LESSON 2 An Ocean of Energy

Lesson at a Glance

Students are introduced to an energy pyramid as a different graphic model to show the energy relationships among producers, consumers, and decomposers. Students construct an energy pyramid using information presented in the PowerPoint *An Ocean of Food Chains and Food Webs* and their marine seafood web.

Lesson Duration

Two 45-minute periods

Essential Question(s)

How does an energy pyramid help us understand the flow of energy in food chains and webs?

How do we calculate the energy flow through the marine food web?

Key Concepts

- Living marine resources are found at all levels of an energy pyramid.
- An energy pyramid illustrates how energy flows from producers through successive levels of consumers in an ecosystem.
- An energy pyramid diagram also shows the relative abundance of organisms at each level in the energy pyramid.
- Each organism can be classified as a producer or consumer; animals may be predators as well as prey.

Instructional Objectives

- I can construct and use an energy pyramid as a model to describe how energy flows from producers to consumers.
- I can demonstrate the interdependent relationship between producers, consumers and decomposers in terms of the cycling of matter.
- I can use models and simulations to help us understand features of processes in the real world.

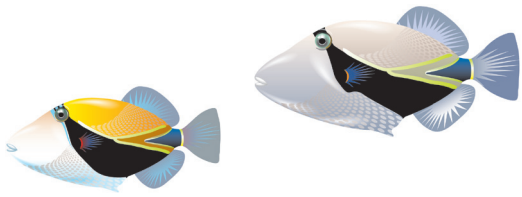
Related HCPSIII Benchmark(s):

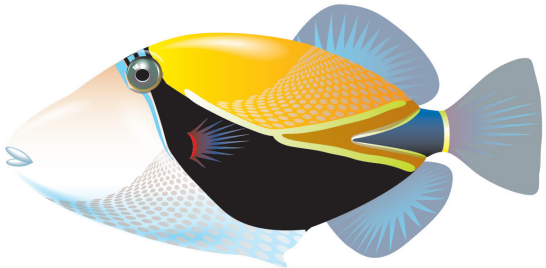
Science SC 5.2.1
Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world.

Science SC. 5.3.1
Describe the flow of energy among producers, consumers and decomposers.

Science SC.5.3.2
Describe the interdependent relationships among producers, consumers and decomposers in an ecosystem in terms of cycles of matter.

Math MA 5.1.1
Represent percent and ratio using pictures and objects.





Assessment Tools

Benchmark Rubric:

Topic		Unifying Concepts and Themes	
Benchmark SC.5.2.1		Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Consistently select and use models and simulations to effectively represent and investigate features of objects, events, and processes in the real world	Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world	With assistance, use models or simulations to represent features of objects, events, or processes in the real world	Recognize examples of models or simulations that can be used to represent features of objects, events, or processes

Topic		Cycles of Matter and Energy	
Benchmark SC.5.3.1		Describe the cycle of energy among producers, consumers, and decomposers	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Explain and give detailed examples of the cycle of energy among producers, consumers, and decomposers	Describe the cycle of energy among producers, consumers, and decomposers	Describe a part of the energy cycle with an example (e.g., describe one or two parts of a food chain)	Recognize an example of part of an energy cycle

Topic		Interdependence	
Benchmark SC.5.3.2		Describe the interdependent relationships among producers, consumers, and decomposers in an ecosystem in terms of the cycles of matter	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Explain and give examples of how specific relationships among producers, consumers, and decomposers in an ecosystem affect the cycling of matter	Describe the interdependent relationships among producers, consumers, and decomposers in an ecosystem in terms of the cycling of matter	Identify a few relationships between producers, consumers, or decomposers in an ecosystem in terms of the cycling of matter	Recall, with assistance, that matter cycles in an ecosystem among producers, consumers, and decomposers

Topic		Numbers and Number Systems	
Benchmark MA.5.1.1		Represent percent and ratio using pictures or objects	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Represent percent and ratio using pictures or objects, with accuracy	Represent percent and ratio using pictures or objects, with no significant errors	Represent percent and ratio using pictures or objects, with a few significant errors	Represent percent and ratio using pictures or objects, with many significant errors

Assessment/Evidence Pieces

Lesson
- Student Products (formative): Energy Pyramid

Materials Needed

Teacher	Class	Group	Student
• Method to present PowerPoint • Chart paper • Markers	• None	• None	• Student Worksheet: *Energy Pyramid of Hawai`i's Marine Ecosystem* • Student Worksheet: *Energy Flow and Matter Cycling*

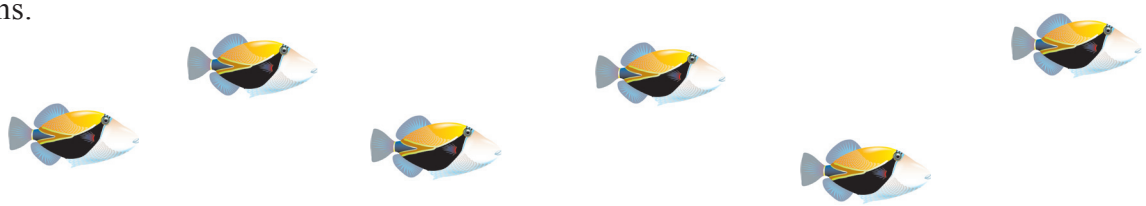
Instructional Resources

Teacher Reading: *Sample Energy Pyramid*
Student Worksheet: *Energy Pyramid of Hawai`i's Marine Ecosystem*
Student Worksheet: *Energy Flow and Matter Cycling*
Teacher Answer Key: *Energy Flow and Matter Cycling*
PowerPoint Presentation: *An Ocean of Food Chains and Food Webs*

Student Vocabulary Words

carnivores: animals that eat other animals.
consumers: organisms that must find and eat food and cannot make it themselves.
crustacean: a class of invertebrates (animals without backbones), which includes crabs, lobsters and shrimp. These animals have a segmented body, a hard external skeleton (exoskeleton), two sets of antennae and one pair of legs per body segment.
decomposers: organisms that return nutrients into ecological cycles by breaking down dead organic material.
ecosystem: community of different living organisms and the physical environment in which they are found.
finfish: a term used in fisheries science to identify true fish from non-fish, such as shellfish, jellyfish, crayfish, etc.
food chain: a graphic representation of the transfer of food, showing how one organism feeds upon another.
food web: a graphic representation showing how many different food chains are linked to each other in an ecosystem.

energy pyramid: a graphic representation of interrelationships among organisms in an ecosystem. The pyramid may be drawn to depict food energy or numbers of organisms, or amount of biomass in an ecosystem.
herbivores (grazers): animals that eat plants or phytoplankton.
living marine resources: all of the living biological organisms in the ocean.
mollusk: invertebrate animals with soft, un-segmented bodies, such as *ophihi*, *pipipi* (nerite snails), clams, oysters, squid and octopus. Misconception alert: Some children use the term squid when referring to what scientists call octopus.
shellfish: general term for crustaceans and mollusks.
scavengers: organisms that look for and feed on dead, decaying or waste material.
producers: organisms that comprise the base of the food chain; often, these are plants and algae in sun-driven ecosystems.



Lesson Plan

Lesson Preparation

- Review the Science Background provided in the Unit Overview and Teacher Reading *Sample Energy Pyramid.*
- Preview PowerPoint Presentation *An Ocean of Food Chains and Food Webs* and make arrangements to project it.
- Review and make copies of Student Worksheet *Energy Pyramid of Hawai`i's Marine Ecosystem*, 2 copies per student, and Student Worksheet *Energy Flow and Matter Cycling*, one per student.

I. Using an Energy Pyramid to Construct a Model of Living Marine Resources in Hawai'i

A. Review the concept of food chains by asking the students to help you create one, keeping in mind that the tertiary consumer is a tuna. Diagram their idea for the food chain on the board. Ask the students to explain what the direction of the arrows mean. Reinforce that the arrows represent the flow of energy from producers to consumers.

B. Explain to students that scientists often use models and drawing or schematic representations to explain the natural world to others in simpler terms. Familiar examples of models and drawings include a globe (model) and a map (drawing). Examples of schematic representations include drawings (e.g., the exterior features of a fish), diagrams like the food chains you recently created, as well as graphs, such as a bar graph.

C. Explain that today, we will explore the features of an energy pyramid to further understand how energy flows from producers to consumers. Distribute a copy of the Student Worksheet: *Energy Pyramid of Hawai`i's Marine Ecosystem*. Use guided questioning to assist students in making connections between the food chain displayed on the board and the energy pyramid (i.e., what do you think the levels of the pyramid represent?). Once understanding of the levels is established, ask students to draw a tuna in the apex of the pyramid.

D. Engage students by creating a scenario. Tell them that the tuna's name is Charley. He is very hungry and he wants to be a BIG tuna. Explain that we must help him by figuring out how much energy is needed at the lower levels of the pyramid to support his big appetite. Explain that, starting from the base of the pyramid, only 10% of the energy reaches the next level. If Charley is 5 kilograms, how many grams of organisms at each of the lower levels is needed to sustain him? Have students work in pairs to complete the pyramid, and solve Charley's problem. Have students share their work and conduct a discussion to clarify their understanding of the process and correct any misconceptions.

E. Distribute a second copy of the *Energy Pyramid of Hawai`i's Marine Ecosystem* worksheet. Reinforce student learning by having the students work on their own to create a second pyramid. This time, have students utilize living marine resources we consume to populate the levels of the pyramid and decide the on the appropriate units for calculation on their own. This student work may be used to assess students formatively.

II. Formulating Conclusions about Energy Relationships in a Living Marine Ecosystem

A. Post an enlarged example of an energy pyramid, or use the slide from the PowerPoint. Inform students that they are to use information from their energy pyramids to decide what an energy pyramid tells us about food energy in a marine ecosystem. Pose the following questions, and engage students in using information from their energy pyramids as evidence:

1. What does the energy pyramid tell us about food energy in a marine ecosystem?
2. Which level of the energy pyramid has the most energy? *(Producers)*
3. How does energy enter the marine ecosystem?
   (It originates with the sun and enters the marine ecosystem through photosynthesis, which is carried out by the producers.)
4. Why is so much energy lost as you move up the levels of the pyramid?
   (Some animals die and don't contribute energy to the next level; not everything that is eaten is converted to biomass, and energy is always being lost as "heat.")
5. What might explain that the total number of organisms decreases at each higher energy level?
   (Most producers – especially the phytoplankton – are very small, whereas organisms get larger moving up the pyramid. The total number of organisms at each level is also known as biomass and will be explained more later in this lesson.)

B. Show and discuss *An Ocean of Food Chains and Food Webs* PowerPoint, slides 8 - 10, to reinforce student learning.

III. What is Biomass?

A. Explain to students that biomass is the total mass of edible organisms available at each energy level. Biomass is the amount of consumable organic material in an entire energy level. What is NOT biomass? (*inedible items such as shells, spines, etc.)*

a. It is a general principle that states the further removed an energy level is from its source (detritus or producer), the less biomass it will contain. This reduction in biomass occurs for several reasons:

   1. Not everything that is eaten is converted to biomass.
   2. Energy is always being lost as heat.

b. A generalization exists among ecologists that, on average, only about **10%** of the energy available in one trophic level will be passed on to the next. This is primarily due to the fact that not everything in a lower trophic level gets eaten, not everything that is eaten is digested, and energy is always being lost as heat. Therefore, it is also reasonable to assume that in terms of biomass, each trophic level will weigh only about 10% of the level below it, and 10 times as much as the level above it. It is a useful concept in terms of human diet and feeding the world's population.

B. Draw one clam on the board or show a picture. Tell them it weighs 500 grams. Ask them how many grams of biomass are available to support the next energy level. They can state any number, but it should represent the "meat" of the clam. Once they answer, ask them how many clams it would take to support a 1,000-gram octopus for a day.

C. Energy and biomass are related in that it takes significant biomass to sustain energy flow as you move up the energy levels of the pyramid.

IV. How Does Matter Cycle?

A. Engage students by having them Pair-Share to discuss the following question: How are nutrients cycled back into the food chains and webs? Explain that the elements needed for life, including carbon and nitrogen, are cycled back through photosynthesis and respiration, but also by decomposition.

B. Where are the decomposers in models of marine ecosystems (Note: The following answers are provided to help you lead the discussion of the process of decomposition with the students.)?

   i. *In marine ecosystems, the decomposers are found in the benthos, or sea floor, as well as in the water column. Most of the biomass of the ocean exists within the top 100 m of the ocean. When an organism dies, like a whale for example, its massive, decaying body starts a long journey down to the seafloor where scavengers like lampreys, hagfish, crabs, and a host of others eat the decaying flesh. Eventually, what's left is broken down organic matter (includes waste material from the scavengers) that once was the tissues and organs of the whale. The process of decomposition is completed by bacteria and fungus that further break apart that organic matter into smaller molecules that the producers of the ocean (phytoplankton and algae) can use for nutrients to grow. Even smaller organisms sink to the bottom, as well as waste and broken down organic matter, which is termed marine snow.*

C. If most decomposition occurs on or near the sea floor, yet most productivity exists in the top 100 m of the ocean, how are nutrients transported from the depths to the surface?

   i. *There are a variety of ways this occurs, but one notable and valuable (in terms of fisheries production) example is called coastal upwelling. Coastal upwelling occurs when winds blow parallel to coastlines (Ekman transport), causing the warm surface waters to be pushed out to sea. Deeper, cool waters replace the warmer surface waters, bringing lots of nutrients to the surface and spurring extremely productive spurts (usually in spring and summer) in these regions. Some of the most productive fisheries in the world (Peruvian coast fisheries, California and the Pacific Northwest fisheries) are powered by this seasonal cycling of deep ocean nutrients.*

D. Optional: Discuss the carbon-oxygen and nitrogen cycle as they relate to matter cycling.

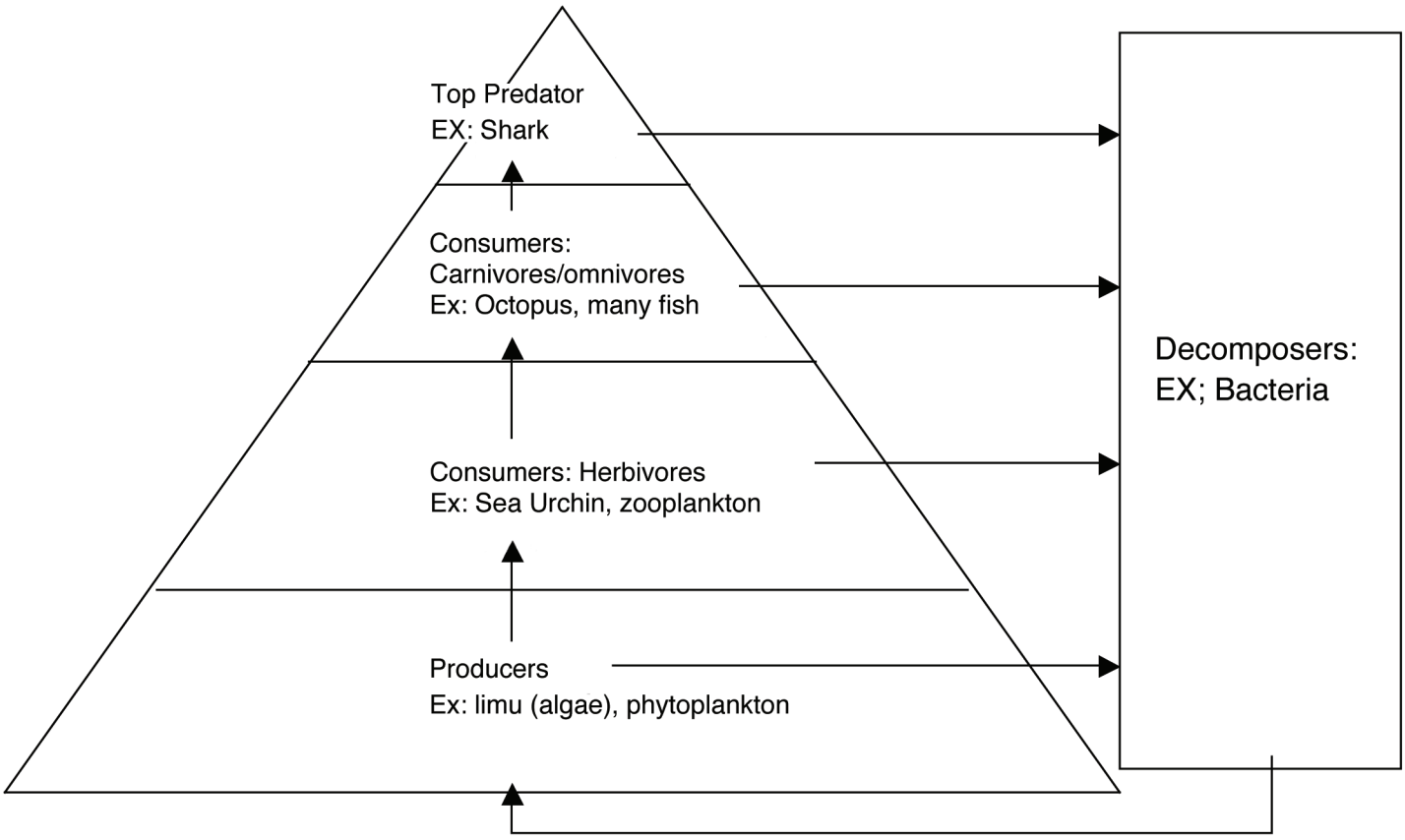
V. Bringing it All Together

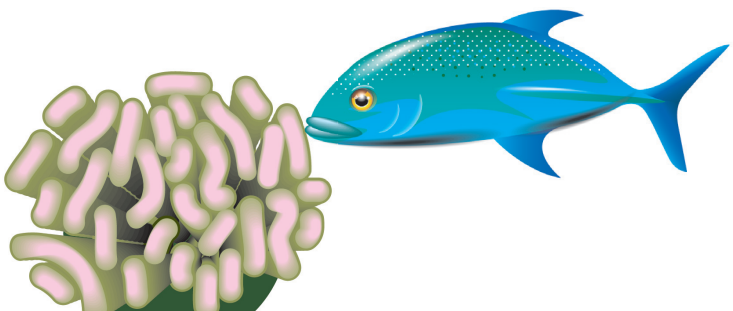
A. Work together with the students to complete Student Worksheet *Energy Flow and Matter Cycling*. This product may be used to assess students formatively.

LESSON 2 - Teacher Reading

Sample Energy Pyramid

Note: The student version of the energy pyramid does not show decomposers. You may want to use their pyramid to introduce a discussion focused on the question "do decomposers fit in the energy pyramid?"or "How are nutrients cycled back into the food chains and webs?" for the **"How Does Matter Cycle?"** portion of the lesson. Explain that the elements needed for life, including carbon and nitrogen, are cycled back through photosynthesis and respiration, but also by decomposition.

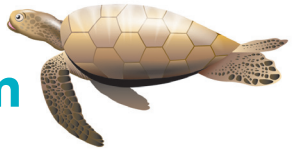




LESSON 2

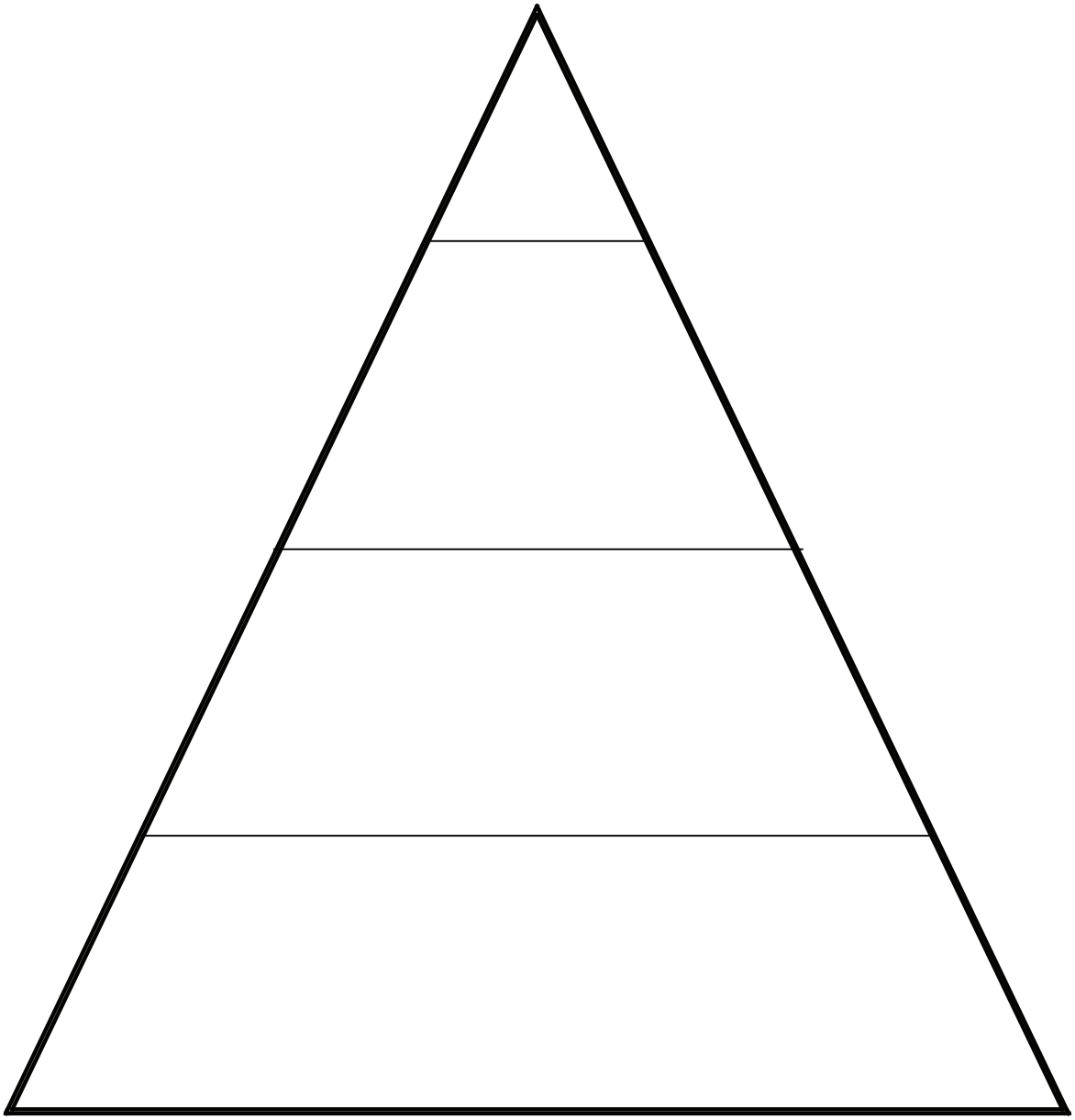
Name: _____ Date: _____

Energy Pyramid of Hawai‘i’s Marine Ecosystem



Directions

Complete the energy pyramid by writing Producer, Primary Consumer, Secondary Consumer and Tertiary Consumer in the correct levels. Next, draw in examples of living organisms for each level. Be ready to explain your reasons for deciding the energy level of each organism.



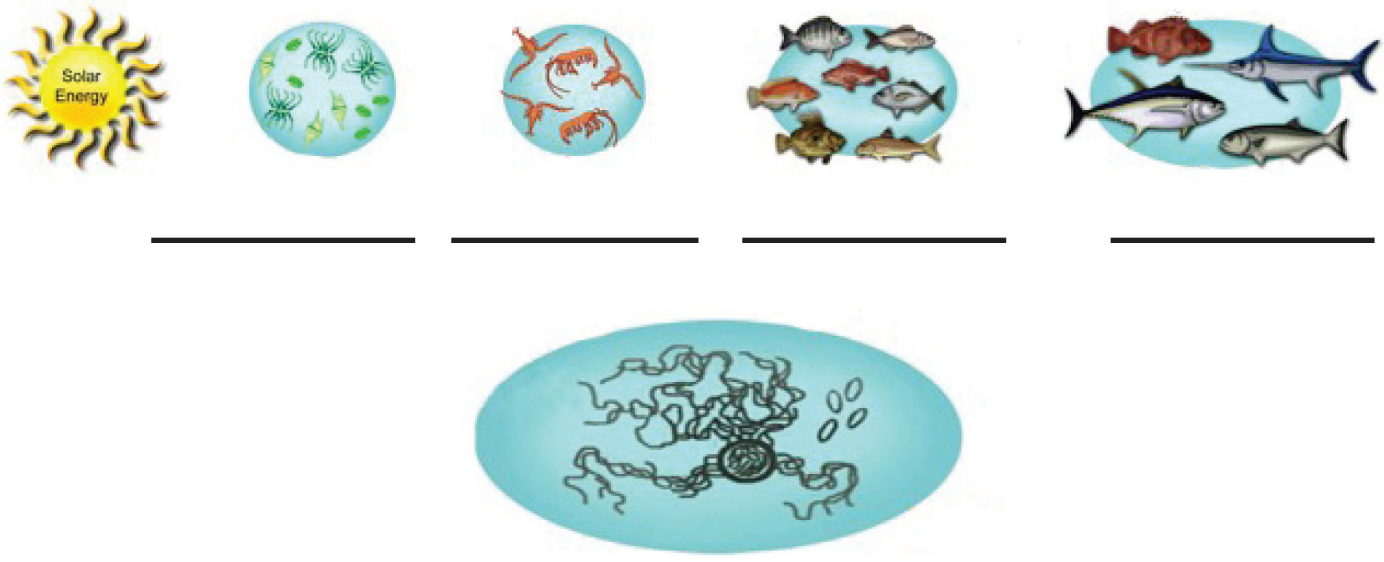
LESSON 2

Name: _____ Date: _____

Energy Flow and Matter Cycling

Directions

Label each group below, then add arrows showing the cycle of matter and the flow of energy.



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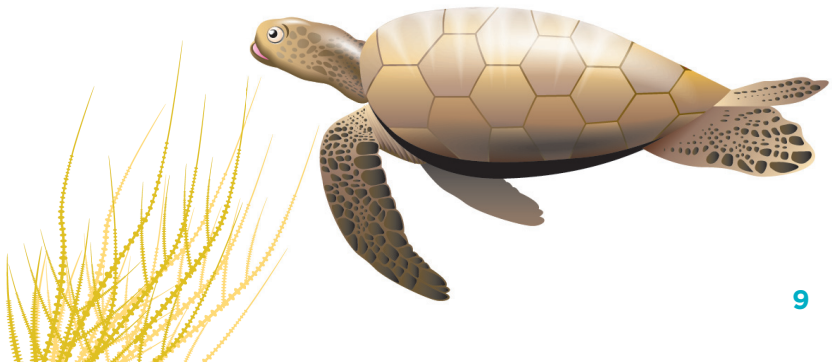

LESSON 2 - Teacher Answer Key

Energy Flow and Matter Cycling