

Energy Flow

INTRODUCTION

- All ecosystems must have a source of energy (usually the sun) because all organism functions such as growth and reproduction require energy. Energy moves through the ecosystem by a series of events that link organisms together.
- Plants have green pigments, called chlorophyll which captures energy from the sun (solar energy) to split carbon dioxide atoms and then combine the carbon atoms with oxygen and hydrogen (photosynthesis) to make sugars (food).
- Solar energy is transformed into chemical energy stored in the bonds that hold the atoms of the sugar molecules. Oxygen also is released. Plants are essential to all ecosystems because they produce oxygen and food needed by all other living things.

PHOTOSYNTHESIS

- Carbon dioxide + water + sunlight + nutrients → Simple sugar + oxygen
(energy) (food)
- Some sugars produced during photosynthesis are broken down during respiration to release energy needed by the plant for growth and reproduction. Others are used to make "building blocks" that are combined to make plant cells, hence plant parts.

RESPIRATION

- Simple sugar (food) + oxygen \rightarrow Carbon dioxide + water + energy (heat)
- Animals that eat plants (herbivores) use them to make animal parts or burn them to produce energy for their cell functions. Any compounds not used immediately are combined and stored as fats. Tissues of animals eaten by other animals (predators/carnivores) are broken down and re-combined into new parts for that animal, and so on.

TROPIC LEVELS

- The different feeding levels in the food chain are called trophic levels.
- Food chains comprised of many feeding or nourishing levels, and each level is called trophic level.
- The first trophic level in the food chain is called primary producers, the second trophic level is the primary consumers (herbivores), and the third level is occupied by the primary carnivores.

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- The number of trophic levels in a food chain is always restricted to 3 to 5.
 - Lower the number of trophic levels, higher the transfer of energy to the top level organisms in the food chain.
 - The energy transfer will be very less to the top predator, if the food chain is having more than three levels of trophic tiers.

ENERGY FLOW

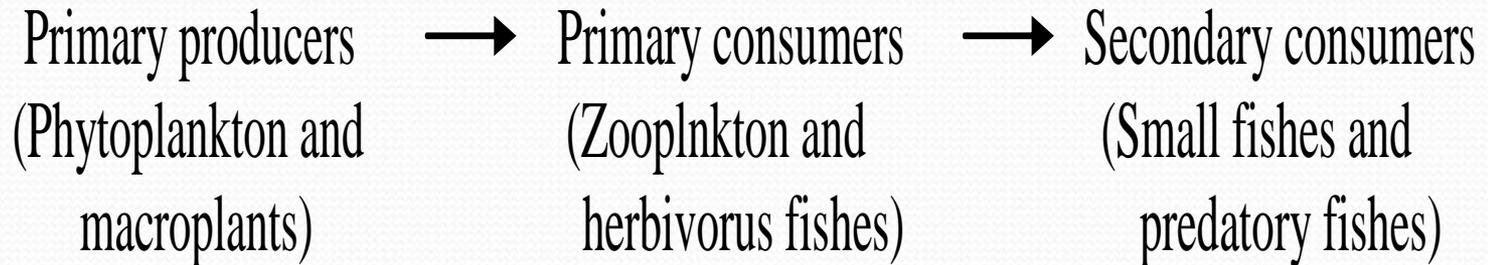
- The transfer of energy from one trophic level to another is called energy flow.
- This flow of energy is always unidirectional and never returns back, like nutrients, which cycles in the ecosystem. So, energy can be utilised once in the ecosystem and otherwise it will go as waste heat.
- Green plants or other photosynthesizing organisms use light energy from the sun to manufacture carbohydrates for their own needs.

- Most of this chemical energy is processed in metabolism and dissipated as heat in respiration. Plants convert the remaining energy to biomass.
- Ultimately, this material, which is stored energy, is transferred to the second trophic level, which comprises grazing herbivores, decomposers, and detrital feeders.
- Most of the energy assimilated at the second trophic level is again lost as heat in respiration; a fraction becomes new biomass.

- Organisms in each trophic level pass on as biomass with much less energy than they receive.
- Thus, the more steps between producer and final consumer, the less energy remains available. Seldom are there more than four links, or five levels, in a food web.
- Eventually, all energy flowing through the trophic levels is dissipated as heat.
- The process whereby energy loses its capacity to do work is called entropy.

FOOD CHAIN

- The biotic components of any ecosystem are linked with each other by food. This food relationship with other organisms is termed a food chain.
- The sequence of eaters being eaten is called food chain. A simple food chain may start with microscopic green algae. Microscopic zooplankton will serve as food for the small fishes.



TYPES OF FOOD CHAIN

i) Grazing food chain

- The producers are the green plants, which prepare their own food in the presence of sunlight. So, they are also called as Autotrophs. The herbivorous animals eat the plants (autotrophs/ primary producers).
- The carnivores eat the herbivorous animals. Thus, the grazing food chain starts with primary producers and ends with carnivores.

Plants → herbivores → primary carnivores → secondary carnivores
(phytoplankton) (zooplankton) (zooplankton feeding fish) (predatory fish / aquatic snakes)

a) Predator food chain

- In this food chain one animal kills and eat the other animals.
- The animal which kills other animals for food is called a predator. This act of hunting is called predation.
- Animals that are caught and eaten by a predator are called prey. Predators that only eat the meat of prey are carnivores

b) Parasitic food chain

- The plants and animals of the grazing food chain are affected by parasites. Parasites derive their energy from their hosts.

Detritus food chain:

It starts from the dead organic matter and ends with inorganic matter. This consists of decomposers like fungi and bacteria.

- These live on the dead matter of the organism and decompose the organic matter and convert to inorganic matter, which is helpful for plants to prepare their food.
- However, these two food chains cannot function separately and are interconnected with each other at different levels.
- The organisms of detritus chain may serve as food for the organisms of grazing food chains

FOOD WEB

Food web is a set of interconnected food chains by which energy and materials circulate within an ecosystem.

The food web is divided into two broad categories:

The grazing web

which typically begins with green plants, algae, or photosynthesizing plankton, and the detrital web, which begins with organic debris.

Detrital web

Materials pass from plant and animal matter to bacteria and fungi (decomposers), then to detrital feeders (detritivores), and then to their predators (carnivores).

ECOLOGICAL PYRAMID

- An ecological pyramid (or trophic pyramid) is the graphical representation of the trophic structure such as number, biomass and energy of an ecosystem.
- Ecological pyramids begin with producers on the bottom and proceed through the various trophic levels, the highest of which is on top.
- There are three types of ecological pyramids, viz. i) pyramid of numbers, ii) pyramid of biomass and iii) pyramid of energy

i) Pyramid of number

- A pyramid of numbers shows the number of organisms at each trophic (relating to nutrition) level.
- In pyramids of numbers, the number of individuals at the trophic level decreases from the producer level to the consumer level.
- In an ecosystem, the number of producers is far high and the number of consumers in the subsequent trophic levels, are lesser than that of the producers.

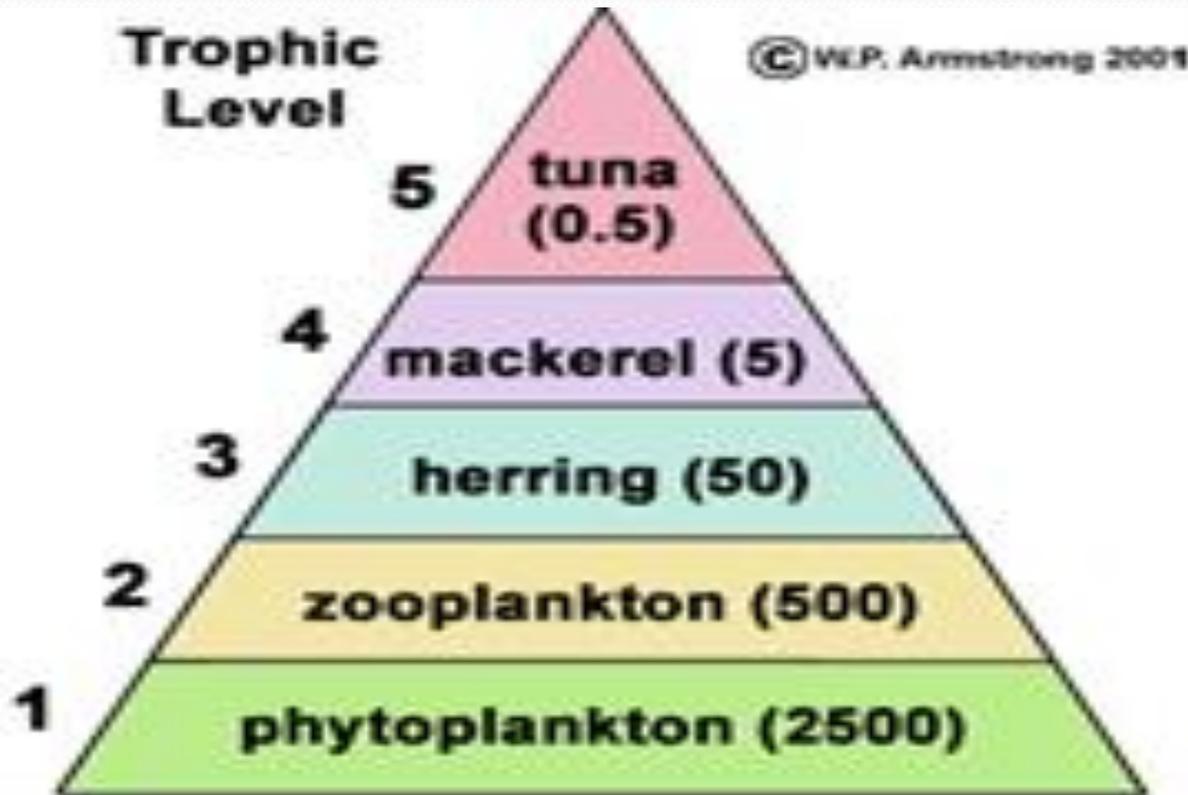
Example: In a pond ecosystem, the number decreases in the following order

Phytoplankton → Zooplankton → Small fishes → Large predatory fishes/ snakes

ii) Pyramid of biomass

- Biomass refers to the total weight of the living organisms in a unit area.
- An ecological pyramid of biomass shows the relationship between biomass and trophic level by quantifying the amount of biomass present at each trophic level.
- In the pyramid of biomass, there will be a clear cut decrease in the biomass from the lower to the higher trophic levels.
- Generally, the pyramid of biomass is an upright one (the apex is pointed upwards) in all terrestrial ecosystems. In certain ecosystems like pond ecosystem, the pyramid of biomass is an inverted type of pyramid (apex is pointed downwards).

In this type of ecosystem, which contain less amount of biomass of producers and more amount of biomass of consumers (fishes).



(iii) Pyramid of energy

- At each trophic level in the food chain, energy that was originally stored by the autotrophic plants is dissipated along the food chain.
- When the links or levels in the food chain are more, the dissipated or unusable energy will also be more.
- There is generally a 90 percent loss at each level of the food chain, creating a pyramid-shaped diagram that is wider at the bottom and narrow at the top.
- **Example:** In a pond, maximum energy is stored by the phytoplankton. Then, the energy decreases when it is transferred to the subsequent consumer levels.