Lesson 5: Decomposers Get Energy From Dead Things

Compost pile being mechanically turned and moistened to encourage the natural decomposition of organic material; Nevada Division of Environmental Protection.

Students explore the process of decomposition and draw conclusions about the important role decomposers play in the flow of energy.

Main Lesson Concept:
Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food.

Scientific Question:
What happens to dead plants and animals?

Objectives	Standards
• Students will use the inquiry process to design and carry out an experiment to determine the factor or factors that cause rotting. • Students will complete their diagrams of the energy flow by adding decomposers and will explain how decomposers get their energy. • Students will explain why decomposers are important to other living things.	**Partially meets:** NSES: C (5-8) 4.2 **Addresses:** 2061: 5E (6-8) #1 2061: 5D (6-8) #2 NCTM: 5, 9

Assessment	Abstract of Lesson
Write up of inquiry experiment, energy flow diagram, and explanation in Astro Journal.	Students use the inquiry process to determine what factor(s) cause rotting. Students observe that water, air, and temperature all play a role in rotting and they observe mold growing. They discuss two types of decomposers, how they get their energy, and the important role decomposition plays for other living things. Students then complete their energy flow diagrams adding decomposers and add decomposers to the class mural.

Prerequisite Concepts	Major Concepts
• All animals, including humans, are consumers that obtain food by eating other organisms. Organisms that eat plants break down the plant structures to produce the materials and energy they need to survive. Then they are consumed by other organisms. (Biology Lesson 4) • Some insects and various other organisms depend on dead plant and animal material for food. (2061: 5D (3-5) #2) • During chemical change, the number of atoms does not change. Matter is neither created nor destroyed, but simply changes form. (Atmosphere Lesson 4)	• Decomposers, such as some bacteria and fungi, get their energy by eating dead organisms. • Individual decomposers are rarely visible without a microscope, but colonies of them (such as bread mold) can be observed. • Decomposers have the ability to break down dead organisms into smaller particles and new compounds, resulting in fertile soil that provides important building materials for plants.

Suggested Timeline (45-minute periods):

Day 1: Engage and Explore – Part 1 sections
Days 2 to 10: Explore – Part 2 (5 to 10 minutes a day)
Day 11: Explain and Extend sections
Day 12: Evaluate section (approximately 20 minutes)

Materials and Equipment:

- A decaying log or a sealed reclosable plastic bag with materials that were "once living." (Items may include cut fruit, grass clippings, moist bread and/or dead insects that you may find around the classroom.)
- A class set of Astro Journal Lesson 5

- Experiment materials may include the following for each group:
  - 2 reclosable bags
  - Stickers and marker or pen for labeling bags
  - 2 pieces of some kind of food (we suggest fruits or vegetables such as apple or banana pieces)
  - A refrigerator
  - Water
  - Dehydrator or dehydrated fruit without preservatives
  - Other materials will depend on the experiment designs students come up with (Make a list after Explore Part 1)

- Students' Flow of Energy diagrams from Astro Journal Lesson 4

- Class mural of two major global food webs from Biology Lesson 1
- Plain paper, crayons and markers to add decomposers to the food web mural
- Yarn of three different colors
- Staples or punch pins
- Chart paper

Preparation:

- Gather materials for experiments and class mural.
- Find a decaying log or prepare reclosable plastic bag with materials that were "once living."
- Duplicate a class set of Astro Journals.
- Prepare chart paper with major concept of the lesson to post at the end of the lesson.

Differentiation
Accommodations For students who may have special needs: • Use a more guided inquiry process by providing them with a choice of experiments to carry out. • Have them work in pairs, draw their observations, and explain their results and conclusions orally.
Advanced Extensions For students who have mastered this concept: Research and report on the number of decomposers in a teaspoon of soil. How many different types of decomposers are in a teaspoon of soil? How many different individual decomposers are in a teaspoon of soil? How does this number compare to the number of plants and animals in a square meter of land?

Engage

(approximately 10 minutes)

Decaying tree stump; Ministry of Forests and Range, British Columbia, Canada

1. Draw on students' prior knowledge of what happens to dead plants and animals.

- Question: What happens if you leave food in the refrigerator for too long?
- *Answer: (Allow students to share their ideas. Student responses may include that food will go "bad" or begin to rot if left in the refrigerator for too long.)*

- Question: What happens to dead plants and animals?
- *Answer: (Allow students to share their ideas. Student responses may include that dead plants and animals rot or decay, that dead plants and animals are foul-smelling, and that dead plants and animals have living things such as mushrooms and fungi growing on them, or insects flying around them.)*

- Prepare a reclosable plastic bag with materials that were "once living." Ideas of items to place in the bag are cut fruit, grass clippings, and moist bread. Including dead insects that you may find around the classroom will help students think about what happens to dead animals as well as dead plants. Be sure to seal the bag when you are done.

Note to Teacher: If you have access to a decaying log, this can be used instead of the plastic bag with materials that were "once living."

- Show students the bag and then pass the bag around for each student to observe more carefully. Explain to the students that they should not open the bag.

- Question: What do you think will happen to the items in this bag?
- *Answer: (Allow students to share their ideas. Student responses may include that the items in the bag will rot or decay.)*

- Question: Do you think all of the items in the bag will rot? Explain your answer.
- *Answer: (Allow students to share their ideas. Student responses will vary depending on the items that are in the bag. Students may respond that the softer plant materials will decay. Some students may respond that materials that are harder such as apple cores or the insects may take a long time to decay.)*

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2. Review Biology Lesson 4.

- Say: In Biology Lesson 4, you completed an activity where you focused on the flow of energy.

- Question: Explain the flow of energy.
- *Answer: The flow of energy starts with the sun. Producers then use energy from the sun to make food. Consumers obtain food by eating producers or other consumers.*

- Question: Do you think consumers obtain food by eating dead plants and animals?
- *Answer: (Allow students to share their ideas. Students may respond that some consumers obtain food by eating dead plants and animals.)*

- Say: Some living things, such as certain types of insects, fungi, and microbes, depend on dead plants and animals for food.

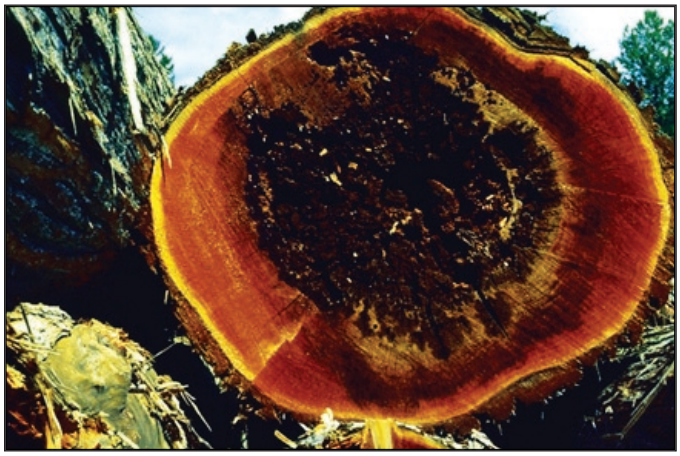
- Question: Do you think that dead plants and animals play a role in the flow of energy? Explain your answer.
- *Answer: (Allow students to share their ideas. Some students, especially those who have had experience with compost piles, may understand the importance of dead plants and animals in the flow of energy.)*

3. Introduce the purpose of this lesson and the scientific question.

- Say: In this lesson, you will design an experiment to determine what happens to animals and plants when they die and how dead animals and plants are important in the flow of energy.
- Say: The scientific question we will be exploring is: What happens to dead plants and animals?

Explore – Part 1

(approximately 35 minutes)



Rotting cross-section of tree; Ministry of Forests and Range, British Columbia, Canada

1. Have students hypothesize what causes rotting.

- Question: What causes rotting?
- Have students record their predictions in the Hypothesis/Prediction section of their Astro Journals.

Note to Teacher: An important decision to make at this point in the lesson is whether you will supply all of the groups with the same substance to rot. For older students, you may want to allow them to choose the substance, while younger students would probably do best with the substance being chosen for them. Try to choose substances that are fruits or vegetables to help students stay focused on living things rotting. Good ideas are slices of banana and pieces of apple. If students choose to use bread, be sure to discuss that the materials that make up bread, such as grains, come from living things. We recommend not using animal/meat products for this activity due to health hazards.

2. Discuss developing an experiment with students.

- Question: How could we test your hypothesis?
- *Answer: (Accept all reasonable answers. Students may respond that we can develop an experiment to test the hypotheses.)*

- Question: In your hypothesis, how many of you listed more than one item that causes rotting?
- *Answer: (Most students will respond that they listed more than one item that causes rotting.)*

- Question: When you develop an experiment, should you test all of the items that you predicted cause rotting?
- *Answer: No, the experiment should only test one item.*

- Question: Why should you not test more than one item in your experiment?
- *Answer: If you test more than one item in your experiment, then you will not know what caused the change in your experiment.*

- Question: When you perform the test for one item, how will you know that the item affected the rotting or not?
- *Answer: We will need to compare it to another piece of food that is not exposed to that item.*

Note to Teacher: With older students, the terms "control" and "variable" could be introduced at this point in the discussion. You may also want to point out that setting up the plan for how the experiment will be conducted is referred to as an "experimental design." Also, be sure to discuss with students the importance of having everything exactly the same in both the control and variable, except for the item that is being tested.

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3. Put students into groups to decide what item they would like to test to determine if it causes rotting and to refine their hypothesis.

- Have students determine the one item that they would like to test to determine if it causes rotting.

Note to Teacher: Student experiments will vary from group to group. Examples of items that students may decide to test to determine if they cause rotting are temperature, air, and water. Listed below are three sample experiments:

- Effect of temperature: Place a piece of fruit or vegetable in two bags. Seal both bags. Place one bag in the refrigerator. Place the second bag in an area that stays at room temperature.

- Effect of availability of air: Immediately place one piece of fruit or vegetable into a reclosable plastic bag. Expose a second piece of the same fruit or vegetable to the air for an extended period of time, and then place it in a reclosable plastic bag. Seal both bags and leave in a warm place.

- Effect of water: Completely dehydrate one piece of fruit and place in a reclosable plastic bag. Place a second piece of fruit that is not dehydrated in a reclosable plastic bag. Seal both bags and leave in a warm place. If a dehydrator is not available, store-bought dehydrated fruit is acceptable, as long as it does not contain any preservatives. Suggested fruits include banana chip vs. banana slice, and dehydrated apple vs. fresh apple slice.

- Go over expectations for hypotheses from the inquiry rubric and model how to revise a hypothesis to improve it (i.e., make it clearer, testable, more specific, etc.)

- Have students develop and record a refined hypothesis in their Astro Journals.

4. Model for students how to create a "test" for the hypothesis and guide them in the recording of the Materials, Procedures, and Data Collection for the test in the Astro Journal for this lesson.

Note to Teacher: Make sure that the students are thinking in terms of data—what data they will be collecting, how they will be measuring their data, and how the data will either confirm or refute their hypotheses.

5. Have students share their questions, hypotheses, and experiment plans.

- Ask questions to help clarify their plan, but try to avoid giving them the answers.
  Sample questions:
  – How does this experiment test your hypothesis?
  – What specific data are you collecting?
  – How will you know if the item you are testing affected rotting?
  – How will you be sure that some other item didn't affect rotting?
  – What two samples will you compare? How will they be alike? How will they be different?
  – How will your data confirm or refute your hypothesis?
  – How are you going to measure your data?

Note to Teacher: Corrections should be focused on science process, not the accuracy of the hypothesis. An incorrect hypothesis with a solid experimental plan is fine. A correct hypothesis without a solid experimental plan should be revised.

6. Ask students for a list of materials they will need to conduct their experiments.

Explore – Part 2

(approximately 5 to 10 minutes for 1 to 2 weeks)

Decaying salmon carcass; Alaska Science Center – Biological Science Office, USGS

1. Have students review their hypotheses and experiment plans and then set up their experiments.

Note to Teacher: Remind students to carefully label each part of their experiment. Many students may use reclosable bags. Encourage them to label each bag with the item that is being tested, the date the experiment was started, and their group members' names or initials.

- After setting up the experiment, have students record observations in their Astro Journal about the substances in their experiment.

Note to Teacher: Observations should include color of the substances as well as the general appearance. Encourage students to record the appearance observations in writing as well as in drawings. Students may also want to record the size of the substance. Older students may be able to determine the percentage of growth on the substances.

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2. Students perform their experiments and collect data daily. This experiment should be conducted until the substance being tested begins to show reactions to the environment.

- Encourage students to use magnifying glasses to make more detailed observations. This will help students observe the growth of living things on their substances.

- Have students record their observations/data in the Observations/Data section of their Astro Journals.

Note to Teacher: Many students will have their experiment enclosed in reclosable bags. Discuss with students the importance of keeping the reclosable bags sealed during the experiments. It is best that students are not exposed to the large amounts of bacteria and fungi that may have grown during the experiment.

Explain

(approximately 30 minutes)

Derelict boat rotting away in the wetlands of Folly Island; NOAA

1. Instruct students to organize their data into a chart in the Charts section of their Astro Journal.

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2. Have students fill out the Results and Conclusion sections in their Astro Journals.

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3. Ask some groups to share their hypotheses, observations/data, what they think their observations/data demonstrate about their hypotheses, and what we can learn from each individual experiment and the experiments as a whole.

MISCONCEPTION: Many students may feel that if their hypothesis is not "right" then their experiment is a failure. Emphasize that this is not true. Scientific understanding grows when we eliminate incorrect answers to scientific questions. The success or failure of a hypothesis and experiment is based on the accuracy of the process, not the result. Either way, we learn something.

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4. Discuss student observations from their experiment.

- Question: What items caused the fruit or vegetable to rot?
- *Answer: (Allow students to share their answers. Depending on the experiments, most, if not all, of the items that the students tested should have caused rotting.)*

- Question: What observations did you make during your experiment?
- *Answer: (Accept all reasonable answers. Observations may include that the substances changed color, that mold began to grow, that the substances smelled foul, or that the fruit or vegetable look shriveled.)*

- Question: Is mold a living thing? Explain your answer.
- *Answer: (Accept all reasonable answers. Students may understand that mold is living. Their reasoning behind why mold is living may not be very strong, but they may observe that mold grows and needs to be on food to live.)*

- Question: In the past few Biology lessons, what have we learned that living things need in order to function?
- *Answer: We have learned that living things need energy (from food) to function.*

- Question: (Hold up one of the student's experiments that has mold growing on it.) Where does this mold get its energy?
- *Answer: The mold got its energy from the dead fruit or vegetable it is growing on.*

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5. Discuss two types of decomposers.

- Say: Mold is an example of a living thing called a decomposer. There are two main types of decomposers, some bacteria and fungi. Mold is a type of fungi. Mushrooms are another type of fungus that you may be very familiar with. If you like to eat mushrooms on your pizza, then you are eating fungi.

- Say: Certain types of bacteria are the second main type of living things that are decomposers. Many of you have heard of illnesses that are caused by bacteria. Some of you may have had strep throat that is caused by bacteria, but not all bacteria cause illnesses. Some bacteria are helpful. Decomposers are one example of a type of bacteria that is helpful.

- Question: Can you see bacteria that cause illnesses?
- *Answer: No, you cannot see bacteria that cause illnesses without the use of a microscope.*

- Question: Could you see mold when it was beginning to grow during your experiment?
- *Answer: With the use of a magnifying glass, we could see mold when it was beginning to grow.*

- Question: Were you ever able to see the mold with just your eyes and no magnifying glass? When were you able to do this?
- *Answer: Yes, we were able to see the mold with just our eyes after the mold had some time to grow.*

- Say: When you were able to see the mold with just your eyes, you were seeing colonies of mold. Since most individual decomposers are so small, they can't be seen without a microscope. As a result, we tend not to notice them and the importance they play. Mold and mushrooms are the few decomposers we can see because they are much larger than bacteria.

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6. Discuss decomposers breaking down dead plants and animals for energy.

- Question: Where do decomposers, such as bacteria and fungi, get their energy?
- *Answer: Decomposers, such as bacteria and fungi, get their energy from dead plant or animals.*

- Question: What must our bodies do to the food to get the energy?
- *Answer: Our bodies must break down the food to get the energy.*

- Question: What do you think decomposers must do to get energy from dead plants or animals?
- *Answer: Decomposers must break down dead plants or animals to get energy.*

MISCONCEPTION: Students think that dead organisms simply dissolve or disappear. They do not realize that the matter from the dead organism is converted into other materials in the environment. The discussion below should help address this misconception.

- Question: When decomposers break down dead plants and animals, do you think they are only breaking down sugars for energy?
- *Answer: (Allow students to share their ideas. Many students may remember that animals break down substances in their food to use as building materials in addition to breaking down sugars for energy. As a result, students may respond that decomposers break down substances for more than just energy.)*

- Question: If they use the dead plants and animals for more than just energy, where does the rest of the material go?
- *Answer: The materials may become part of the decomposers' bodies and help them to survive, or the materials may be broken down into small parts and released into the environment.*

- Question: What might happen to these materials when decomposers release them into the environment?
- *Answer: Decomposers release these materials from dead plants and animals into the soil.*

- Say: The materials that decomposers release into the environment become a part of the soil causing the soil to become fertile. These substances become a part of new plants that grow.

- Say: Many of you have seen insects or earthworms close to or on dead plants and animals.

- Question: Why do you think the insects and earthworms are found close to or on dead plants and animals?
- *Answer: (Allow students to share their ideas. Students may respond that the insects and earthworms are eating or decomposing the dead plant or animal.)*

- Say: Insects and earthworms are not considered decomposers. The reason is that it is actually the bacteria in their stomachs that act as decomposers to break down and recycle dead material into substances that plants need to survive.

- Question: What category of living things do you think insects and earthworms would fit into?
- *Answer: (Students have studied producers, consumers, and decomposers. They should be able to reason that insects and earthworms are consumers based on the fact that they were told they are not decomposers and that insects and earthworms cannot make their own food.)*

Extend/Apply

(approximately 15 minutes)

Detail of leaf; U.S. Fish and Wildlife Service

1. Discuss the decomposition process.

- Question: What process do plants go through to make food?
- *Answer: Plants go through the process of photosynthesis to make food.*

- Question: What materials do plants need to make food?
- *Answer: Plants need sunlight, water, and carbon dioxide to make food.*

- Question: What are the products of photosynthesis?
- *Answer: The products of photosynthesis are sugars and oxygen.*

- Question: In Biology Lesson 3, what did we learn the equation is for photosynthesis?
- *Answer: The equation for photosynthesis in chemical symbols is:*

$$6H_2O + 6CO_2 + \text{solar energy} \longrightarrow C_6H_{12}O_6 + 6O_2$$

and in words:

water + carbon dioxide + solar energy yields sugars + oxygen

Note to Teacher: Write the photosynthesis equation on the board.

- Question: When you eat a piece of food, what process does your body go through to get energy from the food?
- *Answer: Our bodies go through aerobic respiration to get energy from food.*

- Question: What basic materials do consumers need to go through aerobic respiration?
- *Answer: Consumers need sugars and oxygen to go through aerobic respiration.*

- Question: What are the products of aerobic respiration?
- *Answer: The products of aerobic respiration are carbon dioxide, water, and energy.*

- Question: In Biology Lesson 4, what did we learn the equation is for aerobic respiration?
- *Answer: The equation for aerobic respiration in chemical symbols is:*

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + energy$$

and in words:

sugar + oxygen yields carbon dioxide + water + energy

Note to Teacher: Write the aerobic respiration equation on the board.

- Question: What was used in this reaction to break down sugars?
- *Answer: Oxygen was used to break down sugars in the aerobic respiration equation.*

- Say: We have talked about how consumers use aerobic respiration. Some decomposers also use aerobic respiration, but some use anaerobic respiration. Anaerobic respiration takes place when oxygen is not available and another source is used to make energy.

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2. Discuss with students why the variables in their experiments contributed to decomposition.

- Say: As a class, we used a variety of variables in our experiments to determine what causes rotting.

- Question: What variable did you test in your experiment? Did your variable cause rotting?
- *Answer: (Have students share what variable their group tested and whether these variables caused rotting. Record student responses on the board. Variables might include air, water, and temperature. Most, if not all, of the students' variables should have caused rotting.)*

- Have students look at the list of variables. Ask them to discuss with their classmates why each of these variables affected decomposition.

- Question: Why did the availability of air affect decomposition?
- *Answer: There are bacteria and fungi in the air. There is also oxygen in the air, which the bacteria and fungi need in order to live and promote decomposition.*

Note to Teacher: Some fruits such as apples or bananas will begin to change color/turn brown in a short period of time. Students may think that this is the decomposition process beginning. It is important to point out to students that these fruits are changing color due to a chemical reaction in their cells with oxygen in the air, not bacteria or fungi in the air.

- Question: Why did water affect decomposition?
- *Answer: There are bacteria and fungi in water. The organisms that do the decomposing need water to live.*

- Question: Why did temperature affect decomposition?
- *Answer: Temperature affects decomposition because decomposers need a certain temperature to live, and many biological reactions will speed up in warm temperatures and slow down in cold temperatures.*

- Question: Why do you think we place foods in refrigerators?
- *Answer: We place foods in the refrigerator because the cool temperature slows down the growth of decomposers such as mold.*

Evaluate

(approximately 20 minutes)

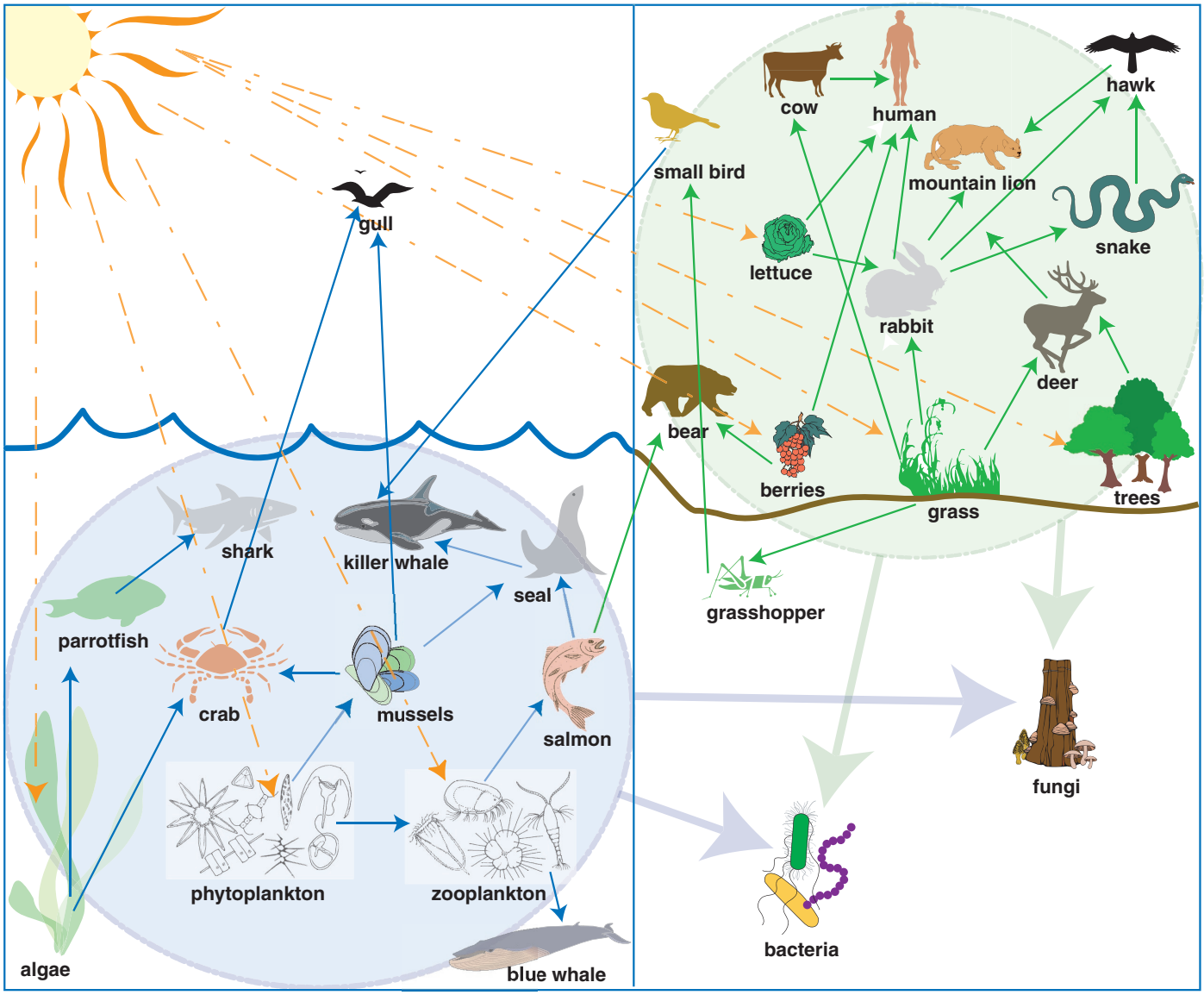
Refrigerator and freezer; Federal Citizen Information Center, Pueblo, CO

1. Lead students in finishing the Flow of Energy Activity from Biology Lesson 4.

- Say: In Biology Lesson 4, you began an activity where you looked at where the energy in the foods you eat comes from. Using your knowledge of decomposers you are going to complete this flow of energy.
- Have students complete the Flow of Energy Activity by following the directions listed in their Astro Journal.
- Have students complete the Flow of Energy Final Questions.
- Have students add the two types of decomposers: fungi and bacteria to the class mural of the global food webs.

Note to Teacher: Students may realize that decomposers break down any dead organisms, therefore requiring yarn connections from all organisms in the food webs. Discuss other ways that this might be symbolized such as creating large arrows from construction paper to symbolize connections to all food web members, or drawing a circle around all members of the food web and connecting a line from this circle to the decomposers. (See example on the following page.)

The Food Web


gull
cow
human
hawk
small bird
mountain lion
snake
lettuce
rabbit
deer
bear
berries
grass
trees
grasshopper
shark
killer whale
seal
parrotfish
crab
mussels
salmon
fungi
phytoplankton
zooplankton
bacteria
algae
blue whale

2. Discuss students' responses in their Astro Journals to ensure they have mastered the major concepts.

- Question: How do decomposers get their energy?
- *Answer: Decomposers get their energy by eating dead animals and plants.*

- Question: Then what happens to the materials that make up dead plants and animals?
- *Answer: Decomposers break down dead plants and animals into new molecules that can be reused by other living creatures.*

- Question: Why are decomposers an important part to humans and all life?
- *Answer: Decomposers are an important to humans and all life because they break down the bodies of dead plants and animals. In this process, decomposers gain their own energy and at the same time recycle substances that producers need back into the soil.*

- Question: Looking at the mural of our global food webs, what can we conclude about how decomposers are connected to other living things?
- *Answer: All plants and animals are eventually broken down by decomposers.*

3. Collect students' Astro Journals and evaluate them to ensure that they have mastered the major concepts:

- Decomposers, such as some bacteria and fungi, get their energy by eating dead organisms.

- Individual decomposers are rarely visible without a microscope, but colonies of them (such as bread mold) can be observed.

- Decomposers have the ability to break down dead organisms into smaller particles and new compounds, resulting in fertile soil that provides important building materials for other living organisms like plants.

4. Bridge to next lesson.

- Say: Today, we learned what happens to animals and plants when they die and how dead animals and plants are important in the flow of energy. In the next lesson, we will learn if matter is ever created or destroyed in food webs.

Note to Teacher: After each lesson, consider posting the main concept of the lesson some place in your classroom. As you move through the unit, you and the students can refer to the "conceptual flow" and reflect on the progression of the learning. This may be logistically difficult, but it is a powerful tool for building understanding.

Astro Journal Biology Lesson 5: Decomposers Get Energy From Dead Things

Name _____ Date _____ Class/Period _____

Scientific Question:
What happens to dead plants and animals?

1. Prediction: What causes rotting? Why do you think this?
2. Materials: What materials will you use to test your hypothesis/prediction?
3. Procedure: What steps will you take to carry out your experiment?

Astro Journal Biology Lesson 5: Decomposers Get Energy From Dead Things

Name _____ Date _____ Class/Period _____

4. Observations/Data Collection: Record and display your data in a chart or table.

5. Charts:

6. Results: What causes rotting? What is rotting? What happens to dead plants and animals? Use data from your experiment to support your answer.

7. Conclusions: Compare and contrast your hypothesis and results. How did testing your hypothesis/prediction and drawing relationships change your original ideas?

Astro Journal Biology Lesson 5: Decomposers Get Energy From Dead Things

Name _____ Date _____ Class/Period _____

Directions:
1. Turn to the Flow of Energy Activity from Biology Lesson 4.
2. Complete the flow of energy by including decomposers in your diagram.
3. Next to each step of the flow of energy, explain what is happening and why that step is important for humans and all life. If you do not have enough room on your diagram, number each of the steps and then complete the explanation of the steps and why they are important on the back of the diagram or on another page.

Flow of Energy Final Questions

1. Explain the flow of energy represented in your diagram.

2. How do decomposers get their energy?

3. What would life be like without decomposition?