Lab: Energy Flow through the Ecosystems Pyramid

Modified from Life On An Ocean Planet

Background Information:

Many processes connect the Earth's nonliving and living components and are the focus for the study of ecology. Scientists often use models as simulations or as approximate depictions of real life systems. This lab activity is an exercise using a conceptual model of the energy flow pyramid.

The pyramid of energy flow is an illustration representing the stream of energy through each trophic level in a food chain or food web from a particular ecosystem. In a food chain, energy stored in the bodies of the organisms is transferred from one trophic level to the next. Some energy is lost as heat. At each new level, some of the organism is not eaten, digested or absorbed – it passes through the digestive tract of the consumer and becomes waste. Only a small amount of what is eaten and digested becomes biomass and the amount of usable energy at each trophic level gets smaller and smaller. The amount of energy lost at each level depends on the ecosystem and the organisms involved. Generally, about 90% of the energy is lost at each level.

Because so much energy is lost between levels, one can see why food chains and webs rarely have more than four or five trophic levels – too little energy is left after 4-5 levels to support the organisms on top. This is why there are fewer numbers of top consumers such as sharks, hawks, lions, etc. They are usually the first to be affected by disruptions in the food chain and are vulnerable to extinction. Therefore the amount of primary production shapes the ecosystem. For example, the more phytoplankton there are in an ecosystem, the greater the population of sharks. Energy flow pyramids also help explain why the Earth can support a greater human population if people eat at lower trophic levels.

Activity:

After receiving a nametag card, line up with your team in order of trophic level. The "sun" must pour water from the initial bucket into the hands of the first trophic level organisms, who then pass the water to the second trophic level, then third, etc. The top trophic level students then pour the remaining water into the final bucket. This goal is to transfer as much water as possible as quickly as possible.

Analysis:

1. Sketch the energy flow pyramid you modeled and label the trophic levels.
2. Approximately how much water made it to the top predators (as a percent)?
3. How was water lost as it moves up the pyramid?
4. How is energy lost in real ecosystems as it moves up the pyramid? Where does it go?
5. Why do most real food chains rarely have more than four or five trophic levels?
6. Why do ocean ecosystems differ in food web complexity? (as in, for example, a coral reef versus the open ocean)
7. Why are there fewer sharks than shrimp in the open ocean ecosystem?
8. Would you anticipate any differences in the flow of energy through food webs in the deep sea compared to surface waters? Why or why not?
9. Why can more people be supported eating lower on the food chain?
10. Describe potential benefits for people eating lower on the food chain.