A Content Secondary Science Newsletter from the Southern Nevada Regional Professional Development Program

Science Dissected

Food Chain – The Transformation of Energy

Model-Evidence Link Diagram (MEL)

Ecology is the study of organisms and the environments they live in. Ecologist, study organisms, water, sunlight, food supply, predator prey relationships, and every possible factor that might affect a living organism in its environment. Ecologists study specific areas of biological activity called ecosystems**.** In every ecosystem living things need energy in order to live. Every time an animal does something (run, jump) they use energy. Animals get energy from the food they eat. Plants use sunlight, water and nutrients to get energy (in a process called photosynthesis). Energy is necessary for living beings to grow.

A food chain shows how each living thing gets food, and how nutrients and energy are passed from creature to creature. Food chains begin with plant-life, and end with animal-life. Some animals eat plants, some animals eat other animals.

Model A:
Energy flows from the top consumer of the food chain down. Those at the top having the most energy and increasing in the number at the expense of those below them.

Model B:
Energy flows from the bottom producer of the food chain up. Those at the bottom having the most energy and decreasing in the number at the expense of those above them.

Evidence #1: Transformations of energy in an ecosystem begin first with the input of energy from the sun. Energy from the sun is captured by the process of photosynthesis.

Evidence #2: As the energy flows from organism to organism, energy is lost at each step. A network of many food chains is called a food web.

Evidence #3: Organisms must expend energy to stay alive.—Reflecting their greater activity.

The following is a suggestion for using this MEL with students:

1. Hand out the Food Chain—The Transformation of Energy Model Evidence Link Diagram (page 1). Instruct students to read the directions, descriptions of Model A and Model B, and the three evidence texts presented.
2. Handout the Three evidence text pages (pages 3-5).
3. Instruct students to carefully review the Evidence #1 text page (page 3), then construct two lines from Evidence #1; one to Model A and one to Model B. Remind students that the shape of the arrow they draw indicates their plausibility judgment (potential truthfulness) connection to the model.
4. Repeat for Evidence #2-3 (pages 4-5).
5. Handout page 2 for the students to critically evaluate their links and construct understanding.

Once students have completed page 2, they can then engage in collaborative argumentation as they compare their links and explanations with that of their peers. Students should be given the opportunity to revise the link weighting during the collaborative argumentation exercise. If time permits, have students reflect on their understanding of a food chain's and its transformation of energy. Have students create questions that they might explore in the future.

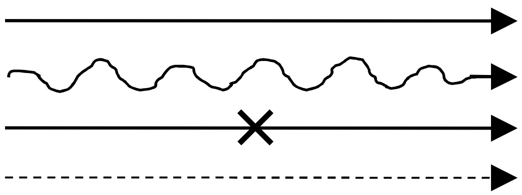
Archived Issues of Science Dissected, *http://www.rpdp.net/link.news.php?type=sciencedis*. ***Instructional Resource resulting from Plausibility, It's All About Connecting the Models Workshop co-sponsored by CPDD and SNRPDP Science March 10, 2012***

Written by: Sherrie J. Essy

Name:____ ____________________ **Period:**_______________

Directions: draw two arrows from each evidence box. One to each model. You will draw a total of 6 arrows.

Key:



The evidence **supports** the model

The evidence **STRONGLY supports** the model

The evidence **contradicts** the model (shows its wrong)

The evidence has **nothing to do with** the model

Standard:
L.8.C.1

Evidence #1

Transformations of energy in an ecosystem begin first with the input of energy from the sun. Energy from the sun is captured by the process of photosynthesis.

Model A

Energy flows from the top consumer of the food chain down. Those at the top having the most energy and increasing in the number at the expense of those below them.

Evidence # 3

Organisms must expend energy to stay alive.— Reflecting their greater activity.

Evidence #2

As the energy flows from organism to organism, energy is lost at each step. A network of many food chains is called a food web.

Model B

Energy flows from the bottom producer of the food chain up. Those at the bottom having the most energy and decreasing in the number at the expense of those above them.

Provide a reason for three of the arrows you have drawn. **Write your reasons for the three most interesting or important arrows.**

A. Write the number of the evidence you are writing about.
B. Circle the appropriate descriptor (**strongly supports | supports | contradicts | has nothing to do with**).
C. Write the letter of the model you are writing about.
D. Then write your reason.

1. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

2. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

3. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

4. Circle the plausibility of each model. [Make two circles. One for each model.]

	Greatly implausible (or even impossible)									Highly Plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10

5. Circle the model which you think is correct. [Only circle one choice below.]

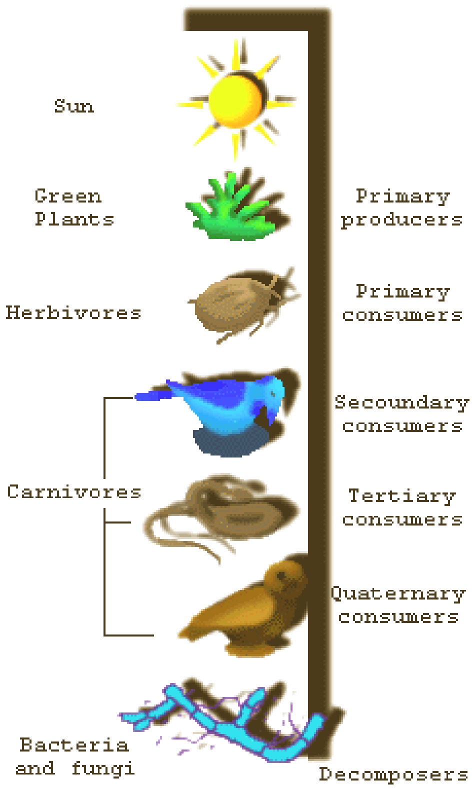
Very certain that Model A is correct	Somewhat certain that Model A is correct	Uncertain if Model A or B is correct	Somewhat certain that Model B is correct	Very certain that Model B is correct

Evidence #1: Transformations of energy in an ecosystem begin first with the input of energy from the sun. Energy from the sun is captured by the process of photosynthesis.

The Transformation of Energy

The transformations of energy in an ecosystem begin first with the input of energy from the sun. Energy from the sun is captured by the process of photosynthesis. Carbon dioxide is combined with hydrogen (derived from the splitting of water molecules) to produce carbohydrates (CHO).

The prophet Isaah said "all flesh is grass", earning him the title of first ecologist, because virtually all energy available to organisms originates in plants. Because it is the first step in the production of energy for living things, it is called ***primary production*** *photosynthesis.* ***Herbivores*** obtain their energy by consuming plants or plant products, ***carnivores*** eat herbivores, and ***detritivores*** consume the droppings and carcasses of us all.



The figure on the left, portrays a simple food chain, in which energy from the sun, captured by plant photosynthesis, flows from ***trophic level*** to trophic level via the ***food chain***. A trophic level is composed of organisms that make a living in the same way, that is they are all ***primary producers*** (plants), ***primary consumers*** (herbivores) or ***secondary consumers*** (carnivores). Dead tissue and waste products are produced at all levels. Scavengers, and decomposers collectively account for the use of all such "waste" -- consumers of carcasses and fallen leaves may be other animals, such as crows and beetles, but ultimately it is the microbes that finish the job of decomposition. Not surprisingly, the amount of primary production varies a great deal from place to place, due to differences in the amount of solar radiation and the availability of nutrients and water.

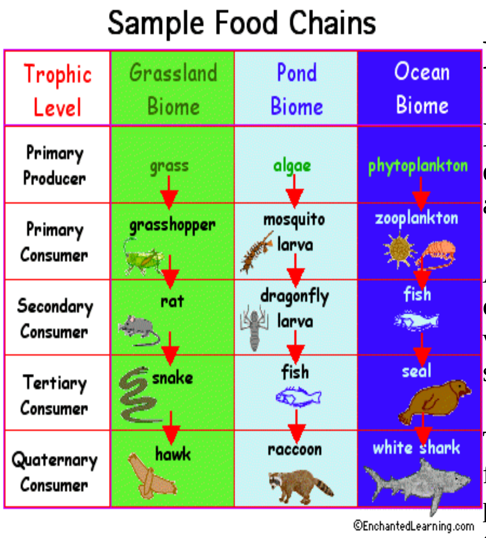
For reasons that we will explore more fully in subsequent lectures, ***energy transfer through the food chain is inefficient.*** This means that less energy is available at the herbivore level than at the primary producer level, less yet at the carnivore level, and so on. The result is a pyramid of energy, with important implications for understanding the quantity of life that can be supported.

Usually when we think of food chains we visualize green plants, herbivores, and so on. These are referred to as ***grazer food chains***, because living plants are directly consumed. In many circumstances the principal energy input is not green plants but dead organic matter. These are called ***detritus food chains***. Examples include the forest floor or a woodland stream in a forested area, a salt marsh, and most obviously, the ocean floor in very deep areas where all sunlight is extinguished 1000's of meters above. In subsequent lectures we shall return to these important issues concerning energy flow.

Finally, although we have been talking about food chains, in reality the organization of biological systems is much more complicated than can be represented by a simple "chain". There are many food links and chains in an ecosystem, and we refer to all of these linkages as a ***food web***. Food webs can be very complicated, where it appears that ***"everything is connected to everything else"***, and it is important to understand what are the most important linkages in any particular food web.

http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/ecosystem/ecosystem.html

Evidence #2: As the energy flows from organism to organism, energy is lost at each step. A network of many food chains is called a food web.



Food Chains and Food Webs

Every organism needs to obtain energy in order to live. For example, plants get energy from the sun, some animals eat plants, and some animals eat other animals.

A food chain is the sequence of who eats whom in a biological community (an ecosystem) to obtain nutrition. A food chain starts with the primary energy source, usually the sun or boiling-hot deep sea vents.

The next link in the chain is an organism that make its own food from the primary energy source -- an example is photosynthetic plants that make their own food from sunlight (using a process called **photosynthesis**) and chemosynthetic bacteria that make their food energy from chemicals in hydrothermal vents. These are called **autotrophs** or **primary producers**.

Next come organisms that eat the autotrophs; these organisms are called **herbivores** or **primary consumers** -- an example is a rabbit that eats grass.

The next link in the chain is animals that eat herbivores - these are called **secondary consumers** -- an example is a snake that eat rabbits.

In turn, these animals are eaten by larger predators -- an example is an owl that eats snakes.

The tertiary consumers are are eaten by **quaternary consumers** -- an example is a hawk that eats owls. Each food chain ends with a **top predator**, and animal with no natural enemies (like an alligator, hawk, or polar bear).

The arrows in a food chain show the flow of **energy**, from the sun or hydrothermal vent to a top predator. As the energy flows from organism to organism, energy is lost at each step. A network of many **food chains** is called a **food web**.

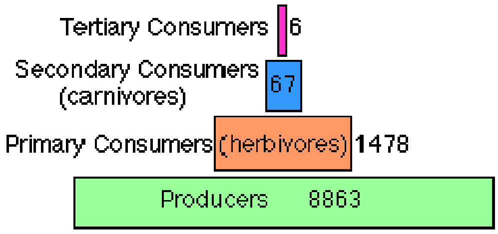
Trophic Levels:
The trophic level of an organism is the position it holds in a food chain.

1. **Primary producers** (organisms that make their own food from sunlight and/or chemical energy from deep sea vents) are the base of every food chain - these organisms are called **autotrophs**.
2. **Primary consumers** are animals that eat primary producers; they are also called **herbivores** (plant-eaters).
3. **Secondary consumers** eat primary consumers. They are **carnivores** (meat-eaters) and **omnivores** (animals that eat both animals and plants).
4. **Tertiary consumers** eat secondary consumers.
5. **Quaternary consumers** eat tertiary consumers.
6. Food chains "end" with top predators, animals that have little or no natural enemies.

http://www.enchantedlearning.com/subjects/foodchain/

Evidence #3: Organisms must expend energy to stay alive.— Reflecting their greater activity.

The Pyramid of Energy



Conversions efficiencies are always much less than 100%. At each link in a food chain, a substantial portion of the sun's energy — originally trapped by a photosynthesizing autotroph — is dissipated back to the environment (ultimately as heat).

Thus it follows that the total amount of energy stored in the bodies of a given population is dependent on its trophic level.

For example, the total amount of energy in a population of toads must necessarily be far less than that in the insects on which they feed.

The insects, in turn, have only a fraction of the energy stored in the plants on which they feed.

This decrease in the total available energy at each higher trophic level is called the **pyramid of energy**.

http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/F/FoodChains.html#EnergyPyramid