Energy Flow Through an Ecosystem

1. Energy and how it behaves.
    a. Everything in the universe is divided into two categories:
        i. Matter are all the things that have mass and take up space.
        ii. Energy is the ability to perform some kind of work.

2. The energy in ecosystems comes from the sun (although some organisms can acquire energy from chemicals).
    a. Only one billionth of the sun's energy actually reaches Earth (because it's 150 million km away). Ozone in Earth's atmosphere reflect or absorb its harmful radiation.
    b. When sunlight hits an object it is either reflected or absorbed.
        i. About 30% of solar energy is reflected by water, land, clouds, plants, buildings, *etc*. Energy that is reflected energy is not used and does not heat objects up.
        ii. About 70% of solar energy is absorbed by water, land, clouds, plants, buildings, *etc*. Energy that is absorbed heats objects up. Dry objects heat up faster than wet objects. This is why on a sunny day the dry sand on a beach is hot to the touch but the wet sand or grass on your lawn does not. The water in the grass or wet sand absorbs solar energy so that the item does not heat up.
        iii. Less than 1% of the solar energy reaching Earth is used by living things.

3. Energy movement in ecosystems
    a. There are two laws that govern the behavior of energy in the universe.
        i. The First Law of Thermodynamics states that energy cannot be created nor destroyed, it can only change form.
        ii. The First Law of Thermodynamics states that when energy changes forms, some is converted into an unusable form. This energy is lost. No transformation is 100% efficient.
    b. Sunlight is the main source of energy for life on Earth. (Some organisms can obtain energy from chemicals rather than using sunlight.) Energy flows through an ecosystem in one direction; it flows from the sun (or from chemicals) to producers and then to consumers.
    c. Without a constant source of energy, living systems cannot function.
    d. The energy stored by producers can be passed through an ecosystem along a food chain, a series of steps in which organisms transfer energy by eating and being eaten.
    e. In reality, each individual organism in an ecosystem is involved in many food chains, which interlock to form a food web.
    f. Food webs are more stable (or sustainable) because organisms usually have several choices of what they will eat and they might be eaten by several different organisms. The loss of any given organism has a smaller effect on a food web than it would on a food chain. A food web links all the food chains in the ecosystem together.

4. The importance of biodiversity.
    a. Biodiversity is the number of different species living in an ecosystem.
        i. The more complex the food web the more stable the ecosystem because if one organism were removed, those that remain still have other options for food.
        ii. The lower the biodiversity, the simpler the food web, and the more vulnerable is each organism.

5. Trophic levels
    a. Of course, organisms do not consume energy directly. Most get energy by eating. Organisms can be put into categories depending on how they get energy (*i.e.*, food). Each step (or level) in a food chain or food web is called a trophic level. Trophic levels let us categorize organisms according to how they gain their energy.
    b. In general, organisms fall into one of two categories:
        i. **Autotrophs** (or producers) capture energy from sunlight or chemicals and use that energy to produce food.
            1. These organisms (plants, algae, and some bacteria) capture energy from the sun to make food. Some of the solar energy absorbed is trapped by chlorophyll and used to make sugar in a process called photosynthesis.
            2. Certain bacteria use chemical energy from chemicals in the environment to produce their energy. This is called chemosynthesis.
            3. Producers are important because they produce food for all other organisms in the ecosystem.
        ii. **Heterotrophs** (or consumers)
            1. These organisms (animals, fungi, and some bacteria) cannot make their own food using photosynthesis so they must eat other organisms.
    c. When a consumer eats a plant, it gets energy from the sugar the plant made.

6. Food Chains
    a. Energy flows through an ecosystem in one direction, from the sun to autotrophs, and then to heterotrophs.
    b. The energy captured by autotrophs is passed through an ecosystem along a food chain.
    c. A food chain is a series of steps showing the flow of energy from producers to consumers.
        i. The first step in a food chain is always a producer because they capture energy for the ecosystem using photosynthesis to produce food for all other organisms.
        ii. The second step is always a herbivore (or omnivore) because they must eat a producer. This organism is called a primary consumer.
        iii. The third step is always a carnivore (or omnivore) because they must eat a consumer. This organism is called a secondary consumer.
            1. The last organism in the chain is called the top carnivore. It is not prey to any other organism.
    d. The first trophic level is **producer** (or autotroph). Most get their energy from photosynthesis.
    e. The second trophic level is **primary consumer** (these are heterotrophs). These organisms get their energy by eating producers.
    f. The third trophic level is **secondary consumer** (these are also heterotrophs). These organisms eat primary consumers.

g. The final carnivore in any food chain is called the top carnivore. While alive, they are not eaten by other animals.

7. There are five different kinds of heterotrophs:
    a. Herbivores eat producers.
    b. Carnivores eat other consumers.
        i. Predators eat live prey.
        ii. Scavengers eat something which is already dead.
    c. Omnivores eat both producers and consumers.
    d. Detritivores eat dead plants and animals.
    e. Decomposers break down organic matter so that it can be recycled back into the ecosystem.

8. Pyramids of Energy
    a. Organisms use energy to grow, maintain its body and move around.
        i. For example, a mouse needs energy to move, stay warm, feed its young, and so on. The energy it uses cannot be passed on to the next trophic level.
        ii. Also, whenever energy changes forms, some is lost according to the Second Law of Thermodynamics.
    b. Only about 10% of the energy at any level is passed to the next level.
    c. This means that the more levels in a food chain, the less energy reaches the top so fewer organisms can be at the top of the chain.
    d. Biomass is the total of all organic matter at any level of a food chain. In natural ecosystems, the plant biomass is greater than the herbivore biomass which is greater than the carnivore biomass.
    e. A pyramid of energy shows the relative amounts of energy contained within each trophic level in a food chain.