning about systems and the criteria for healthy ecosystems in a Scientists Meeting

Ongoing Assessment
■ Scientists Meeting: Building Understanding
■ Student science notebook: Parts of an Ecosystem entry
■ Expert ecosystem explanatory model

Lesson 6
Instructional Focus
■ Build background knowledge about food webs in general and in one of the specific ecosystems
■ Revise Ecosystem Explanatory Diagrams
■ Synthesize learning about food webs and the criteria for healthy ecosystems in a Scientists Meeting

Ongoing Assessment
■ Scientists Meeting: Building Understanding
■ Student science notebook: Producers, Consumers, and Decomposers entry— Food web sketch
■ Expert ecosystem explanatory model

Lesson 7
Instructional Focus
■ Learn how energy transforms as it flows within a food chain through a simulation and a reading
■ Revise Ecosystem Explanatory Diagrams to reflect the flow of energy in an ecosystem
■ Synthesize learning about the flow of energy in an ecosystem and how to develop a model in a Scientists Meeting

Ongoing Assessment
■ Scientists Meeting: Building Understanding
■ Student science notebooks: Matter and Energy Transfer entry— Matter and energy transfer model.
■ Expert ecosystem explanatory model

Lesson 8
Instructional Focus

■ Build background information on the cycle of carbon dioxide/oxygen, water and solid matter in an ecosystem through observation and video
■ Revise Ecosystem Explanatory Diagrams to reflect flow of matter
■ Synthesize learning about the flow of matter and energy and the criteria for healthy ecosystems in a Scientists Meeting

Ongoing Assessment
■ Scientists Meeting: Building Understanding
■ Student science notebook: Water, Air, and Waste Matter entry
■ Expert ecosystem explanatory model

Lesson 9
Instructional Focus
■ Learn about the effect of biodiversity on the balance and stability of an ecosystem through a food web simulation
■ Synthesize learning about stability and balance and the criteria for healthy ecosystems in a Scientists Meeting
■ Practice developing arguments about the health of an ecosystem

Ongoing Assessment
■ Scientists Meeting
■ Student science notebooks: Stability and Balance entry
■ Ecosystem explanatory model

Lesson 10
Instructional Focus
■ Learn how a change in an ecosystem can affect the balance and stability by studying the wolves of Yellowstone
■ Learn more about invasive species
■ Use Ecosystem Explanatory Diagrams to make predictions about a change in the ecosystem

Ongoing Assessment
■ Student science notebooks: Changing Ecosystems entry
■ Participation in Back-to-Back and Face-to-Face protocol
■ Expert ecosystem explanatory model

Lesson 11
Instructional Focus
■ Revisit the anchoring phenomenon and synthesize learning about the criteria for a healthy ecosystem
■ Complete the Summative assessment
■ Use the Engineering Design Cycle to complete the Performance Task
■ Reflect on learning

Ongoing Assessment

- Scientists Meeting: Making Meaning
- Student science notebook: Improving the Health of an Ecosystem entry
- Summative Assessment: Assessing a Forest Ecosystem
- Improving the Health of an Ecosystem Explanatory Model

Alternative Performance Task: Improving the Health of Our Schoolyard Ecosystem

Overview:

Your schoolyard is an ecosystem! How healthy is it? What are some things you can do to make the schoolyard a healthier place for all the organisms who live and interact there (including you)?

Directions:

1. Collect data to assess the health of your schoolyard ecosystem. Your data may include:
   - Pictures
   - Surveys of the organisms present in the schoolyard
   - Surveys of the abiotic and biotic features
   - Lists of native and invasive species in the area
2. After analyzing the data, suggest two or three steps for making the schoolyard ecosystem more healthy. Be sure to present an argument about why these steps will help the schoolyard more fully reach the criteria for a healthy ecosystem.
3. Develop an explanatory model to support your argument and show how your proposal would encourage a healthier ecosystem and cause the flow of matter and energy in the ecosystem to cycle in a balanced way.
4. Present your suggestions and explanatory model to the school board, faculty, and/or parent association.

Grade 5 Life Science Materials List

Estimated cost: $125.00-$175.00

Materials

Bean seeds
Potting soil
Clear plastic cups
Graduated cylinder
Gallon plastic storage bags
Poster board (x10)
2 liter plastic bottles
Eyedropper (x 4)
Ball of string
Hand mirrors or compact mirrors (x25)
Electric tea kettle
Sand or sawdust
Hairspray/air freshener

Safety Procedures for Children

This unit does not require students to work with any dangerous chemicals. Below are general safety guidelines for elementary students.

Always:

- Work with an adult.
- Read and follow all directions for the activity.
- Read all warning labels on all materials being used.
- Wear eye protection.
- Follow safety warnings or precautions, such as wearing gloves or tying back long hair.
- Use all materials carefully, following the directions given.
- Be sure to clean up and dispose of materials properly when you are finished with an activity.
- Wash your hands well after every activity.

Never eat or drink while conducting an experiment and be careful to keep all of the materials used away from your mouth, nose, and eyes!

Never experiment on your own!

Instructions for Teacher Preparation and Materials For Each Lesson

The following are science-specific materials that will require significant advance preparation. More information on quantities and specific instruction is in the materials list in each lesson sequences.

Before beginning this unit

- In Lesson Sequence 3, students will design their own experiment with plants. A few weeks before starting the Life Science Module, seed bean plants or purchase bean plant seedlings from a local nursery. Continue to care for enough seedlings for each group of three or four students to have a seedling.
- Consider creating terrariums or mini ecosystems so students can observe the interaction of abiotic and biotic features. The terrariums could include small animals.
- Consider growing plants hydroponically in your classroom so students can observe that plants get the matter they need for growth chiefly from water and air.

Week 1

Lesson 1

- Create a teacher science notebook.
- Copy and assemble the student science notebooks.
- Create the Assessing the Health of an Ecosystem slideshow.

Lesson 2

- Construct balance from a coat hanger.
- Gather materials for the demonstration of matter: balloons, classroom objects with very different weights, and tape.

Week 2

Lesson 3

Gather materials for plant investigation, including seedlings, sandwich-size plastic bags, rubber bands, graduated cylinder, water and various other liquids, various solids (such as sawdust, sand, or fertilizer), and various gases (such as incense, hairspray, or air freshener).

Week 3

Lesson 4

- Gather materials for demonstrating energy, including, boiling water, electric tea kettle, soccer ball, and if available, Newton's cradle.

Week 4

Lesson 3 (revisit)See above.

Week 5
Lesson 5

- Prepare computers necessary for each student to gather information about forests on a specific website.
- Gather materials for an ecosystem in a baggie, including, bottom half of a 2-liter plastic bottle, pebbles, potting soil, seeds, resealable plastic bag, water, masking tape, and marker.
- Gather poster board for the expert ecosystem explanatory model.

Lesson 6

- Create the Food Web Organism cards and the Forest Organism picture cards.

Lesson 7

- Gather materials for “Pass the Energy, Please,” including, bottle of soda or colored water, plastic cups, 100 milliliter graduated cylinder, and eyedropper.

Week 6
Lesson 8

- Obtain hand mirrors (one for each pair of students).

Week 7
Lesson 9

- Gather materials for the food web activity, including balls of string or yarn and Food Web Name cards

Lesson 10
Create the Invasive Species cards and the Ecosystem Scenario cards.

Week 8
Lesson 11

- Prepare materials for the summative assessment.
- Prepare materials for the Improving the Health of an Ecosystem Model (the performance task).

Teacher and Student Procedures

Duration of Unit: 8 weeks, 25. 5 hours
Grade 5
Life Science: Three cycles of Matter ad Energy in Healthy Ecosystems

Week 1: Approximately 3 hours of instruction

Lesson 1 (1 hour)

Lesson Plan

- Launch module with an anchoring phenomenon: a Healthy Ecosystem slide show
- Gather students' background knowledge about healthy ecosystems, food webs, and the cycling of matter and energy. Have students complete a KWL chart.
- Start the Criteria for a Healthy Ecosystem anchor chart
- Introduce the student science notebook and Scientists Meeting protocol. Involve students in creating Scientists Meeting protocol and an anchor chart to post in the classroom. This should include how students should speak to one another, how to use scientific tools appropriately, etc.

Formative Assessment

- Student science notebook: Anchoring Phenomenon entry
- Scientists Meeting: Gathering Ideas

Lesson 2 (2 hours)

Lesson Plan

- Introduce matter as a crosscutting concept
- Introduce the Concepts Scientists Think About anchor chart and the Scientists Do These Things anchor chart. Create this anchor chart ahead of time.
- Gather baselines data about a student's ability to construct a scientific argument. Present students with a current issue they our aware of and have a scientific argument.

Formative Assessment

- Student science notebook: Defining Matter entry
- Scientists Meeting: Building Understanding

Week 2: Approximately 1.5 hour of instruction

Lesson 3 (1.5 hour)

Lesson Plan

Note: The Plant Investigation began in this lesson sequence will require a week of observation before students may analyze the data in Section 3 of the lesson sequence. Students may go on to Lesson Sequence 4 while they wait for the investigation to finish.

- Build background on the investigation process and how plants get the matter they need for growth chiefly from air and water
- Plan and carry out original investigation about the effect of matter on plant growth

Have students fill in their KWL chart.

Formative Assessment

- Scientists Meeting: Planning Investigation
- Scientists Meeting: Building Understanding
- Participation in Back-to-Back and Face-to-Face protocol
- Student science notebook: Plant Growth entry

Week 3: Approximately 2 hours of instruction

Lesson 4 (2 hours)

Lesson Plan

- Build background information on the crosscutting concept of energy and the Law of Conservation
- Refine an argument by evaluating evidence
- Synthesize learning about the flow of energy and the criteria for healthy ecosystems in a Scientists Meeting

Have students complete a KWL chart.

Formative Assessment

- Scientists Meeting: Building Understanding
- Participation in Back-to-Back and Face-to-Face protocol
- Student science notebook: Flow of Energy entry

Week 4: Approximately 4 hours of instruction

Lesson Sequence 3 revisit (1.5 hours)

Lesson Plan

- Analyze data from Plant Investigation
- Develop model of photosynthesis
- Synthesize learning about the role of plants in the cycle of matter and energy and the criteria for healthy ecosystems in a Scientists Meeting

Have students complete a KWL chart.

Formative Assessment

- Scientists Meeting: Building Understanding
- Participation in Back-to-Back and Face-to-Face protocol
- Student science notebook: Plant Growth entry

Lesson Sequence 5 (2.5 hours)

Lesson Plan

- Introduce the Crosscutting Concept of Systems and how the abiotic and biotic parts of an ecosystem work together
- Create Ecosystem in a Baggie
- Form expert groups and build background on one of the three forest ecosystems: temperate, boreal, or tropical
- Begin Ecosystem Explanatory Diagrams
- Synthesize learning about systems and the criteria for healthy ecosystems in Scientists Meeting

Have students complete a KWL chart.

Formative Assessment

- Scientists Meeting: Building Understanding
- Student science notebook: Parts of an Ecosystem entry
- Expert ecosystem explanatory model

Week 5: Approximately 4.5 hours of instruction

Lesson Sequence 6 (2.5 hours)

Lesson Plan

- Build background knowledge about food webs in general and in one of the specific ecosystems
- Revise Ecosystem Explanatory Diagrams
- Synthesize learning about food webs and the criteria for healthy ecosystems in a Scientists Meeting

Formative Assessment

- Scientists Meeting: Building Understanding
- Student science notebook: Producers, Consumers, and Decomposers entry
— Food web sketch
- Expert ecosystem explanatory model

Lesson Sequence 7 (2 hours)

Lesson Plan

- Learn how energy transforms as it flows within a food chain through a simulation and a reading
- Revise Ecosystem Explanatory Diagrams to reflect the flow of energy in an ecosystem
- Synthesize learning about the flow of energy in an ecosystem and how to develop a model in a Scientists Meeting

Formative Assessment

- Scientists Meeting: Building Understanding
- Student science notebooks: Matter and Energy Transfer entry — Matter and energy transfer model
- Expert ecosystem explanatory model

Week 6: Approximately 2.5 hours of instruction

Lesson Sequence 8 (2.5 hours)

Lesson Plan

- Build background information on the cycle of carbon dioxide/oxygen, water and solid matter in an ecosystem through observation and video
- Revise Ecosystem Explanatory Diagrams to reflect flow of matter
- Synthesize learning about the flow of matter and energy and the criteria for healthy ecosystems in a Scientists Meeting

Formative Assessment

- Scientists Meeting: Building Understanding
- Student science notebook: Water, Air, and Waste Matter entry
- Expert ecosystem explanatory model

Week 7: Approximately 4.5 hours of instruction

Lesson Sequence 9 (2.5 hours)

Lesson Plan

- Learn about the effect of biodiversity on the balance and stability of an ecosystem through a food web simulation
- Synthesize learning about stability and balance and the criteria for healthy ecosystems in a Scientists Meeting
- Practice developing arguments about the health of an ecosystem

Formative Assessment

- Scientists Meeting
- Student science notebooks: Stability and Balance entry
- Ecosystem explanatory model

Lesson Sequence 10 (2 hours)

Lesson Plan

- Learn how a change in an ecosystem can affect the balance and stability by studying the wolves of Yellowstone
- Learn more about invasive species
- Use Ecosystem Explanatory Diagrams to make predictions about a change in the ecosystem
- Model how to create a scale for models.

Formative Assessment

- Student science notebooks: Changing Ecosystems entry
- Participation in Back-to-Back and Face-to-Face protocol
- Expert ecosystem explanatory model

Week 8: Approximately 3.5 hours of instruction

Lesson Sequence 11 (3.5 hours)

Lesson Plan

- Revisit the anchoring phenomenon and synthesize learning about the criteria for a healthy ecosystem
- Complete the Summative assessment
- Students collect and represent the data they collect from the summative assessment
- Use the Engineering Design Cycle to complete the Performance Task
- Reflect on learning

Formative Assessment

- Scientists Meeting: Making Meaning
- Student science notebook: Improving the Health of an Ecosystem entry
- Summative Assessment: Assessing a Forest Ecosystem
- Improving the Health of an Ecosystem Explanatory Model

References

National Science Teachers Association - NSTA. (2018, January). Resources. Retrieved April 25, 2018, from http://www.nsta.org/safety/resources-elementary.aspx