ENERGY FLOW THROUGH A COMMUNITY

BASIC DEFINITIONS/CONCEPTS - 1

POPULATION **is a group of individuals belonging to the** ***SAME SPECIES*** **living and interacting together in a given area.**

COMMUNITY **is a group of** ***DIFFERENT*** **populations living and interacting together in a given area.**

ECOSYSTEM **is a group of** ***DIFFERENT*** **communities living and interacting together in a given area.**

BASIC DEFINITIONS/CONCEPTS -2

ENERGY TRANSFER is the flow of energy through a community in association with a food chain or web.

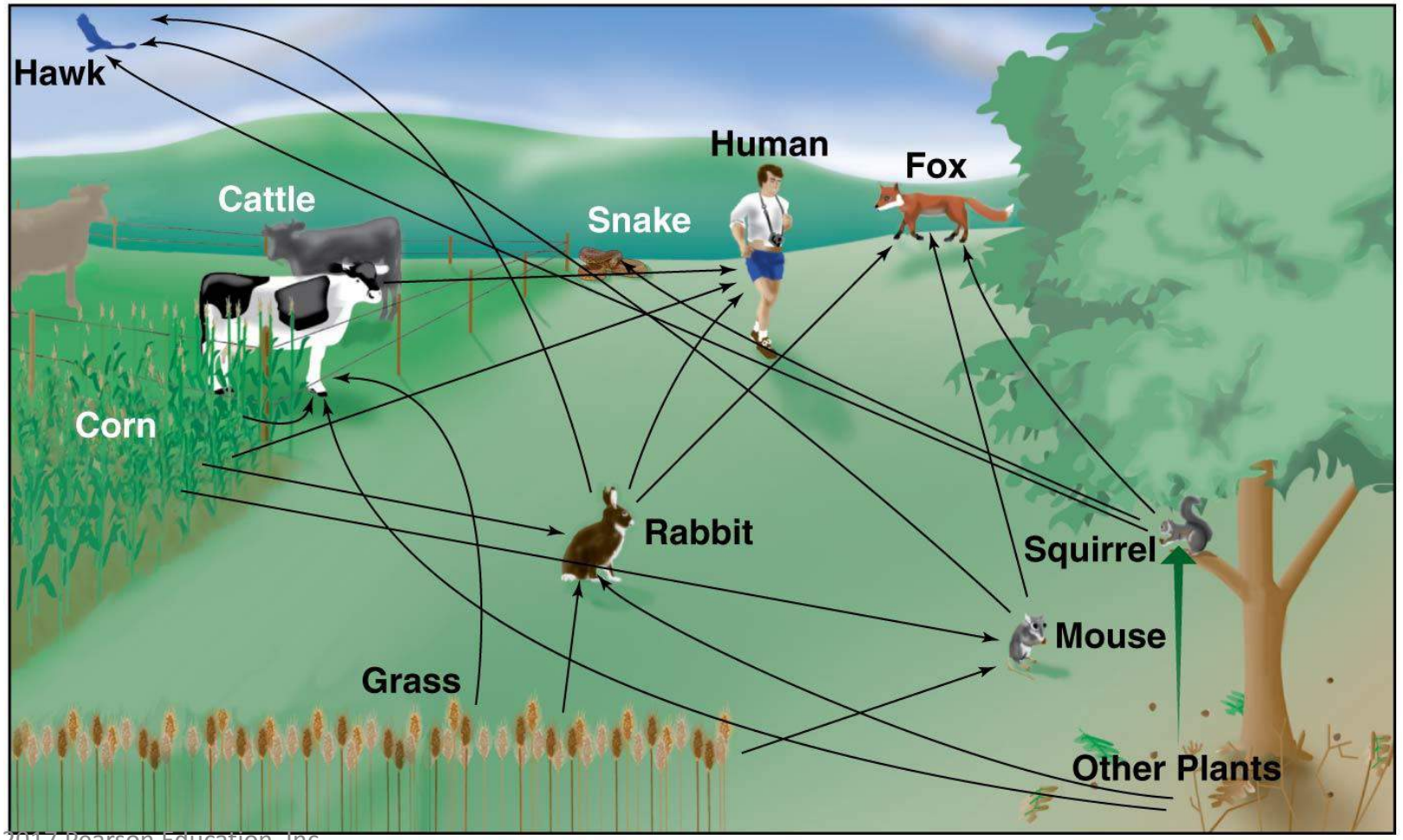
FOOD CHAIN or FOOD WEB describes the feeding relationships within a community.

TROPHIC LEVEL is the position an organism occupies within a food chain or food web.

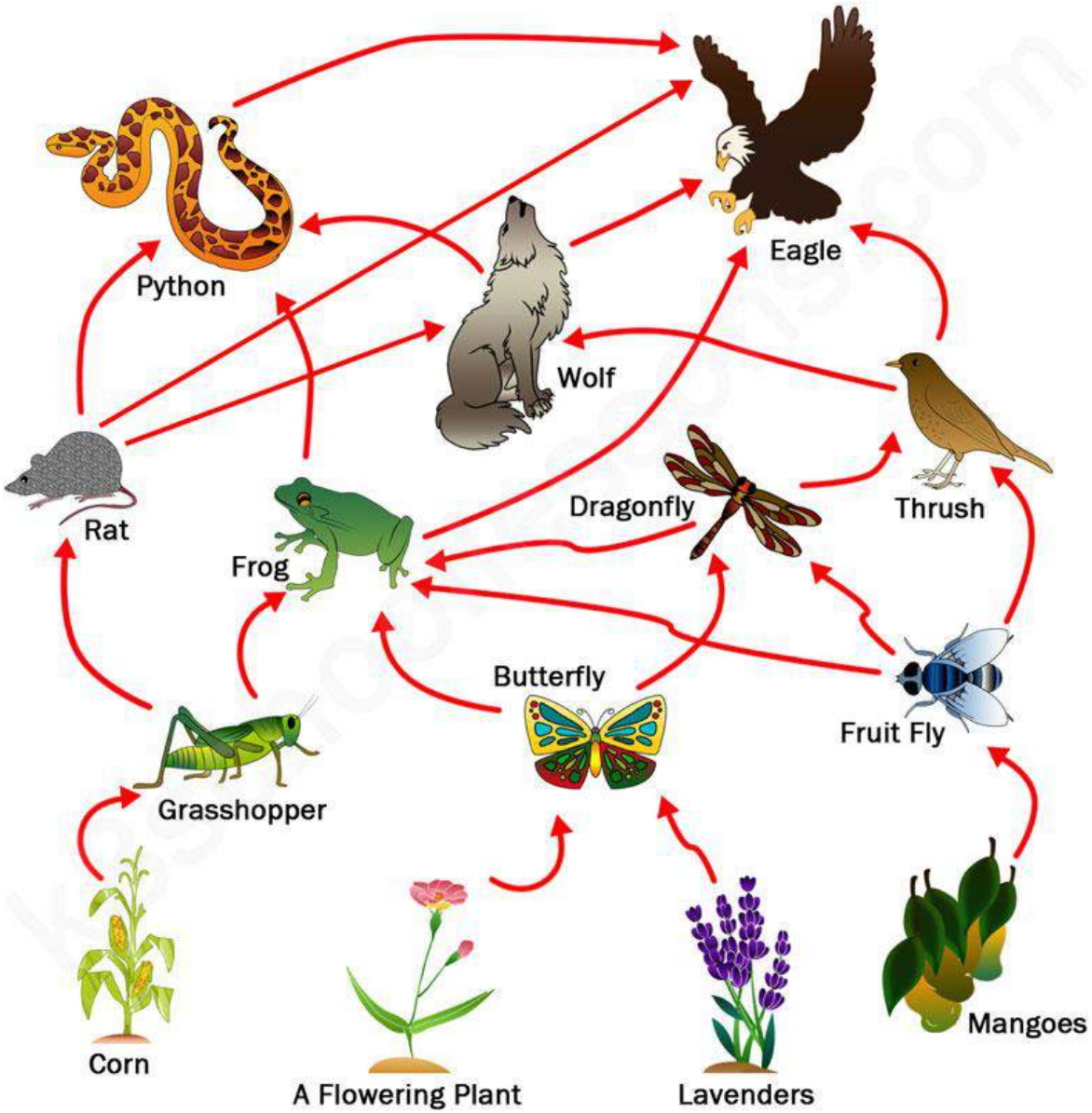
There are **TWO BASIC TROPHIC LEVELS**:

a) PRODUCERS
b) CONSUMERS

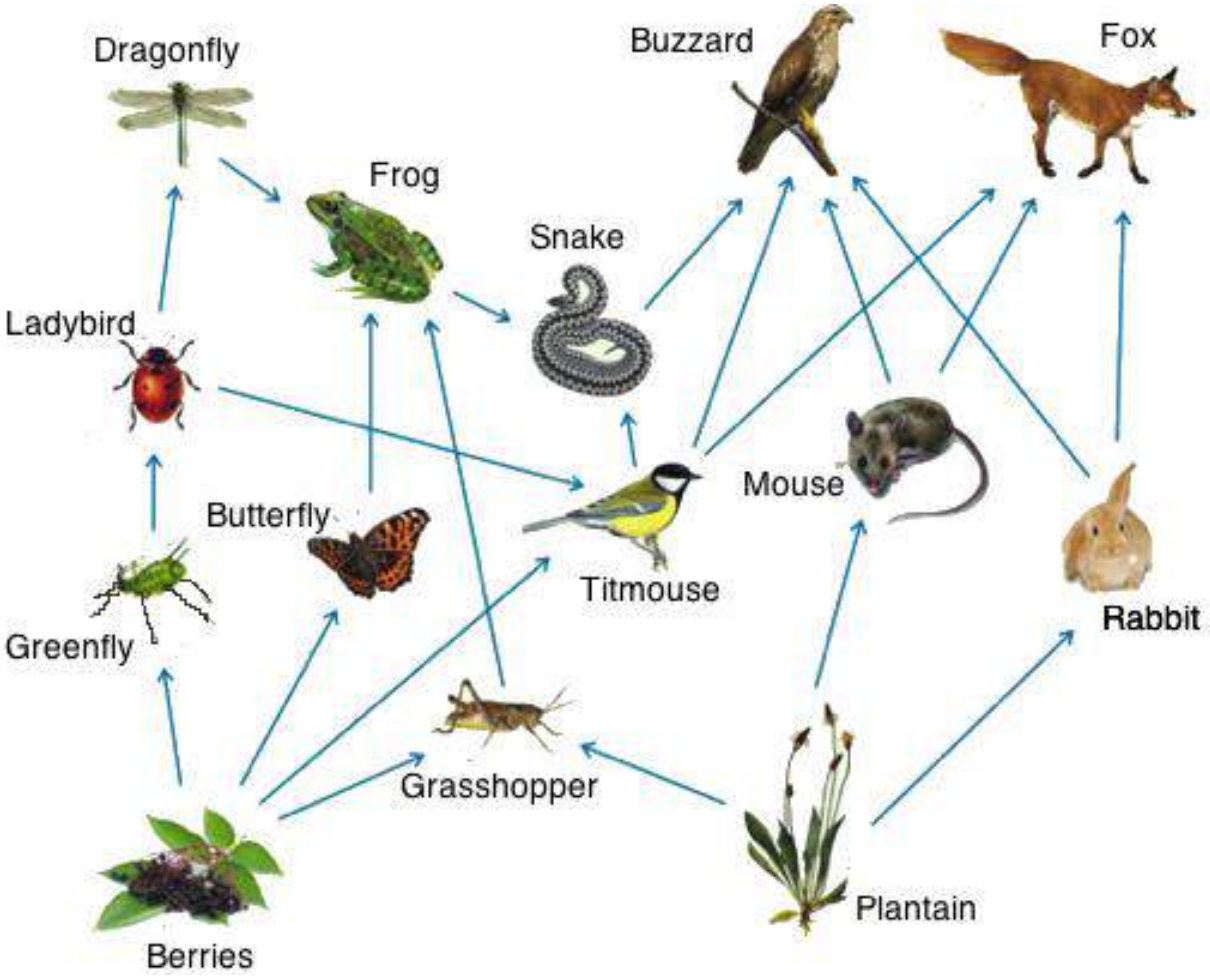
A meadow food web



A Food Web


Python
Eagle
Wolf
Rat
Frog
Dragonfly
Thrush
Butterfly
Fruit Fly
Grasshopper
Corn
A Flowering Plant
Lavenders
Mangoes

ANOTHER FOOD WEB



BASIC TROPHIC LEVELS

- **PRODUCERS (AUTOTROPHS) produce their own food from inorganic molecules by photosynthesis**
  - **Producers are plants, photosynthetic microorganisms, and bacteria**
- **CONSUMERS (HETEROTROPHS) can not make their own food so they must consume organic material for energy by eating other organisms**
  - **Consumers: eat living prey**
  - **Decomposers: break down dead organic material**
- **Organisms produce food, pass it along the food chain, and return materials to the environment**

CONSUMER LEVELS

- **Consumers can be classified by how far removed from the producer level they are or by what they eat**
- **Are categorized according to their food source**
  - **PRIMARY CONSUMERS(HERBIVORES)**: eat producers
  - **SECONDARY CONSUMERS (CARNIVORES)**: eat primary consumers
  - **TERTIARY CONSUMERS (CARNIVORES)**: eat secondary consumers

ANIMALS CAN OCCUPY DIFFERENT TROPHIC LEVELS

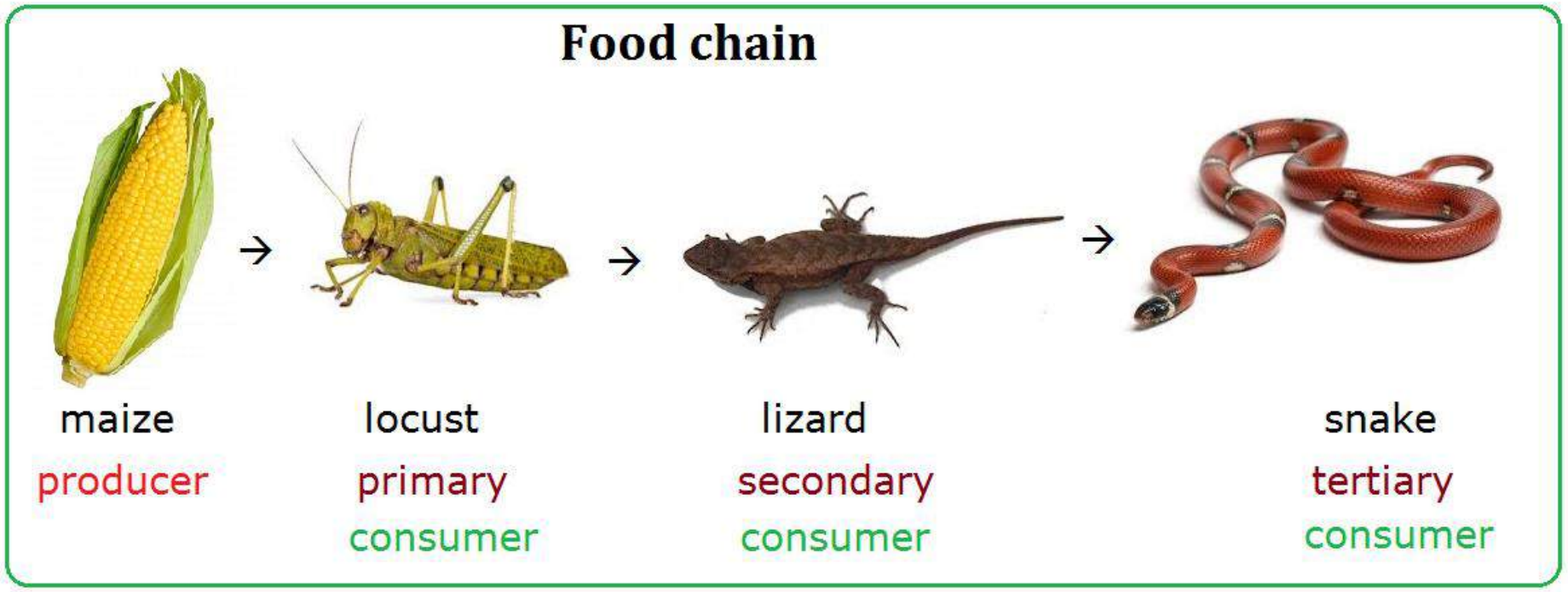
This depends on the food they eat

CARNIVORES: **can be Primary or Secondary and sometimes Tertiary consumers**

OMNIVORES: **feed on both plants and animals**

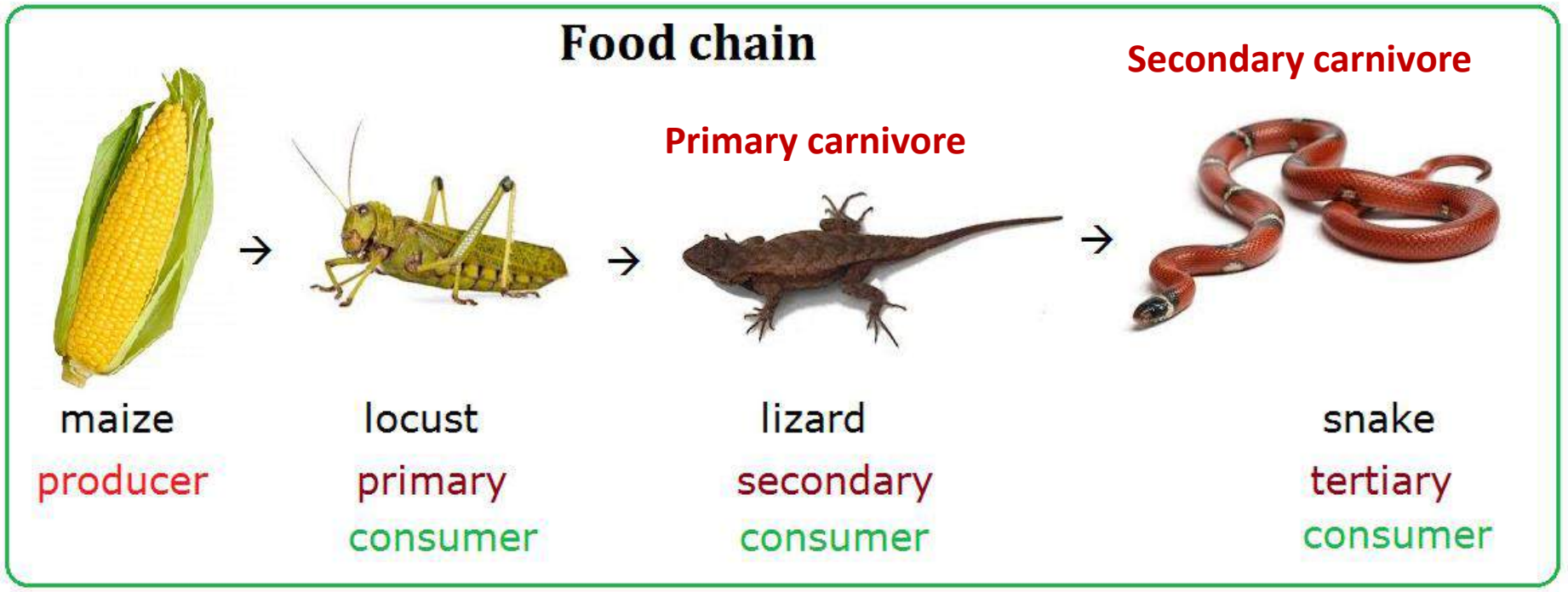
A RULE FOR DETERMINING THE LEVEL OF CONSUMER

DETRMINE HOW FAR REMOVED FROM THE PRODUCER LEVEL A CONSUMER IS. For example: HERBIVORES are *one trophic level removed* from the producer level, so they are classified as PRIMARY CONSUMERS. The first CARNIVORE LEVEL is *two trophic levels removed* from the producer level, so they are classified as a SECONDARY CONSUMER, etc. (see illustration below)

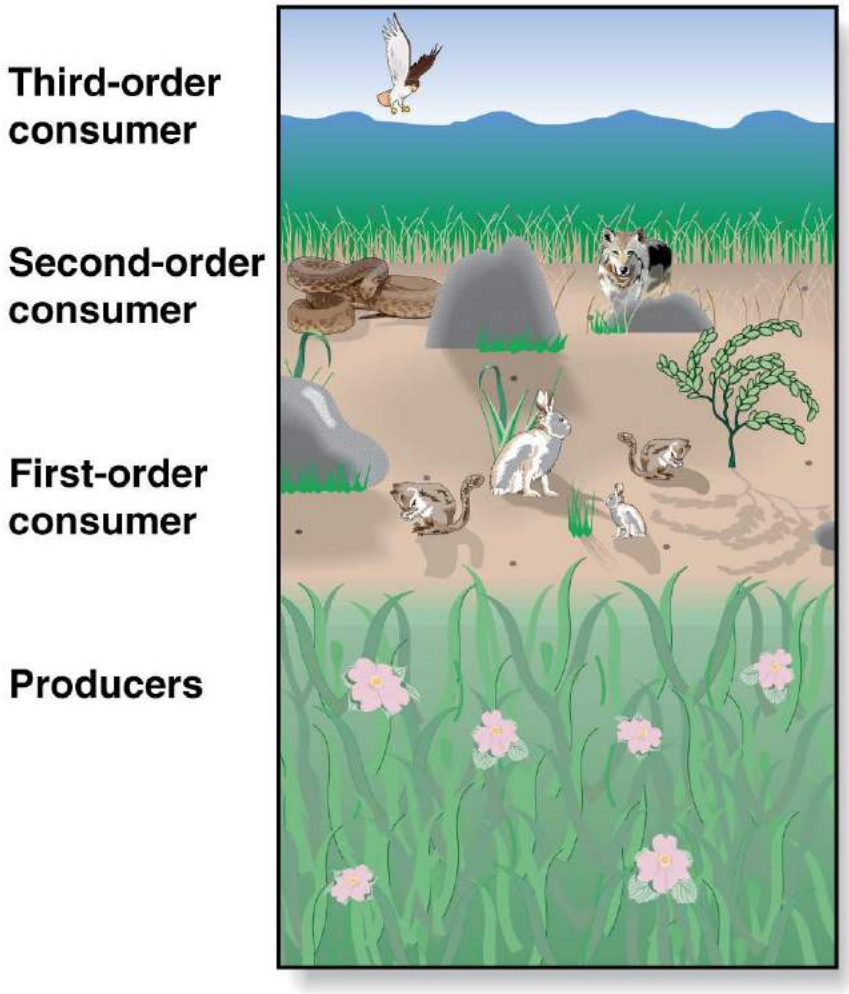


A RULE FOR DETERMINING THE LEVEL OF A CARNIVORE

DETRMINE HOW FAR REMOVED FROM THE HERBIVORE LEVEL A CARVINVORE IS. For example: **CARNIVORES** that are ***one trophic level removed*** from the producer level, so they are classified as **PRIMARY CARNIVORE**. The second **CARNIVORE LEVEL** is *two trophic levels removed* from the herbivore level, so they are classified as a **SECONDARY CARNIVORES**, etc. (see illustration below)



Trophic levels in a grassland



This grassland food chain shows producers and several levels of consumers

PRODUCERS

HERBIVORES (PRIMARY CONSUMERS)

CARNIVORES (SECONDARY OR HIGHER LEVELS OF CONSUMERS)

ADDITIONAL CONSUMERS

OMNIVORES: feed on more than one trophic level at a time, thus they feed on both plants and animals

DECOMPOSERS: organisms, usually a bacterium or fungus, that breaks down the cells of dead plants and animals into simpler substances.

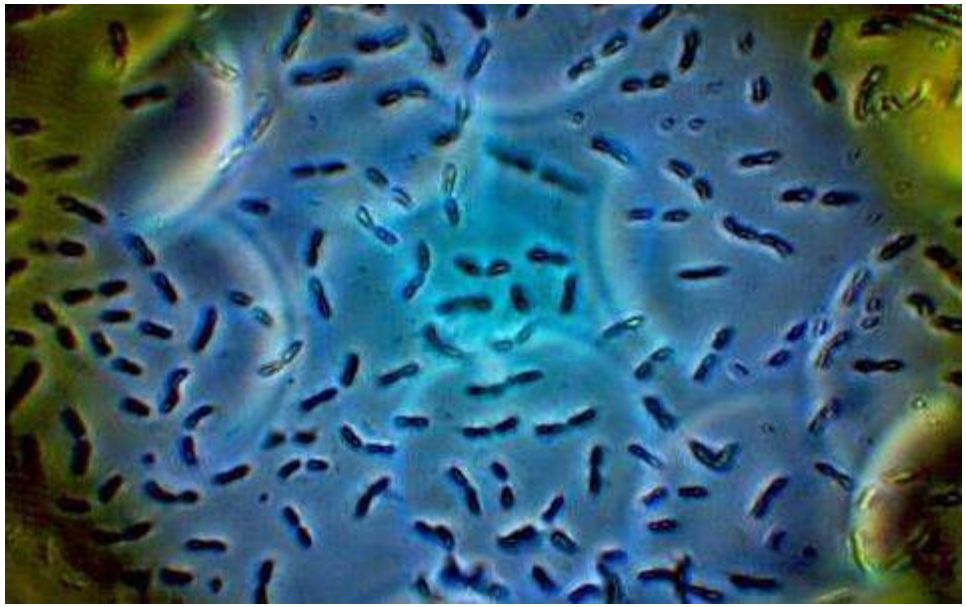
OMNIVORES

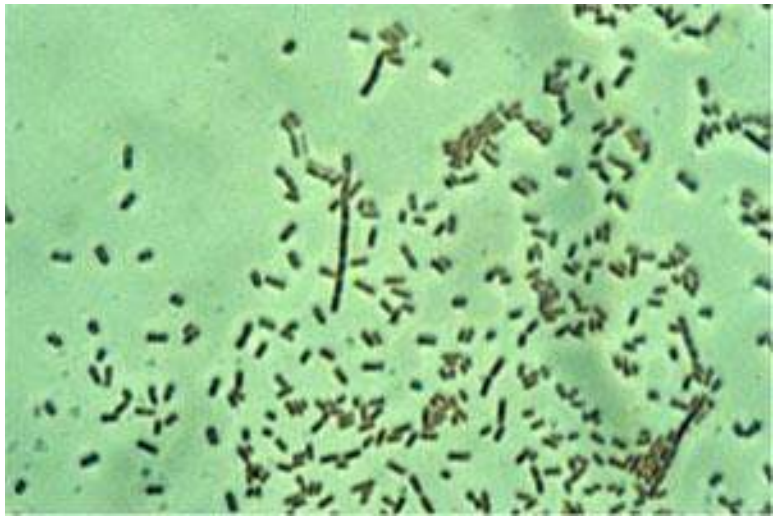
DECOMPOSERS

Microorganisms like bacteria and fungi can be DECOMPOSERS. Decomposers feed on the dead bodies of producers and consumers decomposing them into simpler compounds. The inorganic nutrients and other organic compounds released during the decomposition process are then utilized by producers synthesis of other compounds.

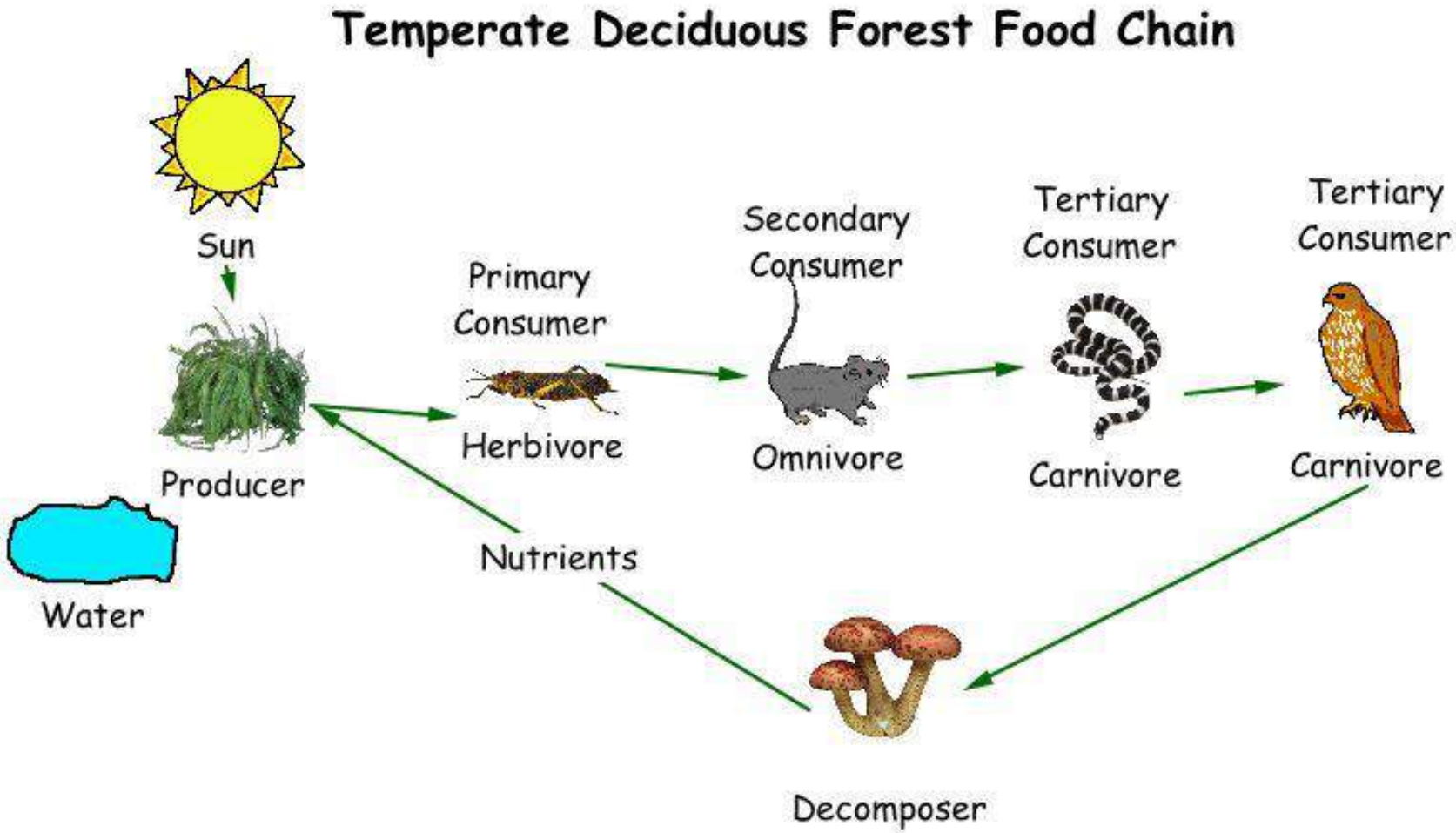

Decomposers
Organisms, such as fungi, that break down the remains of, or waste from, other organisms.

BACTERIAL DECOMPOSERS





A FOOD CHAIN WITH A DECOMPOSER COMPONENT



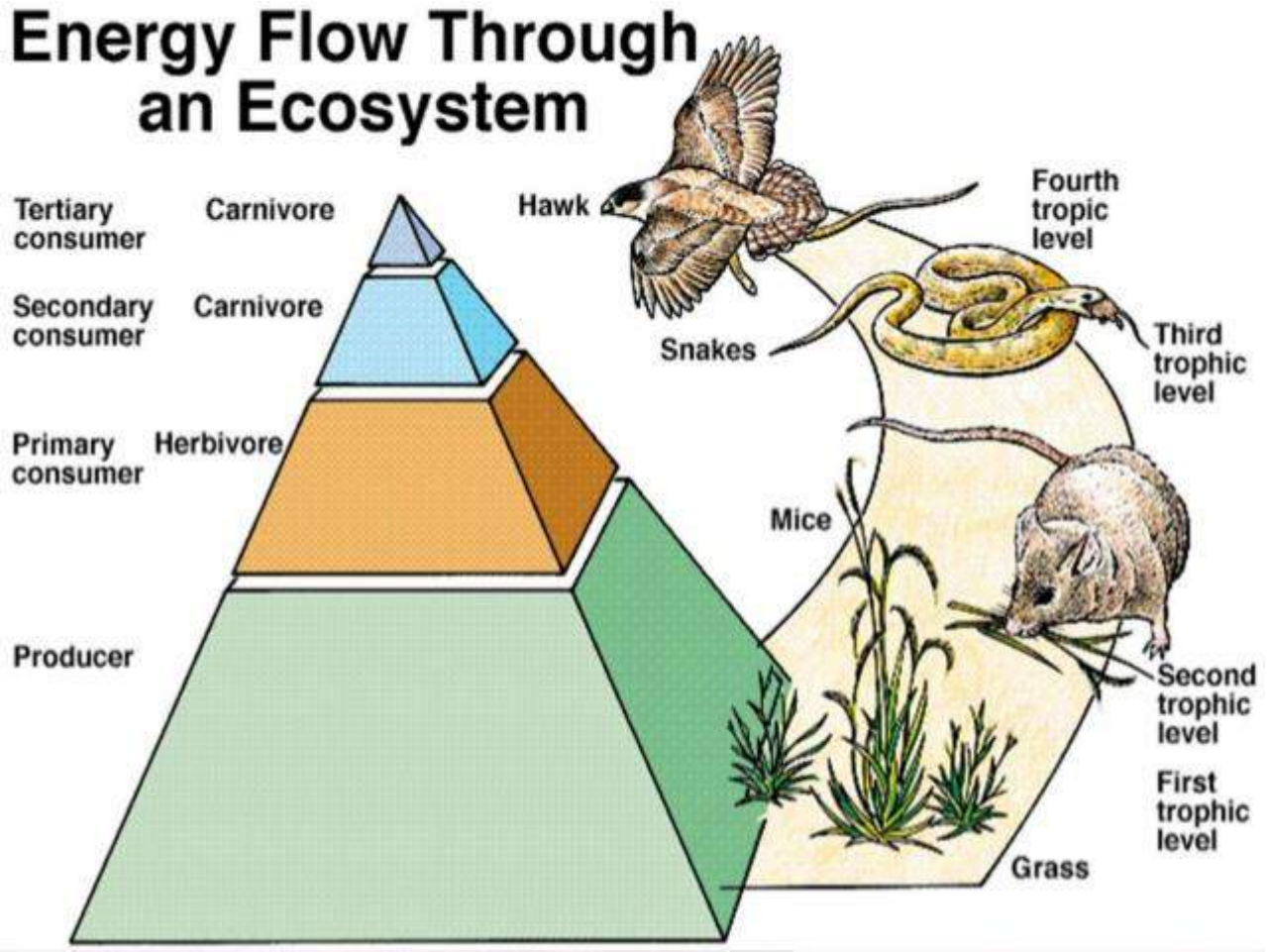
SOME ENERGY PRINCIPLES

PHOTOSYNTESIS is the conversion of solar energy into chemical energy. The primary product of photosynthesis is the sugar **GLUCOSE** which contains lots of useable energy in its chemical bonds.

CELLULAR RESPIRATION (CR) is the conversion of the energy in the bonds of glucose into other forms of energy for use by the organism in various processes (chemical synthesis, movement, etc.) with the release of heat and other waste products such as water and oxygen.

Energy flow in a community (or ecosystem) is always one way, decreasing in useable amounts as it moves from one trophic level to the next. The general rule of energy transfer is: ***only 10% of available energy stored in one trophic level gets stored in the tissues of the organisms in the next trophic level up*** **(=RULE OF 10)**. 90% of the available energy in a trophic level goes to the organisms' cellular respiration.

One law of thermodynamics states that **ENERGY CAN BE NEITHER CREATED NOR DESTROYED, ONLY CHANGED FROM ONE FOR TO ANOTHER ALWAYS BECOMING LESS CONCENTRATED IN THE EXCHANGE PROCESS.**



Note that the size of the blocks in the pyramid narrow and become smaller it goes up through the food chain. This is a reflection of the loss of energy from one trophic level to the next (Rule of 10) as well as a decrease in the number of individuals that can be supported by the energy transfer in each level.

PRODUCTIVITY

PRODUCTIVITY is the amount of energy formed by a community, ecosystem, etc. in a specific time period

Productivity can be either PRIMARY PRODUCTIVITY (energy formed by the producer level by photosysnthesis) or SECONDARY PRODUCTIVITY (energy stored in the tissues of consumers

PRIMARY PRODUCTIVITY

Primary productivity refers to the amount of energy produced through photosynthesis by the individuals in the producer level

There are two types:

- **GROSS PRIMARY PRODUCTIVITY (=GPP)**
- **NET PRIMARY PRODUCTIVITY (=NPP)**

GROSS PRIMARY PRODUCTIVITY is the total amount of energy produced through photosynthesis by the individuals of the producer level in a given time period

NET PRIMARY PRODUCTIVITY is the amount of energy stored in the tissues of producers

The relationship between the two types of productivity is:

NPP = GPP – CR, where CR = the energy used in cellular respiration

PRIMARY PRODUCTIVITY

SECONDARY PRODUCTIVITY (SP) is the amount of energy stored in the tissues of consumers

The general formula for estimating the SP of a specific consumer trophic level is:

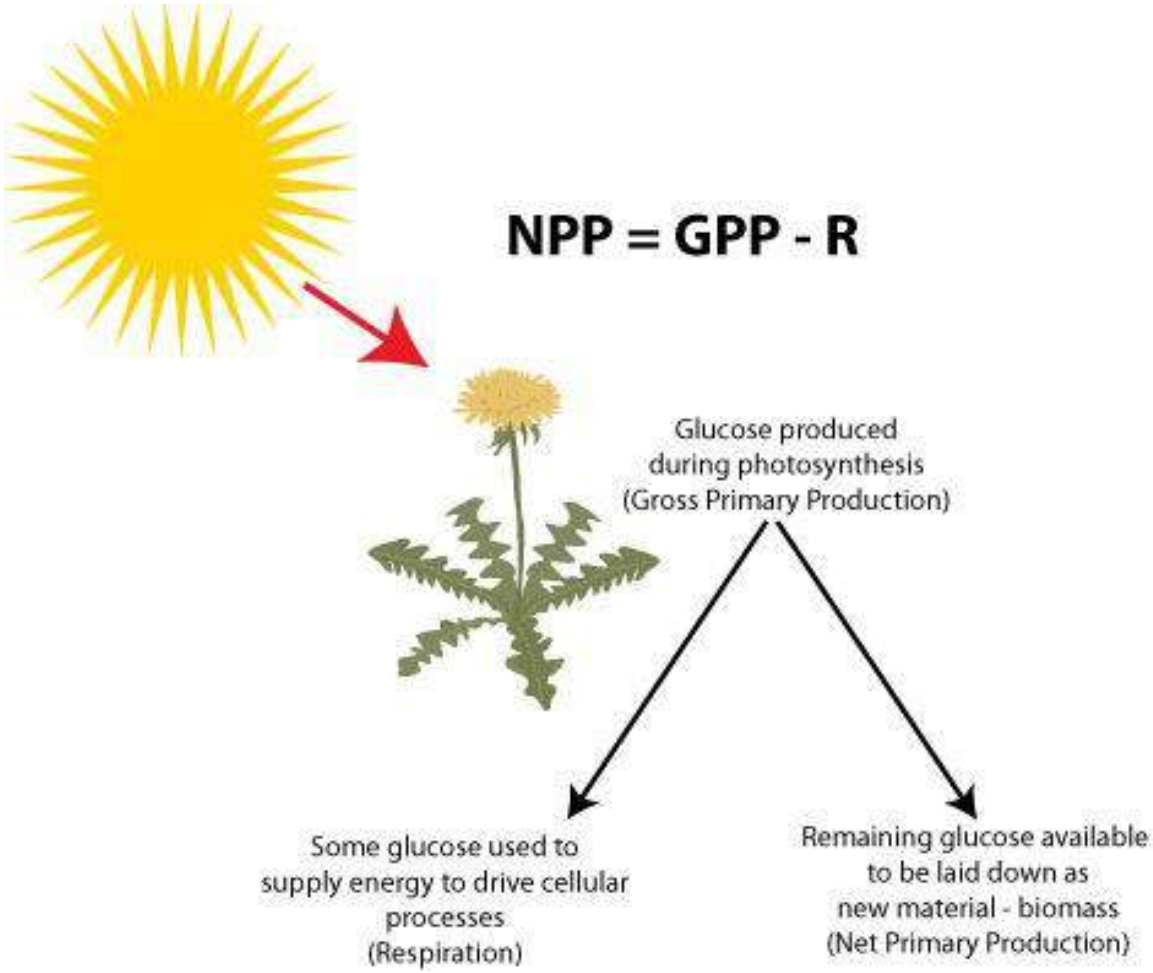
SP_X = ENERGY IN THE FOOD TAKEN IN – $CR_{X,}$ where x = the trophic level under discussion

Examples:

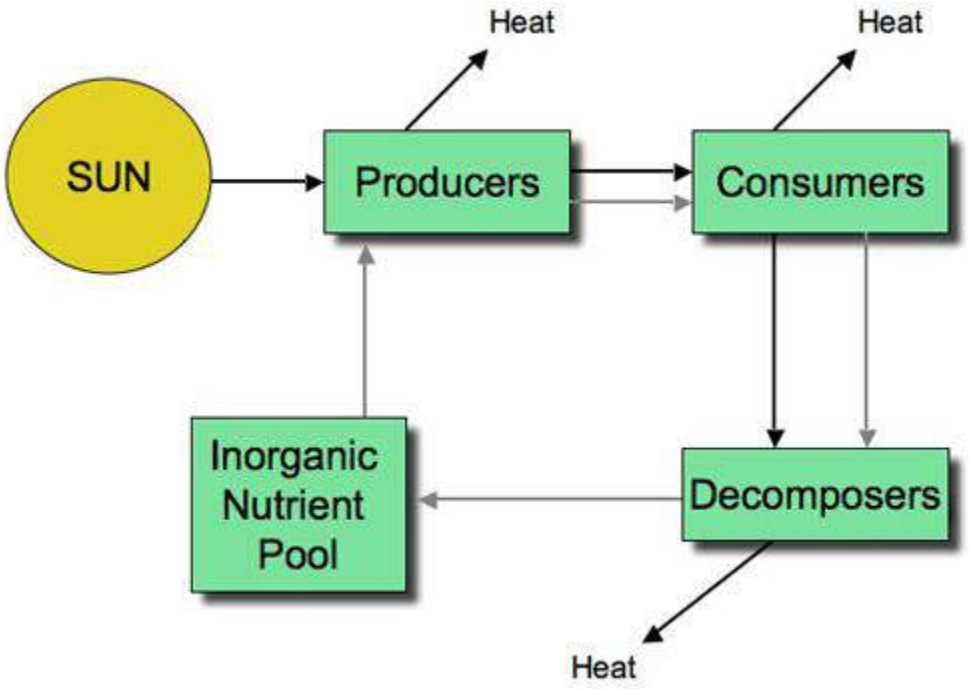
SP_{cow} = NPP of grain – CR_{cow}

SP_{eagle} = SP_{snake} – CR_{eagle}

NOTE: NPP can only be used as an energy food intake when plant materials are being eaten by a consumer (i.e., by an herbivore or by an omnivore)


NPP = GPP - R
Glucose produced
during photosynthesis
(Gross Primary Production)
Some glucose used to
supply energy to drive cellular
processes
(Respiration)
Remaining glucose available
to be laid down as
new material - biomass
(Net Primary Production)

BASIC SUMMARY OF ENERGY FLOW



QUIZ ON ENERGY FLOW

1) Examine slide #2. What trend do you see in the definitions of a population, community and ecosystem?
2) If 10 units of energy were available in the producer level of a 5 level food chain, how much energy would be stored in the tissues of a tertiary consumer in that food chain?
3) George's lunch consisted of a bacon cheeseburger with cheese, lettuce, and tomato; French fries; and coffee with cream. Write an equation for George's SP from that meal.