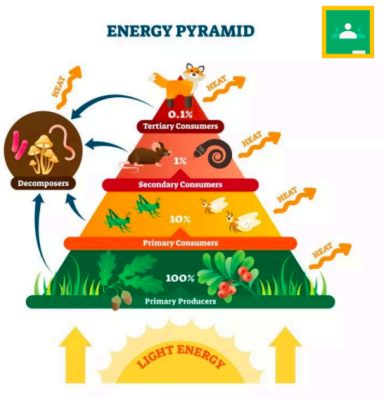
Energy Pyramids and Food Webs - Teacher Guide

Setting the Stage

In this lesson students will identify the sun as the source of virtually all energy, understand the direction of flow within an energy pyramid and why they get smaller at the top, and understand that only about 10% of available energy makes it to the next pyramid level. In order to promote understanding students will create and compare food webs in class, knowing that if one member of a food web is disrupted or altered, that perturbation is felt throughout the entire web.



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Activity Overview

- *Part 1 – Engage (10 minutes) Ecosystem Interactions and Energy Pyramids*
  Introduce the concepts of ecology and ecosystems, develop a focus on energy transfers, and explain how energy flows in a pyramid.

- *Part 2 – Explore and Explain (20 minutes) Food Webs*
  Discuss food webs by having the students draw their own webs using arrows to demonstrate energy flow, then move onto food web construction using string in smaller groups; finish this activity with a disturbance example.

Instructional Overview	
Grade Level	Middle School
Instructional Time	30 minutes *(total time needed)*
NGSS Standards Alignment	DCIs: MS-LS2.B: Cycles of matter and energy transfer in ecosystems. Performance Expectation: MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
Anchoring Phenomenon	Energy is found in food.
Driving Question(s)	● How does energy from the sun power an ecosystem? ● What would happen if all photosynthesis on the planet stopped?
Learning Goals	Students know and understand how living things interact with each other and their environment. ● Explain how and energy flows through ecosystems and describe the significance of photosynthesis and respiration in this process. ● Analyze the implications of interactions among organisms, populations, and their environment. ● Compare and contrast food webs within and between different ecosystems. ● Infer the number of organisms or amount of energy available at each level of an energy pyramid.
Materials	❑ Enough string for food webs to be constructed by each of the groups into which the class is divided (groups of 5 to 10 are recommended). ❑ Energy Pyramids and Food Webs slides
Material Preparation	This activity works best with examples of organisms that live in the local environment of students. If possible, select organisms for this activity that students may know from their area.
Vocabulary	Ecosystem: includes all the living and nonliving components and their interactions within a given area. Ecology: *Eco-* comes from the Greek word *oikos*, meaning home, and *-ology* is simply the study of, thus ecology means the study of our home Energy Pyramid*: a graphical representation, showing the flow of energy at each trophic level in an ecosystem Food Web*: a system of interlocking and interdependent food chains

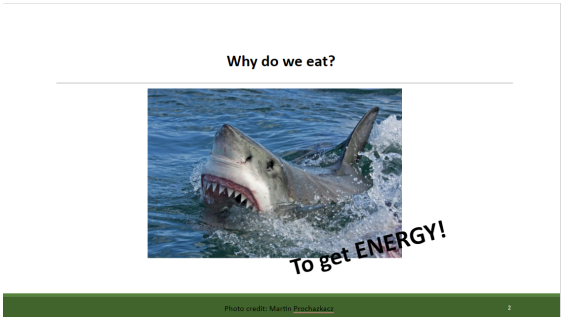
	*For the purposes of energy pyramids and food webs, we are primarily talking about energy from the sun (nonliving) and how it gets distributed among the biotic members of a system.

Part 1 (Engage)
Ecosystem Interactions and Energy Pyramids (10 minutes)

Middle school students may or may not know the definition of ecology. Take the time to define this field of study. Mention that in this activity they will be exploring topics in ecology related to how ecosystems function. The term ecosystem can refer to all the living organisms and nonliving components interacting in an area that is large or small. Ask students to provide examples of small, medium, and large ecosystems, and how they may fit the definition. Here are additional examples to use in the discussion:

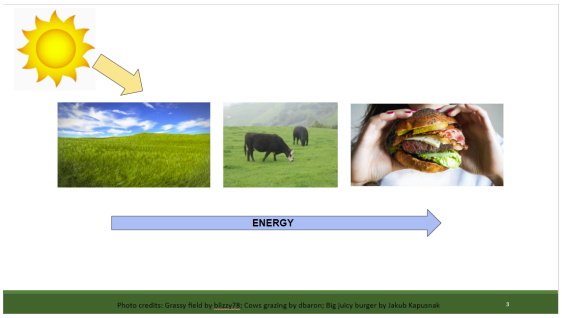
- For instance, the city/town in which you live could be considered an ecosystem (urban).
- Streams and the vegetation they support are ecosystems (riparian). This leads to one aspect of ecosystems, a way in which members of the system interact.
- The Earth is an ecosystem (global).

Mention in this activity they are going to learn one way in which parts of an ecosystem interact. To do that, ask the question: Why do things eat? You can show a picture of a predator such as the one below to gain attention (See slide 2).



Students may respond with various thoughts which should all be acknowledged; however, assist them if they do not add that organisms eat **to gain energy**, the focus of this lesson.

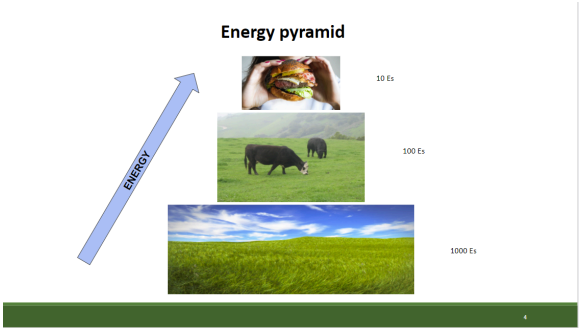
Next, show a picture of a field of grass, and ask where the grass gets its energy. Hopefully, they are able to arrive at the answer, the sun, on their own. This is a good point to emphasize that virtually ALL of the energy on the earth comes from the sun and is made available through photosynthesis. (See slide 3)



Have the students think about a cow that comes along and eats the grass. Then, a person comes along and eats a hamburger. Ask, which way is energy moving? (This can be tricky for some and the point will need to be emphasized at a few points throughout the lesson).

Energy moves from what is being eaten TO the eater.

Now, tell the kids to suppose that one cow has 100 units of energy in it. Ask, how many cows would a person need to eat to get all 100 units? After allowing some time for them to generate answers, tell them that a person would have to eat 10 cows. (See slide 4)



Explain that the reason why the pyramid gets smaller toward the top is because only a small amount of the energy available at the level below is passed to the level above. The rate of energy exchange is about 10%, so if there are 1000 units in the grass, the cow gets about 100 units and the person in turn gets about 10 units. The remaining energy (90%) is either:

- Lost as heat as the organism metabolizes the food or moves while utilizing the energy
- Not consumed (we don't eat every single part of the cow)
- Lost via excretion

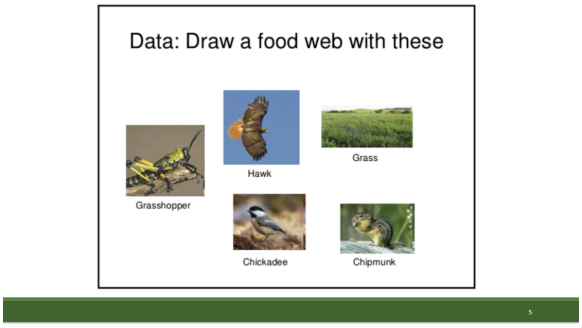
You might want to ask where all the units are coming from again to emphasize the idea that the energy is originating with the sun. This is why we say that energy "flows." It comes to us from space (the sun) and returns to space (as lost heat). It comes in, it leaves. It does not cycle the way that water, for instance, does. Remind them that when using arrows in a diagram to show energy flow, the arrow always points to where the energy goes, and not from where it comes from as stated above.

Part 2 (Explore & Explain)
Food Webs (20 minutes)

Now that we know that energy comes from the sun (plants) and from eating food (all other organisms), and that much of this energy is lost when moving up an energy pyramid, this activity transitions into exploring food webs, or the interactions among organisms within an ecosystem.

- Provide the students with a list of 5 or 6 organisms that could compose a food web. Slide 5 connected to this activity may be used. However, this works best if the organisms are representative of a local ecosystem. Another option is to select organisms found in the biome where students live.

- Have them draw a food web that connects the organisms using arrows to indicate the direction of energy flow. Note: Students often want to have the arrow going from the predator to the prey showing what is eating what. When this happens, ask the student, “which way is the energy flowing?” That is the direction in which the arrow should be oriented.



Within groups of 5 students create a food web for another ecosystem. Pass out the string to each group.

- Have each group choose an ecosystem. You may want to have a list of ecosystems ready for groups who cannot identify an ecosystem.
- Ask the group members to think of a plant or tree in that ecosystem.
- Have the individual who thought of the plant first take one end of the string.
- Ask the remaining members of the groups to think of something that relies upon that plant for food.
- Run the string from the first group member to the student who first comes up with an organism.
- Continue this process until the string is connecting all members of the group. The resulting set of connections is a food web.

Tell students to think of some kind of a disturbance to one of the points of the food web, such as a wildfire burning all of one of the plants.

- Have whichever group member was affected pull on the string.
- Then ask every group member who felt the tug to tug on the string.
- Repeat that instruction until all group members are tugging on the string.

Bring students back as a group. After students have gone through the two steps above, ask them to document (draw a model) the food web in their notebooks, and describe what happens when a disturbance occurs within the ecosystem.

Emphasize the idea that with the food webs they created, when one part of the food web was disturbed, the whole food web felt the effects. For instance, if a farmer kills all the insects in an area, all of the birds that eat the insect will have to look for other food, the plants that rely on the insect for pollination will be affected, etc.