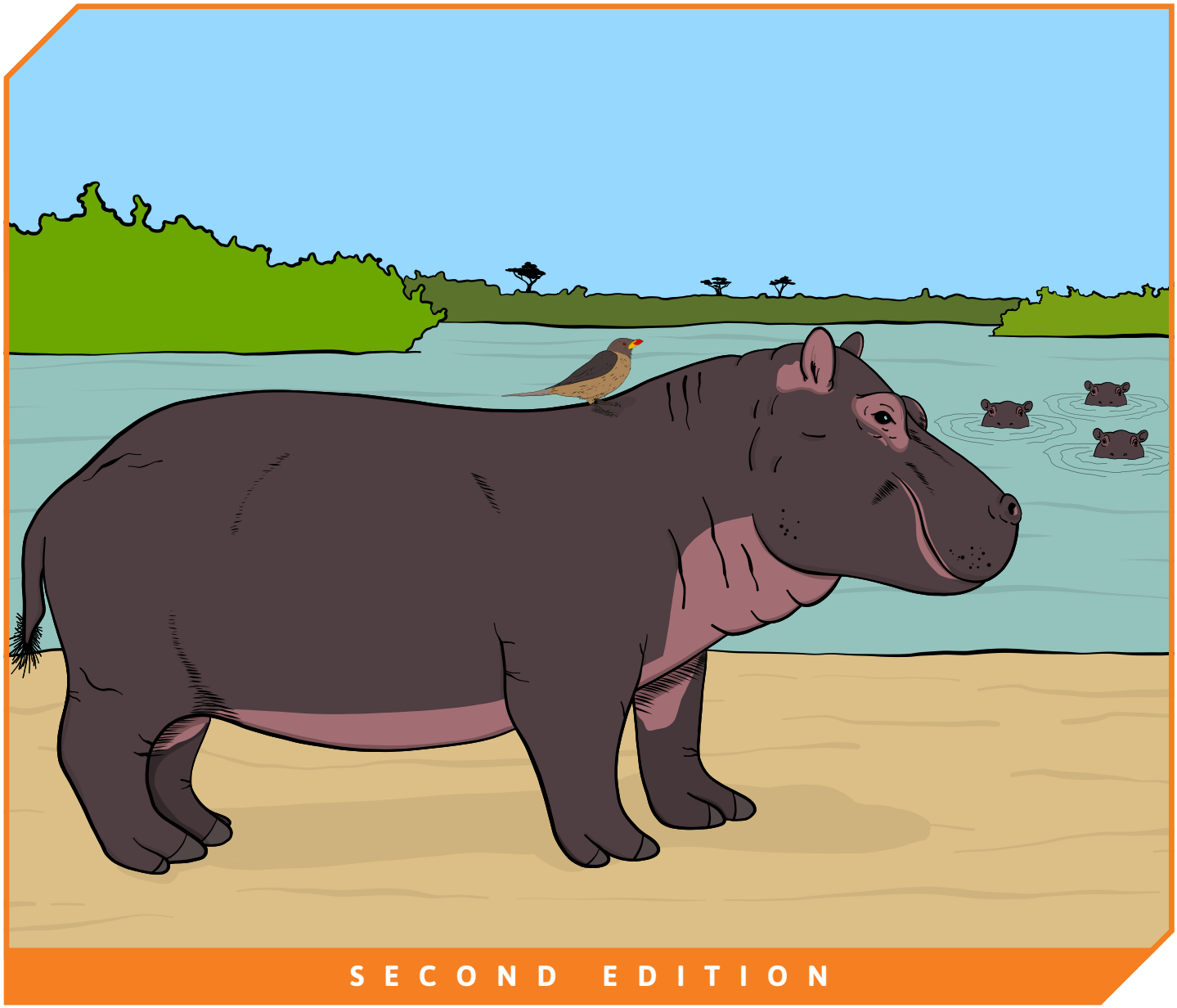
CEREAL CITY SCIENCE by BCAMSC

Teacher Guide and Student Journal
Sample Activity and Planning Pages

Matter and Energy in an Ecosystem
5LNG



SECOND EDITION

A fifth grade unit supporting Next Generation Science Standards
and Michigan Science Standards

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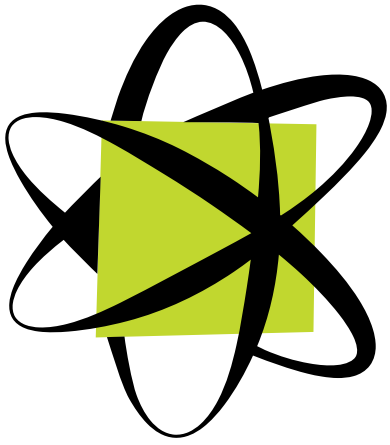
Matter and Energy in an Ecosystem 5LNG

A fifth-grade unit supporting **Next Generation Science Standards** and the **Michigan Science Standards** developed and written by the Battle Creek Area Mathematics and Science Center for



CEREAL CITY SCIENCE™

by BCAMSC

Matter and Energy in an Ecosystem

Pre-activity Informational Pages

Activities

Appendix

NEXT GENERATION SCIENCE STANDARDS

DISCIPLINARY CORE IDEAS	Activities
PS3.D: Energy in Chemical Processes and Everyday Life • 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).	3,4
5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.	3,4
LS1.C: Organization for Matter and Energy Flow in Organisms • 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. • Plants acquire their material for growth chiefly from air and water.	3,4
5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.	3,4
5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.	4
LS2.A: Interdependent Relationships in Ecosystems • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.	1,2,5
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.	1,2,5
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, water, and minerals from the environment and release waste matter (gas, liquid, or solid) back into the environment.	2
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.	2

NEXT GENERATION SCIENCE STANDARDS

SCIENCE AND ENGINEERING PRACTICES	Activities
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use models to describe phenomena. • Develop a model to describe phenomena.	1,2,3,5
5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.	3,4
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.	1,2,5
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Construct an argument with evidence, data, and/or a model. • Make a claim abut the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	4
5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.	4

CROSSCUTTING CONCEPTS	Activities
Systems and System Models • A system can be described in terms of its components and their interactions.	1,2,5
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.	1,2,5
Energy and Matter • Matter is transported into, out of, and within systems. • Energy can be transferred in various ways and between objects.	1,2,3
5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.	3
5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.	1,2,3

COMMON CORE STATE STANDARDS - READING

Reading Standards for Informational Text—Grade 5	Activities
Key Ideas and Details	
RI.5.1: Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from text.	1,2,3
RI.5.2: Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.	1,2,3
RI.5.3: Explain relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in a text.	3
Craft and Structure	
RI.5.4: Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.	1,2,3,5
RI.5.5: Compare and contrast the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in two or more texts.	1,2,4,5
RI.5.6: Analyze multiple accounts of the same event or topic, noting important similarities and differences in the point of view they represent.	3
Integration of Knowledge and Ideas	
RI.5.7: Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.	3
RI.5.8: Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).	1,2,3
RI.5.9: Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.	1,2,3,4,5
Range of Reading and Level of Text Complexity	
RI.5.10: By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently.	1,2,3

COMMON CORE STATE STANDARDS - WRITING

Writing Standards—Grade 5	Activity
Text Types and Purposes	
W.5.1: Write opinion pieces on topics or texts, supporting a point of view with reasons and information. a. Introduce a topic or text clearly, state an opinion, and create an organizational structure in which related ideas are logically grouped to support the writer's purpose. b. Provide logically ordered reasons that are supported by facts and details. c. Link opinion and reasons using words, phrases , and clauses (e.g., *consequently, specifically*). d. Provide a concluding statement or section related to the opinion presented.	1,5
W.5.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly. a. Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. b. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. c. Link ideas within and across categories of information using words, phrases, and clauses (e.g., *in contrast, especially*). d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Provide a concluding statement or section related to the information or explanation presented.	1,2,3,4,5
W.5.3: Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences. a. Orient the reader by establishing a situation and introducing a narrator and/or characters; organize an event sequence that unfolds naturally. b. Use narrative techniques, such as dialogue, description, and pacing, to develop experiences and events or show the responses of characters to situations. c. Use a variety of transitional words, phrases, and clauses to manage the sequence of events. d. Use concrete words and phrases and sensory details to convey experiences and events precisely. e. Provide a conclusion that follows from the narrated experiences or events.	

COMMON CORE STATE STANDARDS - WRITING

Writing Standards—Grade 5	Activity
Production and Distribution of Writing	
W.5.4: Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3.)	1,2,3,4,5
W.5.5: With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.	1,2,4,5
W.5.6: With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of two pages in a single sitting.	
Research to Build and Present Knowledge	
W.5.7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.	2,3,4
W.5.8: Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.	1,2,3,4,5
W.5.9: Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 5 reading standards to literature (e.g., "Compare and contrast two or more characters, settings, or events in a story or a drama, drawing on specific details in the text [e.g., how characters interact]"). b. Apply grade 5 reading standards to information texts (e.g., "Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point[s]").	1,2,3,4,5
Range of Writing	
W.5.10: Write routinely over extended time frames (time for research, 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.	1,2,4,5

COMMON CORE STATE STANDARDS - MATHEMATICS

Mathematics—Grade 5	Activities
Mathematical Practices	
1. Make sense of problems and persevere in solving them.	1–5
2. Reason abstractly and quantitatively.	1–5
3. Construct viable arguments and critique the reasoning of others.	1–5
4. Model with mathematics.	1–5
5. Use appropriate tools strategically.	1–5
6. Attend to precision.	1–5
7. Look for and make use of structure.	1–5
8. Look for and express regularity in repeated reasoning.	1–5
5.NBT Number of Operations in Base Ten	
3. Read, write, and compare decimals to thousandths. a. Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., $347.392 = 3 \times 100 + 4 \times 10 + 7 \times 1 + 3 \times (1/10) + 9 \times (1/100) + 2 \times (1/1000)$. b. Compare two decimals to thousandths based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons.	
5.MD Measurement and Data	
Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.	
3. Recognize volume as an attribute of solid figures and understand concepts of volume measurement. a. A cube with side length 1 unit, called a "unit cube," is said to have "one cubic unit" of volume, and can be used to measure volume. b. A solid figure which can be packed without gaps or overlaps using *n* unit cubes is said to have a volume of *n* cubic units.	
5. Relate volume to the operations of multiplication and addition and solve real-world and mathematical problems involving volume. a. Find the volume of a right rectangular prism with whole-number side lengths by packing it with unit cubes, and show that the volume is the same as would be found by multiplying the edge lengths, equivalently by multiplying the height by the area of the base. Represent threefold whole-number products as volumes, e.g., to represent the associative property of multiplication. b. Apply the formulas $V = l \times w \times h$ and $V = b \times h$ for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths in the context of solving real world and mathematical problems. c. Recognize volume as additive. Find volumes of solid figures composed of two non-overlapping right rectangular prisms by adding the volumes of the non-overlapping parts, applying this technique to solve real world problems.	

UNIT AT A GLANCE

Activity	Time to Complete	Lesson Level Learning Goals	Phenomena	Summary: Students Will…
1 **The Oxpecker and the Hippo**	Preparation: 35 min. Activity 1: 6 classes Lesson 1A: 50–55 min., 2 classes Lesson 1B: 50–55 min. Lesson 1C: 50–55 min., 2 classes Lesson 1D: 50–55 min.	Develop an initial model that explains the relationship between the oxpecker and the hippo.	Oxpecker birds on the backs of hippos pecking at their hides. Carp cleaning the hides and teeth of the hippo.	• Make observations of the oxpecker and the hippopotamus. • Ask questions about the relationship between the oxpecker and hippopotamus. • Obtain information about the relationship among animals from video and text. • Read a chapter book, *Birdbrain Amos*, to obtain information about the African lakes and rivers ecosystem. • Develop and revise models of their thinking about the African lakes and rivers ecosystem.
2 **Interdependence Within an Ecosystem**	Preparation: 40 min. Activity 2: 6 classes Lesson 2A: 50–55 min., 2 classes Lesson 2B: 50–55 min., 2 classes Lesson 2C: 50–55 min., 2 classes	Plan and carry out an investigation that answers a "what would happen if…" question in a bottle ecosystem.	Oxpecker birds on the backs of hippos pecking at their hides. Carp cleaning the hides and teeth of the hippo.	• Complete the reading of the chapter book *Birdbrain Amos* and complete addition of information to their models. • Ask "what would happen if" questions about the balance in a bottle ecosystem model. • Build a bottle ecosystem and make observations of changes over time. • Read the book *How Ecosystems Work* to obtain information about balance and energy and matter in an ecosystem.
3 **More About Plants**	Preparation: 40 min. Activity 3: 6 classes Lesson 3A: 50–55 min. Lesson 3B: 50–55 min., 2 classes Lesson 3C: 50–55 min., 2 classes Lesson 3D: 50–55 min.	Obtain information about plants and how they get their food from other scientists and observations.	Manchineel tree goes to extremes to survive. Poisonous sap helps the tree to survive. The giant sequoia tree can grow to more than 275 feet (84 m) in height and 26 feet (8 m) around.	• Collect plants from the schoolyard. • Make observations of plant parts and determine the function of the parts. • Read informational text about the adaptations of some plants to get food. • Read about Jean van Helmont's experiment with plants.

UNIT AT A GLANCE

Students Figure Out How to:	Practices and Crosscutting Concepts	Assessment
• Develop a model that demonstrates why the oxpecker rides on the back of the hippo. • Determine the main idea and supporting details from information obtained through video and text. • Identify scientific information from fiction. • Use new information to revise models of the relationship among organisms in the African lakes and rivers ecosystem. • Develop a model of a food web. • Collaborate to develop a consensus model of a food web.	**Asking Questions and Defining Problems** **Developing and Using Models** **Constructing Explanations and Designing Solutions** **Obtaining, Evaluating, and Communicating Information** **Systems and System Models**	**Formative Assessment** initial models, Activity Page, revised models, consensus model, Science Talk, Journal Entry
• Develop a bottle ecosystem investigation based on their "what would happen if" questions. • Use the Engineering Design Plan to design an ecosystem in a bottle to determine how living and nonliving things balance in an ecosystem. • Use text to obtain information on ecosystems and how matter and energy cycle in a system. • Determine the main idea and supporting details from information obtained from text. • Determine that the observations of their bottle ecosystems reflect changes and a balanced or unbalanced system.	**Constructing Explanations and Designing Solutions** **Planning and Carrying Out Investigations** **Analyzing and Interpreting Data** **Systems and System Models** **Energy and Matter**	**Formative Assessment** Bottle Ecosystem Investigation Proposal, investigation questions, and ecosystems **Summative Assessment** *Data Table: Ecology* handout, Science Talk, Journal Entry
• Ask questions about the function of plant parts and how plants get food for growth and repair. • Develop and revise a model with new information that explains how plants get food.	**Obtaining, Evaluating, and Communicating Information** **Constructing Explanations and Designing Solutions** **Asking Questions and Defining Problems** **Developing and Using Models** **Energy and Matter**	**Formative Assessment** Activity Page, Science Talk **Summative Assessment** Activity Pages, Science Talk, group models, revised models

UNIT AT A GLANCE

Activity	Time to Complete	Lesson Level Learning Goals	Phenomena	Summary: Students Will…
4 Investigating What Plants Use for Food	Preparation: 25 min. Activity 4: 6 classes Lesson 4A: 50–55 min., 2 classes Lesson 4B: 50–55 min., 2 classes Lesson 4C: 50–55 min., 2 classes	Plan and carry out investigations to determine what plants use for food.	The giant sequoia tree can grow to more than 275 feet (84 m) in height and 26 feet (8 m) around.	• Carry out investigations into plants' need for air and sunlight. • Share their results from their investigations
5 When Something Happens to the Balance	Preparation: 15 min. Activity 5: 8 classes Lesson 5A: 55-60 min., 2 classes Lesson 5B: 55-60 min., 2 classes Lesson 5C: 55-60 min., 2 day Lesson 5D: 55-60 min., 2 classes	Use models to explain how changes in the environment can cause a change in the food web of an ecosystem.	Hippopotamus waste can cause change in the river. Rats are accidentally introduced into the ecosystems in Hawaii.	• Review how the hippopotamus deposits its waste in the lakes and rivers. • Obtain information from video about the effect of the waste of hippos in the lakes and rivers. • Select an ecosystem and develop a skit that demonstrates balance in the ecosystem. • Conduct research on a Michigan invasive species. • Write a letter to the governor of Michigan about the invasive species problem in Michigan.

UNIT AT A GLANCE

Students Figure Out How to:	Practices and Crosscutting Concepts	Assessment
• Plan and carry out an investigation into how plants need air and sunlight. • Discuss findings of investigations to reach a conclusion that plants acquire material from air and water to make food. • Use data from investigations to write a scientific explanation of how plants get food. • Reach a consensus to answer the question "What do plants use for food?" based on investigation results and informational text.	**Planning and Carrying Out Investigations** **Analyzing and Interpreting Data** **Engaging in Argument from Evidence**	**Formative Assessment** Activity Page **Summative Assessment** Activity Page, Questions 2 and 3 Journal Entry Science Talk revised African lakes and rivers models
• Develop a model to explain how changes in the environment can cause a change in the food web of an ecosystem. • Develop a skit as a model to demonstrate a balanced and unbalanced ecosystem. • Use information from research to construct an argument that an invasive species causes change in an ecosystem and the food web. • Propose an opinion of what needs to be done about invasive species and their effect on ecosystems in Michigan.	**Developing and Using Models** **Constructing Explanations and Designing Solutions** **Asking Questions and Defining Problems** **Obtaining, Evaluating, and Communicating Information** **Cause and Effect** **Systems and System Models**	**Summative Assessment** Ecosystem skits Activity Page Science Talk group presentations Journal Entry What We Think chart group research presentations Journal Entry

CEREAL CITY SCIENCE by BCAMSC

Dear Parent:

Your child is beginning a unit created at the Battle Creek Area Mathematics and Science Center. This unit was designed by area teachers to promote inquiry-based science and is complete with materials to accompany the activities. During the next twelve weeks, your child will be actively involved with the unit *Matter and Energy in an Ecosystem.*

This unit is designed for fifth-grade students and focuses on four main themes that dominate the unit: how plants and animals are dependent on one another in an ecosystem, the role of different organisms in an ecosystem, how plants get their food, and how change affects the balance in an ecosystem. All living things need food for growth and maintaining life. It is all that food-getting that happens in an ecosystem that keeps it balanced and also susceptible to change and decline.

Students will explore:

- All organisms in an ecosystem are related in a food web.
- Organisms can survive in an ecosystem where their needs are met.
- Organisms interact and are interdependent in meeting their needs.
- All food energy can be traced to the energy from the sun.
- Change and newly introduced organisms damage the balance in an ecosystem.

During this unit of study, your child will begin to explore the relationship between the hippopotamus and the oxpecker (tick bird) and other organisms in the African lakes and rivers ecosystem. They will compare what they learned about the ecosystem in which the hippo lives to other ecosystems. Students make a connection among a variety of organisms to construct an explanation about the interdependency among animals and plants that live in the same ecosystem.

We hope you enjoy discussing the concepts involved in *Matter and Energy in an Ecosystem* with your child. Suggestions for activities to do at home are included with this letter. These activities will reinforce the concepts taught during this unit instruction. Let us know if we may be of assistance.

The Outreach Staff
Battle Creek Area Mathematics and Science Center
(269) 213-3907 or (269) 213-3908

ACTIVITIES TO DO AT HOME

1. Take this opportunity to explore ecosystems within your backyard, neighborhood, and local parks. Turn over a rock or log and see how many organisms make it their home. Construct a food web of the organisms in your backyard.
2. Take a walk through a local park or neighborhood and discuss the populations and communities of organisms that live there. Keep a log of the different populations over the seasons.
3. Do some research with your child to see what invasive species of plants and animals are in your area.
4. Conduct a family observation and data collection investigation of your backyard or local park. Have your student draw a map of the yard, including the biotic (living) and abiotic (nonliving) components of the yard. Design an observations log to record the backyard temperature, precipitation, plant growth, and animal activity.
5. Plan and plant a family garden of Michigan native plants. Have your students keep a log of the different animals that visit the garden.
6. Visit a nearby native plant garden or butterfly garden.

ACTIVITY 1

THE OXPECKER AND THE HIPPO

Teacher Background Information

The opening lessons in the unit introduce students to the phenomenon of the interdependent relationship between the bird called an oxpecker and the hippopotamus. The oxpecker rides on the back of the hippo, and at first, the observer may think it a nuisance to the hippo. But the oxpecker is picking ticks and other pests off the hide of the hippo. The oxpecker gets its meal and the hippo gets a cleaner hide, benefiting both animals. As the students dig deeper into the relationship, they will discover that the oxpecker does a bit of damage to the hide when pecking at the ticks, but not enough to threaten the survival of the hippo.

The following lessons are intended to pique the curiosity of the fifth-grade student in raising questions about the relationship between the hippo and oxpecker and where they live, what other organisms live there, how their survival is dependent on the relationship among the plants and animals, and how energy and matter is cycled through the ecosystem.

In following lessons, students will be given the opportunity to design an investigation using a bottle ecosystem. The organisms for their bottle ecosystems—aquatic plants, algae, snails, and guppies—in the meantime, will need an aquatic habitat set up to keep them alive and healthy. Students are given little information about the organisms and habitat at this time but are encouraged to make observations and take part in the care of the habitat until the class is ready for their investigations. Students will need little instruction or encouragement to make casual observations of the habitat.

In this lesson, students plant marigold and bean seeds to be used in their investigations in Lesson 3C.

Engage the Learner

This phase of the learning introduces and activates prior knowledge regarding interactions among plants and animals, food webs, and movement of matter and energy within an ecosystem. Students observe the interaction between the hippopotamus, oxpecker, and tick and make connections to the interaction and what the animals need for survival in the African lakes and rivers ecosystem. Students develop and share a model that explains their initial thinking about the relationship among the animals.

ESTIMATED TIME:

Lesson 1A: 50–55 minutes, 2 classes
Lesson 1B: 50–55 minutes
Lesson 1C: 50–55 minutes, 2-3 classes
Lesson 1D: 50–55 minutes

LESSON LEVEL LEARNING GOAL

Develop an initial model that explains the relationship between the oxpecker and the hippo.

MATERIALS NEEDED

For each student:
- student pages

For each group of four:
- chart paper
- markers
- handout: *Planting Seeds*
- 9 oz. cups with soil, 4
- bean seeds
- marigold seeds

For the class:
- 3-gallon aquarium
- conditioned water
- water conditioner
- 8 guppies
- 8 pond snails
- aquatic plant
- algae
- duckweed
- aquarium gravel
- flake fish food
- marigold seeds, 2 packets
- bean seeds, 2 packets
- potting soil
- spray bottle
- plastic wrap
- rubber bands

Teacher provides:
- Post-It Notes
- chart paper/white board
- markers
- water

TEACHING TIP
For faster germination, soak the seeds overnight prior to planting and have students place plastic wrap over the cups and secure with a rubber band.

TEACHING TIP
For faster germination, soak the seeds overnight prior to planting and have students place plastic wrap over the cups and secure with a rubber band.

LS2.A: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS

- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.

Considerations for Students with Special Needs
All prompts and passages in the Student Journal should be read aloud, with repeated directions and checking for understanding prior to writing.

Students are asked to draw and write in their Student Journals. Students may benefit by working with a partner in the longer writing pieces. Students with an IEP should be allowed to dictate their ideas and answers.

Advance Preparation
The potting soil is very dry. Mix 2 to 3 cups of water into the bag to pre-moisten the soil. For ease of planting, fill 4 cups approximately 2/3 full of moistened potting soil for each group. For faster germination, soak seeds overnight.

Assemble the classroom aquatic habitat. Line the bottom of the aquarium with the aquarium gravel. Fill the tank ¾ full with conditioned water. Add aquatic plants and animals to the tank. Add a small pinch of fish food to the tank. Display the aquarium in a warm location. Do not place in direct sunlight. Develop a schedule for care, feeding, and observations of the classroom aquarium.

Conditioned water: Fill one-gallon milk containers with water. Add four to six drops of water conditioner to each. Let stand overnight to reach room temperature.

Preview the following videos that show the oxpecker and the hippo:

Initial videos:

Hippopotamus and the Red-billed Oxpeckers:
https://www.youtube.com/watch?v=QpvQ_CMgQvo

Red-billed Oxpeckers Eating Snacks:
https://www.youtube.com/watch?v=QSS-JUNITGI

Video with narration and additional animals:

Animal Partnerships - David Attenborough
https://www.youtube.com/watch?v=Qqa0OPbdvjw

Information:

https://hipposarethebomb.weebly.com/symbiotic-relationships.html

Choose one video that is suitable for your class or do a Google search on "oxpecker and hippopotamus" and select a video of your choosing. **Turn the sound off and have students view the video without narration.**

Make a What We Think About Hippos and Oxpeckers chart.

What We Think About Hippos and Oxpeckers	Questions We Have	What We Did	What We Figured Out	How does this help us to explain the phenomenon?

The chart will serve as an area where students can place questions that will build the driving questions for the remainder of the unit. As questions are answered, they can be removed from the Questions We Have column and added to the What We Figured Out column.

Plan for an area where students can sit or stand in a circle to share their models and ideas about the phenomenon and the results of their investigations and research.

Ask students to begin collecting two-liter soda bottles for future lessons.

LESSON 1A: WHAT IS THAT BIRD DOING ON THE BACK OF THE HIPPO?

Procedure

Setting up your life science classroom.

Explain to the class that in this life science unit the class will be learning about plants and animals and how they are interact and form interdependent relationships in ecosystems. Display the classroom habitat with the snails, guppies, and aquatic plants. Set up a schedule with students to feed and clean the habitat. Inform the class that in the following weeks, the plants and animals will be used in an investigation to create a model of a balanced ecosystem. Encourage students to share their previous experiences in taking care of animals in an aquarium.

Inform the class that in a few weeks they will also be experimenting with plants and that today the class will plant seeds to grow plants for their investigations. The plants will have four to six weeks to grow prior to use in their investigations. Review what all plants need to grow.

Divide the class into groups of four. Distribute the *Planting Seeds* handout, seeds, and cups with soil to each group. Have students follow the directions on the package or handout and plant the class garden. Have students place the cups with seeds in a warm, well-lit area. After seeds germinate (7 to 10 days) have students remove the plastic wrap and keep soil moist.

TEACHING TIP

Do not attempt to explain or offer information about the guppies and snails at this time. Allow students to begin to form their own ideas about the plants and animals in the aquarium based on observation and experiences.

TEACHING TIP

Develop a class rubric for the common components in the student models. Explain that models in science are a tool that make thinking visible and ideas public. Models throughout the unit are generally drawings with labels and symbols of student thinking that demonstrates progression in understanding as the unit develops. Example of components of ecosystems models: plants, animals, air, water, sun, arrows, labels, and a key if necessary.

SYSTEMS AND SYSTEM MODELS

- A system can be described in terms of its components and their interactions.

TEACHING TIP

The initial lessons provide the framework for the storyline and Driving Questions throughout the unit. The use of the What We Think chart as a combined Driving Questions and Summary Board will make visible students' initial ideas and questions, what they did, what they found out, and questions they have answered and questions they still have.

Be sure the chart is revisited, revised, and reviewed often throughout the unit.

Engage the learner.

Begin the lesson by asking the students to observe a video about two very different animals and think about how the animals interact and what they are doing. Show the video of the bird and hippo. Allow sufficient time for students to jot down thoughts, questions, and ideas in their Student Journals while watching the video.

Record your ideas and questions about your observations of what the bird is doing on the back of the hippopotamus.

Observations	*Questions*

Divide the class into groups of four students. Ask students to share their observations and questions from the video. Encourage students to add to their own ideas with ideas from their classmates. Facilitate the sharing of information and ideas by circulating among the groups and listening to their initial responses to the video. To help students elaborate on their explanations, ask:

- What do you think the bird is doing on the hippo's back and around its ears and face?
- What makes you think that?
- What do you mean when you say…?
- Tell me more about the ecosystem of the hippo and bird. What information did you gather about where they live from the video?
- Can someone describe the observation everyone had in common? What questions did the observation raise?
- Are there some unique observations that popped up in your conversation? What questions did that observation raise?
- Based on your observations, where do you think the hippo and the bird live? What kind of habitat?
- What makes you think that?
- How might you find out?

Listen for student ideas that there is a food chain between the bird and insects. Students may not mention the term *food chain*, but may begin to explain that the bird is eating something off the hide of the hippo. Ask students to elaborate on that idea of the animals using one another as a food source.

Read the prompt on the Activity Page as a class. Ask groups to work together to develop a model of their thinking. Discuss the use of the term *ecosystem* and their initial understanding of the term.

Work with your group and use the space below to draw and label a model that explains what the bird is doing on the back of the hippopotamus. Include any observations of different living and nonliving things in the African lakes and rivers ecosystem where they live.

After the groups have had the opportunity to complete their initial models, ask the groups to bring their models and form a circle for discussion and sharing. Ask each group to display and discuss their models 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?
- What does _____ represent on your model? How does it interact with other parts of your model?
- Tell us more about what you mean by _____.
- How can we make our wonderings about the hippo and bird into questions we can investigate?
- Are there any other animals that you can think of that interact like the hippo and bird?

Ask the class if the development and presentation of the models gave them more ideas and questions about the relationship between the bird and hippo.

Display the What We Think chart and as a class write their ideas in the first column and their questions about the hippo and bird in the second column. Explain that they will enter their findings in the final three columns to help them explain the phenomenon.

Listen for ideas that relate to what the students know about the needs of plants and animals, how they meet their needs, and relationships among animals. Encourage students to draw on their knowledge of who eats what, predator/prey relationships, and structures that function to help plants and animals obtain or make food. The What We Think chart will remain on display to revise and use as the unit progresses.

DEVELOPING AND USING MODELS

Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Identify limitations of models.
- Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.
- ~~Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.~~
- **Develop and/or use models to describe and/or predict phenomena.**
- **Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.**
- ~~Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.~~

SYSTEMS AND SYSTEM MODELS

- A system can be described in terms of its components and their interactions.

ASKING QUESTIONS AND DEFINING PROBLEMS

Asking questions and defining problems in grades 3–5 builds from K–2 experiences and progresses to specifying qualitative relationships.

- ~~Ask questions about what would happen if a variable is changed.~~
- **Identify scientific (testable) and non-scientific (non-testable) questions.**
- **Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause-and-effect relationships.**
- Use prior knowledge to describe problems that can be solved.
- ~~Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.~~

Take this opportunity to develop the Driving Questions for following lessons by building on student ideas. Help students to turn their wonderings into questions that can be answered in future activities. Driving Questions may include questions similar to:

- What is the relationship between the bird and the hippo?
- Do the bird and hippo benefit from their relationship or is one animal harmed?
- Does the relationship help either animal or both in their survival?

Distribute Post-It notes to each group. Have students write their questions on the notes. Have students limit themselves to one question per note. Encourage groups to generate at least three questions for the board. Have students place their questions on the Driving Questions board to use in the following lesson.

Ask students for their ideas of how they can find out more information about the animals' relationship and if it is helpful in their survival.

Assessment: Formative

Use the initial models to assess the students' beginning ideas about how different animals form relationships that can be beneficial, harmful, or neutral.

LESSON 1B: ANIMAL PARTNERSHIPS

Teacher Background Information

In the previous lesson students generated questions about the relationship between the hippopotamus and the oxpecker. This lesson opens with the categorizing of the student questions and combining similar questions to develop the Driving Questions for the unit.

The unit includes a chapter book, *Birdbrain Amos*, that provides information about the hippopotamus, the oxpecker (tick bird), the surrounding ecosystem, and other animals and plants that make up the community. The novel includes an example of bullying among the hippos because Amos is different and builds a friendship with his tick bird. The book can be part of silent reading in Language Arts or a whole-class teacher read. The purpose for reading the book is to gather information and make connections to how people show kindness and respect toward one another. The story is both science and socially oriented. The instructions in the Teacher Guide suggests chapters to be read before or after the science lesson where students are encouraged to make connections and discern between the fiction story and the science the author chose to insert within the story. Students will be able to add to their models as the story progresses. They will make connections among the animals in terms of who eats what and energy flow through the ecosystem.

Advance Preparation

Preview the video with narration and additional animals:

https://www.youtube.com/watch?v=Qqa0OPbdvjw

or Google "The Oxpecker's Role in the Animal Kingdom"

Review the student-generated questions from Lesson 1A and determine what categories and types of questions students are asking. Check for questions that ask about habitat, the diet of each animal, and what other animals live in the same habitat. Example categories for Questions We Have column.

Questions We Have About the Hippopotamus and Oxpecker

Food Source/ Diet	Habitat	Predators	Interaction or Relationship
■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■	■ ■ ■

MATERIALS NEEDED

For each student:
student pages

For each group of four:
hippo/oxpecker model from Lesson 1A

For the class:
book: *Birdbrain Amos*

Teacher provides:
chart paper/white board markers

LS2.A: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS

- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.

TEACHING TIP

If your class lacks initial questions about the hippo and oxpecker habitat, other animals and plants that live there, or predators, feel free to offer a question of your own to encourage a new line of thinking and questioning.

OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION

Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.

- **Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.**
- Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.
- Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices.
- **Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.** t

Procedure

Explore the concept.

Review the video observations from the previous lesson and the students' initial ideas about why the bird is on the hippo and what it is doing. Allow time to add to or revise any new ideas for the What We Think chart.

As a class, review the student questions and develop a Driving Questions board by categorizing questions that are similar in topic. Explain that you were looking through the questions, and noticed that some questions were asking what the hippo and bird ate. Suggest that all questions relating to the diet of the animals be placed under the heading Food Source or Diet. Repeat the procedure with the remaining questions.

After all student questions have been addressed and categorized, inform the class that the chart will change as the unit progresses and some questions are answered and new questions arise.

Inform the class that they are going to watch a video called *Animal Partnerships*. Ask students to listen to the narration for information that may help them to answer the Driving Question and other questions from the question board. Take this opportunity to have students take notes on the important and relevant information from the video. (See Note-Taking Strategies in the appendix.) Review the video note-taking chart in the Student Journal as a class.

Divide the class into groups of four and allow time for students to complete the pre-viewing notes prior to starting the video. Show the first two minutes and forty seconds of the video (stopping after the segment on the hippopotamus) and allow time for students to write, share, and revise. Show the last segment of the video and allow time for students to write, share and revise in their small groups.

Animal Partnerships

Title of Video	*Animal Partnerships*
Pre-viewing notes: Write down the main ideas or question you will focus on during the viewing.	
Pre-viewing notes: Write any information you learned from viewing the previous video of the hippo and bird.	

Listen and watch the first 2:40 of the video then discuss with your group and take notes: • *Write the main idea or concept in your own words.* • *Write a description of the habitat where the birds and their host animals live.* • *Write any terms or phrases that were new or unclear.* • *List other animals that were present in the video.* • *Review and compare your notes with the group.*	
Continue watching the video to the end with your group and take notes: • *Write the main idea or concept in your own words.* • *Write how the bird is helping the host animal.* • *Write how the host animal is helping the bird.* • *List other animals that were present in the video.* • *Write any terms or phrases the were new or unclear.* • *Review and compare your notes with your group.*	
Compare and combine the pre-viewing notes with the notes from the video. • *How did the video answer the question?* • *How did the video cover the main idea?* • *Write the meaning of any new or unfamiliar terms from the video.*	
List questions or concepts that are unclear in the video.	

WRITING

Text and Type Purposes

W.5.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Production and Distribution of Writing

W.5.4: Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3.)

W.5.5: With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

Research to Build and Present Knowledge

W.5.7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

W.5.8: Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.

TEACHING TIP
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 students face one another and address one another. No student has his or her back to a classmate. Allow sufficient time for each student to express ideas and opinions. Encourage student-led conversation in the classroom.

Facilitate the sharing of their observations from the video by circulating among the groups and listening to their ideas and questions. To help students with recall and to elaborate on the concept, ask:

- What concepts or information from the video did the group have in common?
- Does that information help us to answer our questions about the hippo and bird?
- What do you mean when you say…?
- Tell me more about….
- What did the narrator say about the diet of the oxpecker? What do you think about that?
- Do you think the oxpecker helps its host animal? Why do you think that?
- Do you think the oxpecker harms its host animal? Why do you think that?
- Were you surprised that the oxpecker lived on other animals besides the hippo?

Explain the concept and define the terms.

Science Talk

After all students have shared their video observations and explained their understanding within the group, have students gather in a circle to make meaning and connections to the focus question. Begin the Science Talk by choosing a comment or idea that was conveyed in one of the group discussions. To start the conversation and help students make connections among ideas and applications, ask:

- _____ , I heard you say _____ during your group discussion. What did you mean by that?
- Did anyone else have a similar idea?
- I heard many groups use the phrase *benefits from the oxpecker eating the ticks and bugs*. What do you mean by that?
- Do the rest of you agree? Why or why not?
- What other animals were mentioned in the video? Can someone share their list?
- Based on your new information from the video, does anyone have ideas about modifying or adding to your models from the previous lesson?

Reading Integration: Introduce the book *Birdbrain Amos* to the class. Explain that the class will be using the fiction chapter book to learn more about the unusual relationship between the huge hippo and the small bird. Discuss the difference between fiction and nonfiction. Ask students if they have ever read a fiction book that also had scientific or historical knowledge. Ask what the author needed to know in order to write a fiction story and include science information. Read chapters 1 through 3 in *Birdbrain Amos.*

At the conclusion of the reading, discuss the information the author relays about the hippo and his problem and how other hippos solve their problem. Ask students to separate the real from the fictional in the first few chapters of the story.

Allow time for students to return to their groups, retrieve their oxpecker/hippo models, and make additions and revisions based on their new information from the reading. Have students display their revised models for evaluation in the following lesson. Circulate among the groups and listen for ideas that relate to the role of the animals and plants in the ecosystem. Listen for ideas that may relate to plants as producers and animals as consumers and decomposers. Make a note of discussions that begin to relate to food webs, the different roles organisms play, and their food (energy) sources.

Assessment: Formative
Use the Activity Page and revised models to assess the students' emerging ideas about how different animals form relationships that can be beneficial, harmful, or neutral.

TEACHING TIP
The initial lessons in the unit are intended to engage the students in reasoning about the connections and relationships among organisms in food webs. Listen for ideas about who eats what and that the link to survival of all organisms is traced back to plants. Make note of conversations that are beginning to recognize the relationship to use in Science Talk in following lessons. Listen for the use of terms that describe the eating habits and roles of organisms in an ecosystem *(producer, consumer, decomposer, scavenger, carnivore, herbivore, omnivore).*

READING
Key Ideas and Details
RI.5.2: Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.
Craft and Structure
RI.5.4: Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.
Integration of Knowledge and Ideas
RI.5.8: Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).

LESSON 1C: BEYOND THE OXPECKER AND HIPPO

Teacher Background Information
The hippopotamus has a relationship not only with the oxpecker, but also with the carp in the pond, to help keep the hippo clean. Carp in the pond clean the algae from the hide, teeth, and mouth of the hippo.

From the previous lessons, students should have a model that is beginning to make links between organisms in the ecosystem.

Advance Preparation
Preview the following videos:

Hippo Spa:

https://video.nationalgeographic.com/video/hippo_fishclean

http://www.pbs.org/wnet/nature/perfect-partners-hippos-get-clean/14200/

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

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

The anchor posters are developed and worded by the students. The samples listed are ideas that should be expressed in students' own words. Students may have additional ideas that are not listed in the samples. Welcome all ideas that are applicable to a friendly, nonthreatening contribution to the Science Talk and sharing of ideas. The anchor posters should be displayed in the classroom for the entire unit.

Procedure
Explain the concept and define the terms.
Revisit the revised group models and What We Think chart from the previous lessons. Ask students to recap what they have learned about the hippopotamus and oxpecker. Visit the Driving Questions board and move questions the students feel they have answered to the What We Think chart. Write the class conclusions or answers to the questions in the What Do We Conclude column.

Explain to the class that each group will be given the opportunity to share their models of the relationship between the oxpecker, hippo, and tick with the rest of the class and that they will be analyzing and critiquing each other's models.

MATERIALS NEEDED
For each student:
student page
For each group:
model from previous lesson
For the class:
chart paper
markers
Teacher provides:
chart paper
markers

LS2.A: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS
- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.

TEACHING TIP

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 students face one another and address one another. No student has his or her back to a classmate. Allow sufficient time for each student to express ideas and opinions. Encourage student-led conversation in the classroom.

CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- **Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).**
- Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.
- Identify the evidence that supports particular points in an explanation.

In order to conduct a friendly, nonthreatening critique, as a class, establish some guidelines and rules for their critiquing methods. Ask students to 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. As a class, have students suggest how they might start a question that asks a group to clarify, probe or dig deeper, disagrees, or adds to an idea. It is important for success in student-to-student interactions for the anchor charts to be developed by the students.

Sample charts:

Respectfully Disagreeing With an Idea

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 I 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 that supports that?
How do you know?
Can you tell us more about…?
What do you mean by…?

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…?

Adding to an Idea

I agree with you, but also…
I would like to add…
I agree but also think…
I agree with this part, but could you 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 make it more clear if you added…?

Science Talk
After the completion of the anchor questioning charts, allow time for each group to share their models and explain their thinking. Listen for students to use the terms *food source, energy source, balance,* and *relationship among organisms.* Listen for ideas and representations in their models that relate to the hippo eating plants and the importance of plants in an ecosystem. Make a note of groups that are beginning to recognize that there is a relationship among organisms that helps them to survive.

As students present their models, ask them to identify how each animal finds what it needs to survive. At the end of each presentation, encourage the class to ask questions and comment on the models. Remind students that scientists and engineers share their ideas with others to add new ideas and improve models. Encourage students to use the suggestions on the anchor charts to ask questions and make comments on the models of others.

Introduce the terms *consumer* and *producer*. Write the terms on the board and ask students if there are any consumers in the ecosystem. As a class, discuss and define the terms. Check for understanding that all animals are consumers and that plants are producers. Ask the class to identify the consumers and producers in the hippo ecosystem. After the class is satisfied with their definitions, have them write the class definition in the Key Terms section of their Student Journal.

Elaborate on the concept.
Explain to the class that there is one more organism that has an interesting relationship with the hippopotamus: a fish! Ask students to predict how a fish might have a relationship with a hippo. Accept all ideas at this time. Record students' initial ideas on the board or chart paper to revisit at the conclusion of the video.

Show the video of the hippo and the carp (National Geographic: *Hippo Spa* and/or PBS *Nature's Perfect Partners*). At the completion of the video, invite groups to retrieve their models or, if necessary, develop a new model that includes the role of the carp and algae in the ecosystem.

At this point in their learning and exploration, students may begin to recognize the connectivity among plants and animals in an ecosystem, beyond the predator-and-prey relationship from previous units. As students develop their new models, facilitate the activity by circulating among the groups and listening to

OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION
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- Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices.
- **Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.**

DEVELOPING AND USING MODELS

Modeling in 3–5 builds on K–2 experiences and progresses to building and **revising simple models** and using models to represent events and design solutions.

- Identify limitations of models.
- **Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.**
- Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.
- Develop and/or use models to describe and/or predict phenomena.
- ~~Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.~~
- ~~Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.~~

their ideas about the inclusion of the carp in the ecosystem. To help students reason scientifically and collectively make sense of the science, ask:

- How will you demonstrate the role of the fish in your model? Is it a producer? Consumer? How do you know?
- How is the fish connected to other organisms in the ecosystem?
- What do you mean when you draw an arrow from_____ to _____?
- In the video the narrator explains that the carp clean the hippo's hide of algae. What is algae? How does it fit into your model of the hippo ecosystem?
- I see you have the fish eating algae off the hippo's hide. Is algae living? What is its food source?
- Can someone explain the connection among the animals through their food source? What do you mean when you say_____?
- Do the rest of you agree? Why or why not?
- Does anyone have a different way to explain it?
- _____, can you add to _____'s explanation?

Discuss the concept that living things not only take in food but also release waste into the ecosystem. Ask how the waste in the ecosystem is a part of the matter that moves within the system and is part of the balance.

Allow time for students to adjust and display their models and do a gallery walk to observe the changes and additions to the models.

Science Talk: Consensus Building

Focus the discussion on the representation in their models of how organisms get their food. Explain that, using arrows to represent food sources, the class is going to build a consensus model that explains how each plant and animal is connected in the ecosystem that is home to the hippo, oxpecker, and fish. Choose a group to explain their use of arrows in their model. They may have arrows that go from the oxpecker to the tick or the tick to the oxpecker. Ask what the arrows represent. Listen for ideas that relate to who eats what or who supplies the food or energy to other organisms. The goal of this Science Talk is for the class to try to reach a consensus as to how plants and animals are interconnected through their food or energy source. Ask:

- What similarities did we recognize in the majority of our models?
- How can we represent that in our consensus model?
- Do the rest of you agree? Why or why not?
- What assumptions are we making in our model?
- _____, I heard you use the term *energy* when talking about the food web. What do you mean by energy when making a model of the ecosystem?
- I see that _____'s representation of fish included _____. Do the rest of you agree with that? Why or why not?
- The fish eat algae from the hide of the hippo. What is algae? Does algae require food to survive? What makes you think that?
- _____, I see that your model shows a connection between the hippopotamus and plants. Tell us more about that relationship. Does the grass that the hippo eats need food? What do you mean by that?
- Does everyone agree? Why or why not? How can we find out?
- We have been exploring the connections between plants and animals in terms of who eats what. Why is all this eating going on?

Continue the meaning-making discussion until the class is satisfied with the consensus model as a representation of their collective thinking. If some students still struggle with the model, encourage students to relate questions that still remain about the ecosystem model. Check for questions that relate to the plants. Save the class model for future reference and modifications. Ask students to revisit their definitions of producers and consumers and make additions or revisions to the definitions if necessary.

Continue the reading of the book *Birdbrain Amos*. Read chapters 4 through 9 and the introduction of the bird eggs and the python to the ecosystem. After reading, allow time for discussion of the introduction of more organisms into the ecosystem and make adjustments to the class model.

TEACHING TIP

Consensus models are a representation of the students' collective thinking. It serves as a formative assessment for the teacher and students alike. The class may not reach 100% consensus, but should agree that there are areas that some students need further information or evidence to complete the model. Encourage students to use symbols, colors, and arrows to explain their thinking and mark areas that have not reached consensus.

READING

Key Ideas and Details

RI.5.2: Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.

Craft and Structure

RI.5.4: Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.

Integration of Knowledge and Ideas

RI.5.8: Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).

SYSTEMS AND SYSTEM MODELS

- A system can be described in terms of its components and their interactions.

WRITING

Text and Type Purposes

W.5.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Production and Distribution of Writing

W.5.4: Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3.)

W.5.5: With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

Research to Build and Present Knowledge

W.5.7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

W.5.8: Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.

Pre-Writing Strategy: Science Talk

Divide the class into groups of four or teams of two and invite students to review their current information and have the opportunity to orally express what they are going to write in the Student Journal and listen to the ideas of others. Facilitate the pre-writing strategy by circulating among the students and listening to their exchange of ideas. To help students who are stuck, ask:

- Would it help to restate the question you are trying to answer?
- What information do you already know about animals and eating?
- What about making a list of what you already understand?
- How can you write that idea in your response?

Journal Entry

Your class has been developing a model that represents the African lakes and rivers ecosystem and the different plants and animals that live there. The class has been making connections between animals and plants and who eats what. Write why you think all this eating is going on in an ecosystem.

Assessment: Formative

Use the group models, consensus model, and Science Talk to assess the students' understanding of the energy flow among organisms.

Use the group models and Journal Entry to assess the students' ability to develop and use a model to represent their thinking.

LESSON 1D: FOOD WEBS

Teacher Background Information

Students have spent considerable time obtaining information about the African lakes and rivers ecosystem and the food web within the ecosystem. In this lesson students are given vocabulary and additional components that make up food webs within an ecosystem.

Advance Preparation

Prepare the *Food Web Card Set* for each group. Pull the vulture, snail, and bacteria cards from each set and set aside to introduce after students have read the selections in *What Are Food Chains and Webs?*

Decide on a reading strategy for your class. Your unit contains six copies of *What Are Food Chains and Webs?* Determine if you will have small-group readings or a whole-class teacher read for the reading selections in this lesson.

Procedure

Elaborate further on the concept.

Continue the reading of the book *Birdbrain Amos.* Read chapters 10 to 16 and the introduction of baby birds and the elephants into the ecosystem. After the reading allow time for discussion of the introduction of more organisms into the ecosystem and have students make adjustments to their models.

Divide the class into groups of four students and distribute the *Food Web Card Set* (without the vulture, snails, and bacteria cards) to each group. Ask the groups to discuss what they know about the organisms on the card and make a food web that explains the flow of food or who eats what within the web. Allow sufficient time for groups to discuss their ideas and map out their web. Facilitate the group activity by circulating among the students and listening to their ideas and suggestions. To help students elaborate on their ideas, ask:

- Can someone explain how you have arranged your cards so far?
- What is the connection between _____ and _____? How do they interact?
- What do you mean when you say…?
- Tell me more about…
- How might you find out more or confirm?
- Is there something missing from this food web? What might that be? What makes you think that?
- Can you connect all living things to a food source? What is missing?

MATERIALS NEEDED

For each student:
student pages

For each group:
Food Web Card Set (hippo, carp, oxpecker, reeds, grass, tick, snail, rhinoceros, elephant, algae, lily pads, crocodile, vulture, crustaceans, egret, bacteria, grass, bird eggs, python, giraffe, earthworm)

For the class:
book: *Birdbrain Amos*
book: *What Are Food Chains and Webs?*, 6 copies

Teacher provides:
chart paper
markers

LS2.A: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS

- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.

READING
Key Ideas and Details
RI.5.1: Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from text.
RI.5.2: Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.
Craft and Structure
RI.5.4: Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.
RI.5.5: Compare and contrast the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in two or more texts.
Integration of Knowledge and Ideas
RI.5.8: Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).
Range of Reading and Level of Text Complexity
RI.5.10: By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently.

Allow time for groups to share and compare their grouping of the cards and justify their thinking with one another. After they have had time to listen to the ideas of others, introduce the book *What Are Food Chains and Webs?* Ask students to answer the author's questions and discuss their initial ideas of a food chain and food web.

Divide the class into reading groups of six and distribute a book to each group. Have students read pages 4 through 7. After the groups have concluded the reading selection, have them complete the Respond to Text in the Student Journal.

Write the main idea and supporting details for the reading selection, pages 4 through 7 in What Are Food Chains and Webs?

Main Idea:	
Supporting Details:	*Supporting Details:*

Encourage groups to share their main ideas and supporting details from the reading. Ask the class if they have new information about what makes up a food web within an ecosystem that can help them in explaining their models of the African lakes and rivers ecosystem and the relationship among the living things.

Discuss the key terms that the author used to help explain food webs. Write the terms *food chain*, *food web*, and *ecosystem* on the board. Ask students to describe the relationships between the words and, as a class, develop definitions for each term. When the class is satisfied with their definitions, have them write them in the Key Terms of the Student Journal.

Have the class return to the picture on page 4 and ask a volunteer to read the caption for the picture. Introduce the terms *scavenger* and *decomposer*. Discuss the important role of each type of organism in an ecosystem. To learn more about animals that are scavengers, have students turn to pages 16 and 17 and read the selection about hunting and scavenging. Have students define the term *scavenger* in their own words and enter their definitions in the Student Journal.

Read the selection "Decomposers" on pages 20 to 21 and discuss the importance of their role in the balance of an ecosystem.

Have students define the term *decomposer* in their own words and enter their definitions in the Student Journal. Discuss the possibility of adding scavengers and decomposers to the African lakes and rivers models.

Discuss how the author uses the term *energy* when describing who eats what in an ecosystem. Listen for ideas that relate the food as a source of energy for the body that is necessary for growth, repair, and sustaining life. As a class, develop a definition for *energy* as related to an ecosystem and have students enter it in their Key Terms section of the Student Journal.

As a class, review the "forest food web" on pages 22 and 23. Ask students to look at the direction of the arrows and read the author's explanation that the arrows show the energy flow or the animals that receive the food. Review the roles of the producer, consumer, decomposer, and scavenger in the forest web.

Discuss how the class has been developing models of an ecosystem and learning about who eats what and the different roles organisms play in an ecosystem. Ask students to think about the nonliving things that is also necessary to maintain the ecosystem. Listen for ideas that include air, water, sun, land or soil.

Have the students retrieve their group models of the African lakes and rivers models and make final adjustments that reflect the new information from the reading. Allow time for students to display their models and do a gallery walk to observe the work of others. Distribute the remaining cards from the *Food Web Card Set* that represent scavengers and decomposers to the groups as they work out their models.

Science Talk: Consensus Building

Focus the student discussion on the representation in their models of how organisms get their food and the roles they play in an ecosystem. Explain that, using arrows to represent energy flow in the ecosystem, the class is going to build a consensus model that explains how each plant and animal is connected in the ecosystem that is home to the hippo. Choose a group to explain the use of arrows in their model. They may have arrows that go from the oxpecker to the tick or tick to the oxpecker. Ask what the arrows represent.

The goal of this Science Talk is for the class to try to reach a consensus as to how plants and animals are interconnected through their ability to get food.

ENERGY AND MATTER

- Matter is transported into, out of, and within systems.
- Energy can be transferred in various ways and between objects.

CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- **Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).**
- Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.
- Identify the evidence that supports particular points in an explanation.

TEACHING TIP

As a class, determine what all ecosystem models must include. Example: plants, animals, air, sun, water, arrows, labels, key (living and nonliving elements and symbols and labels).

DEVELOPING AND USING MODELS

Modeling in 3–5 builds on K–2 experiences and progresses to building and **revising simple models** and using models to represent events and design solutions.

- Identify limitations of models.
- **Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.**
- Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.
- Develop and/or use models to describe and/or predict phenomena.
- ~~Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.~~
- ~~Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.~~

SYSTEMS AND SYSTEM MODELS

- A system can be described in terms of its components and their interactions.

Ask:

- What similarities did we recognize in the majority of our models?
- How can we represent that in our consensus model?
- Do the rest of you agree? Why or why not?
- What assumptions are we making in our model?
- _____, I heard you use the term *energy*. What do you mean by energy when making a model of the ecosystem?
- I see that your representation of the fish included _____. Do the rest of you agree? Why or why not?
- The fish eat algae from the hide of the hippo. What is algae? Does algae require food to survive? What makes you think that?
- _____, your model shows a connection between the hippopotamus and plants. Tell us more about that relationship. Does the grass that the hippo eats need food? What do you mean by that?
- Does everyone agree? Why or why not? How might we find out?
- What about the arrows that connect the organisms in the ecosystem? What direction should they point?
- What kind of organisms are missing based on our reading? What might we add to represent them?
- What about nonliving components in the ecosystem? How do air, water, soil, and sunlight fit into our model?

Evaluate the students' understanding of the concept. Continue the meaning-making discussion until the class is satisfied with the model as a representation of their current thinking. If some students still struggle with the model, encourage students to relate questions that still remain about the ecosystem model. Check for questions that relate to the plants. Save the class model for future reference and modifications. Ask students to revisit their definitions of producers, consumers, scavengers, and decomposers and make additions or revisions to their definitions if necessary.

Pre-Writing Strategy: Science Talk

Read the Journal Entry prompt as a class. Allow time for students to orally express some ideas for a response. Encourage the students to use their models, *Food Web Card Set*, and information from the reading to help them in their written response.

Journal Entry

Your class has been developing a model that represents the ecosystem of the hippopotamus and the different plants and animals that live there. Draw and label a model of what you think would happen if there was a drought and the hippos in the area had very little grass to eat. Include why you think a change would occur and the effect of the change.

Assessment: Formative

Use the group models, consensus model, and Science Talk to assess the students' understanding of the energy flow among organisms.

Use the group models and Journal Entry to assess the students' ability to develop a model to represent their thinking.

Use the Journal Entry to assess the students' initial thinking about the effect of a change (drought) in the African lakes and rivers ecosystem.

WRITING

Text and Type Purposes

W.5.1: Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

Production and Distribution of Writing

W.5.4: Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3.)

W.5.5: With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

Research to Build and Present Knowledge

W.5.8: Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.

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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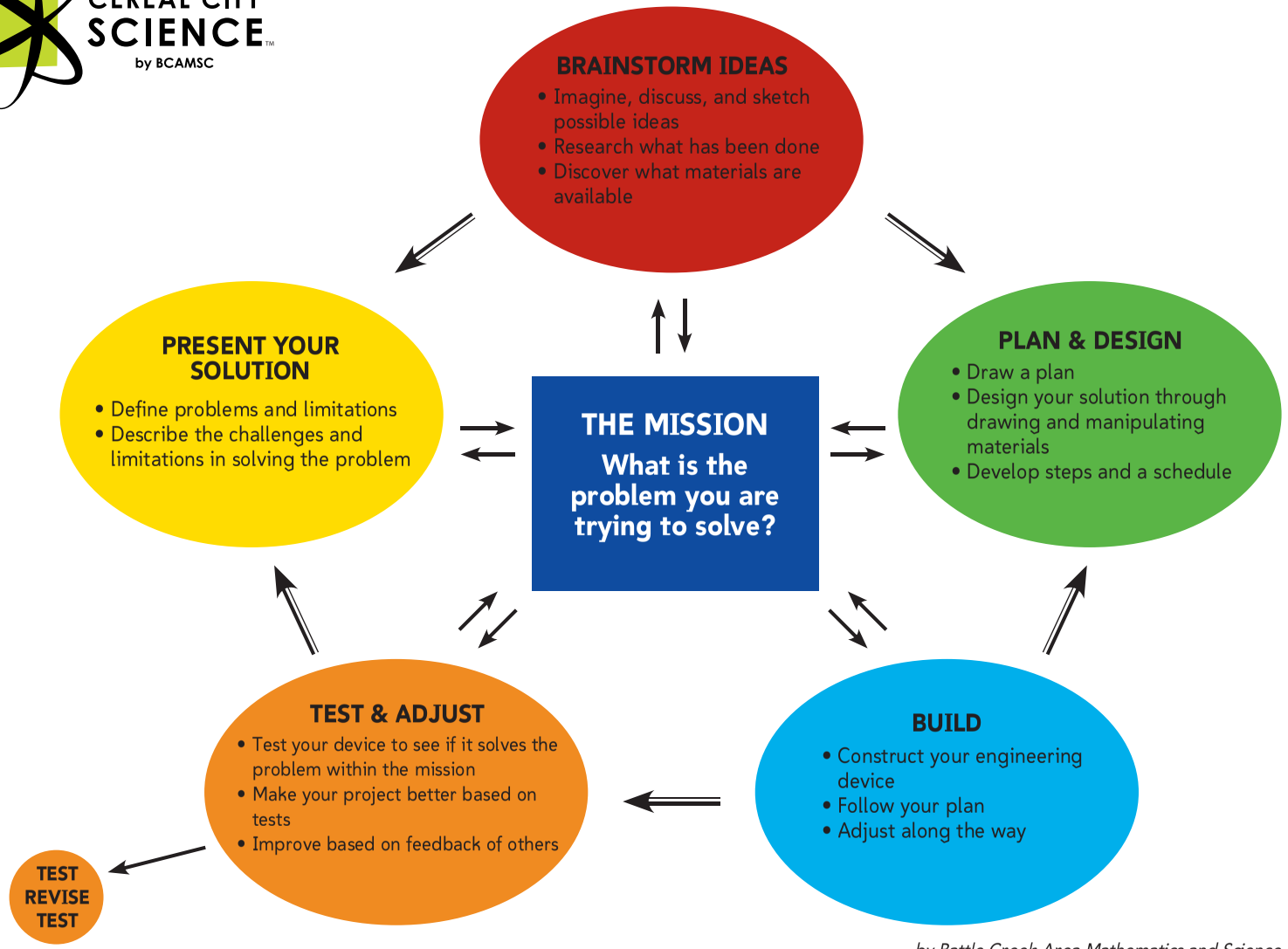
ENGINEERING DESIGN PROCESS



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

APPENDIX

Name: _____

Date: _____

ACTIVITY **1A**

What is that Bird Doing on the Back of the Hippo?

Record your ideas and questions about your observations of what the bird is doing on the back of the hippopotamus.

Observations	Questions

1A ACTIVITY
What is that Bird Doing on the Back of the Hippo?

Name: _____

Date: _____

Work with your group and use the space below to draw and label a model that explains what the bird is doing on the back of the hippopotamus. Include any observations of different living and nonliving things in the African lakes and rivers ecosystem where they live.

Name:_____

Date:_____

Animal Partnerships

Title of video:	Animal Partnerships
Pre-viewing notes: Write down the main ideas or question you will focus on during the viewing.	
Pre-viewing notes: Write any information you learned from viewing the previous video of the hippo and bird.	

Name: _____

Date: _____

Title of video:	Animal Partnerships
Listen and watch the first 2:40 minutes of the video then discuss with your group and take notes: • Write the main idea or concept in your own words. • Write a description of the habitat where the birds and their host animals live. • Write any terms or phrases that were new or unclear. • List other animals that were present in the video. • Review and compare your notes with the group.	

Name:_____

Date:_____

Title of video:	Animal Partnerships
Continue watching the video to the end with your group and take notes: • Write the main idea or concept in your own words. • Write how the bird is helping the host animal. • Write how the host animal is helping the bird. • List other animals that were present in the video. • Write any terms or phrases the were new or unclear. • Review and compare your notes with your group.	

Name: _____

Date: _____

Title of video	Animal Partnerships
Compare and combine the pre-viewing notes with the notes from the video. • How did the video answer the question? • How did the video cover the main idea? • Write the meaning of any new or unfamiliar terms from the video.	
List questions or concepts that are unclear in the video.	

Name: _____

JOURNAL **1C**
Beyond the Oxpecker and Hippo

Date: _____

Your class has been developing a model that represents the African lakes and rivers ecosystem and the different plants and animals that live there. The class has been making connections between animals and plants and who eats what. Write why you think all this eating is going on in the ecosystem.

1D RESPOND TO TEXT

Food Webs

Name: _____

Date: _____

Write the main idea and supporting details for the reading selection, pages 4-7 in *What are Food Chains and Webs?*

Main Idea:	
Supporting Details:	Supporting Details:

Name:_____

Date:_____

Your class has been developing a model that represents the ecosystem of the hippopotamus and the different plants and animals that live there. Draw and label a model of what you think would happen if there was a drought and the hippos in the area had very little grass to eat. Include why you think a change would occur and the effect of the change.

K E Y T E R M S

Name:

Date: