

# Ecology: Limits of Energy Transfer

06 - 07 Lesson 7

Text Reference **1.11**, page 34 - 39

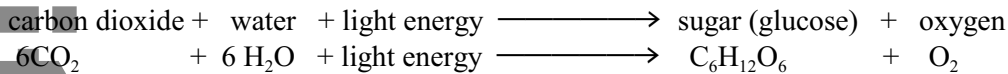
All living things need energy, to carry out their daily activities, organisms such as animals, fungi, and bacteria get their energy by consuming food.

All food webs are based on green plants: \_\_\_\_\_ . The producer provides the necessary energy link with the abiotic environment. The producer collects solar energy and basic nutrients and converts them to chemical energy through the chemical process \_\_\_\_\_ . This chemical energy is stored in plant structures such as roots and seeds, where it is usually called food energy.

## **Photosynthesis Equations**

Photosynthesis comes from three Greek words that mean "putting together with light".

Photosynthesis occurs in producers, i.e. plants, these are able to capture the energy from the Sun through pigments called chlorophyll formed in organelles called chloroplast, together with carbon dioxide from the atmosphere and form sugars and oxygen:

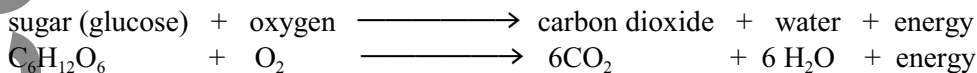


## **Cellular Respiration Equation**

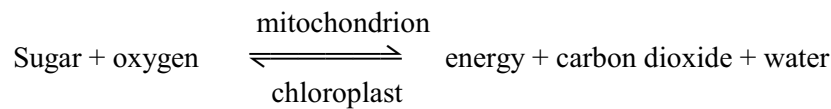
Respiration occurs in cells, in an organelle called the mitochondrion.

Respiration and photosynthesis occur constantly. During respiration, aerobic organisms break down or decay plant and animal materials, releasing carbon dioxide into the atmosphere.

The equation for cellular respiration is:



Together, they form a natural cycle called the carbon cycle. The carbon cycle is a nutrient cycle, illustrated as:



## **Flow of energy along the food chains:**

There is a constant flow of energy along food chains but each consumer uses or wastes nearly all the energy it takes in.

Food energy is used first of all by the plants themselves for their own life functions – to stay alive and to manufacture the chemicals they need to grow, thus less than 100% of the solar energy they collect is available as food energy for \_\_\_\_\_ .

Stored plant energy is transferred to animals when herbivores eat the plants. Energy stored in herbivores is transferred again when \_\_\_\_\_ eat the herbivores.

Herbivores likewise use much of the food energy for their own body functions - again less than 10% of the energy taken in is available for consumers at the next trophic level.

Some of the energy was lost as the plant respired, and some is lost as indigestible material which passes through the herbivore's gut. The same losses occur when carnivores eat herbivores, and to the end of the chain.



## **2. Pyramid of Numbers**

A pyramid based on number of organisms at each trophic level in an ecosystem is called a Pyramid of Numbers – it describes the **number of organisms that are required to feed the next trophic level**.

Pyramid of numbers is the easiest to construct and it assumes that each organism has the same amount of energy as the next.

Usually more organisms are found at lower trophic levels than at higher levels, because the producers and the primary consumers have the greatest numbers in a pyramid.

A large number of producers are required to support the food transfer through the food chain.

### **Assignment:**

Create a pyramid of numbers, given the following information: 85 000 blades of grass, 8 500 beetles, 850 sparrows, 85 snakes, 8 hawks.

There are many **exceptions** due to various reasons, for example, due to the physical size of the members of a food chain, example: For every one tree there are many more insects feeding on it; or as in early spring, when many more consumers arrive before an appreciable number of producers do — these situations would lead to an inverted pyramid.

A pyramid of numbers does not show energy flow because of the great disparity in the size of the organisms.

## **3. Pyramid of Biomass**

Another useful way to represent an ecosystem is through a pyramid of biomass. Ecologists must **directly** measure mass. Mass **must** be dry.

However, a pyramid of biomass is most difficult to use in the field, it also assumes that 1 g of a species has the same energy as 1 g of another species; it does not consider the energy contribution of each organism: e.g. 1 kg of grain is not equivalent in energy to 1 kg of chicken.

**Definition: Biomass:** weight of matter after the water content has been removed after drying.

Biomass is based on the total dry mass, (after water has been removed), of the organisms at each trophic level, and it shows the energy available in each trophic level of an ecosystem.

Under natural conditions, the amount of biomass decreases progressively with each higher step of the pyramid.

**Assignment:** Create a pyramid of biomass, given the following information:

1. 50 000 kg of roots, 5000 kg of mice, 500 kg of snake, 5 kg of hawk.

2. 900 g moss, algae → 45 g duck → 9 g falcon

A pyramid of biomass is slightly more useful than a pyramid of numbers because it takes into account of the size of the organisms, a pyramid of energy is the most useful.

### **Laws of Thermodynamics**

Two basic laws govern the flow of energy through an ecosystem.

The first law describes the way in which energy flows through an ecosystem:

- as transfers through food chains – from the sun to producers,
- to consumers to top carnivore.

To complete the nutrient cycle, this energy needs to be replaced.

The second law describes the continual replacement of nutrients through exchanges between producers and consumers. These laws shape the way organisms in ecosystems interact with one another.

The first law of thermodynamics:

the total amount of energy in a system remains constant but it can be transformed from one form into another; it can not be created or destroyed.

The second law of thermodynamics:

during any energy transformation, some energy is lost, usually in the form of heat.

### **Summary**

A pyramid of energy shows the total chemical energy being passed along each organisms to use at subsequently higher trophic levels.

A pyramid of numbers shows that organisms in lower trophic levels are usually more abundant than organisms in higher trophic levels.

A pyramid of biomass shows biomass decreasing among organisms in subsequently higher trophic levels.

### **Homework**

1. Read pages 34 - 38
2. Answer: Understanding Concepts, page 39, # 1 – 13
3. Worksheet: Energy and Types of Pyramids