Environmental Studies

Unit-1 Lecture-II

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Introduction

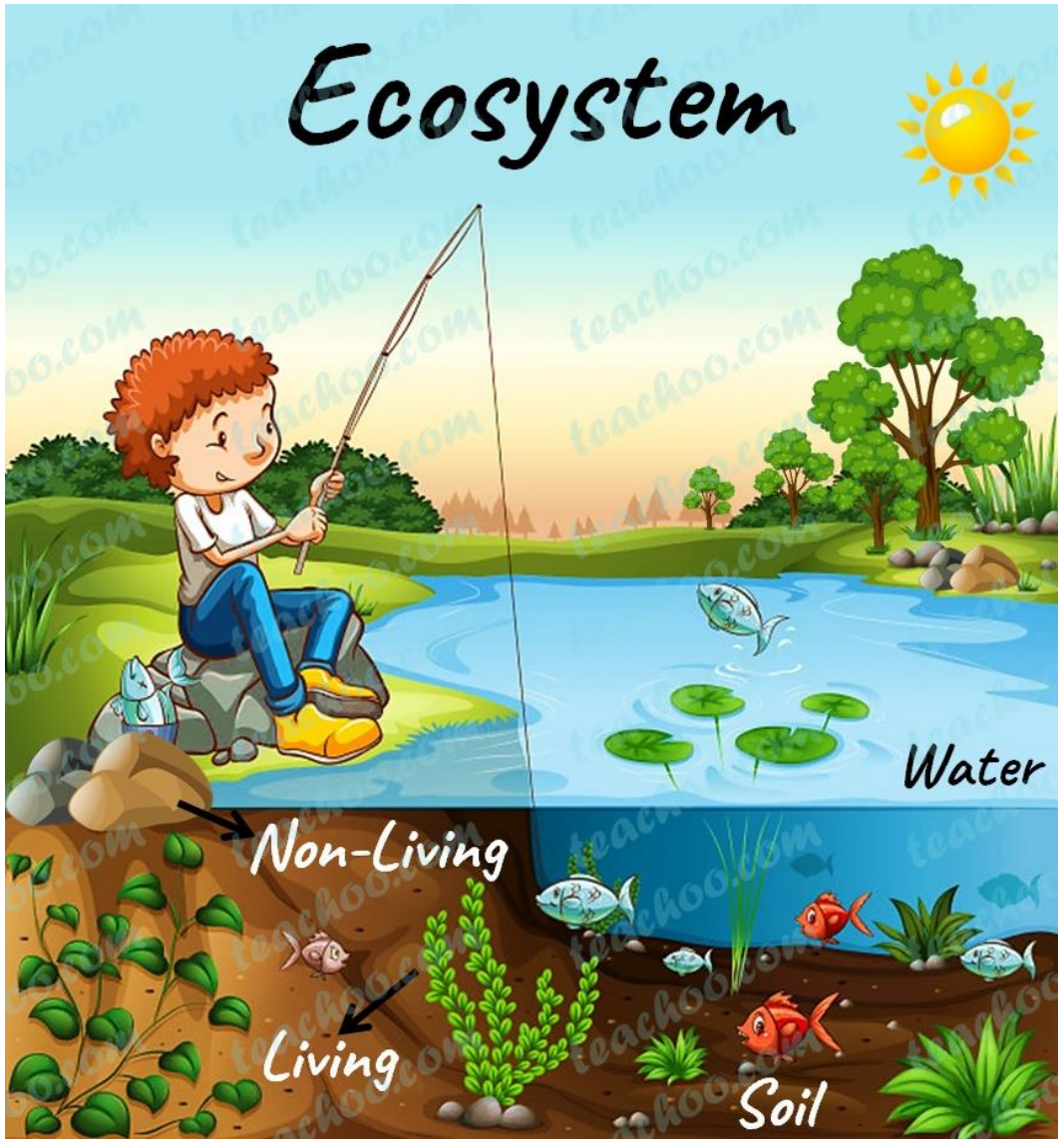
- The term ‘Ecology’ was coined by Earnst Heckel in 1869
- **Definition**- it is defined as a scientific study of the relationship of the living organisms with each other and their environment
- It deals with the way each and every organisms is connected to its environment and how the environmental factors affect its life
- Ecology is derived from the word ‘ Oikos’ which means home or place of living and ‘logos’ means study

Environment and Its Components

- Everything that surrounds or affects an organism during its life time is collectively known as its environment
- Therefore, environment is defined as the sum total of living, non-living components
- All organisms from virus to man are dependent upon other organisms and environment for food, energy, water, oxygen, shelter and for other needs
- The relationship between organisms and its environment is highly complex
- It comprises both of living and non living components

Environment and Its Components

- The environment is not static
- Components of the environment
  - Biotic (living) components
  - Abiotic (non-living) components
- Both biotic and abiotic components are in flux and keep changing continuously



Environment and Its Components

- **Biotic components**
  - Green Plants
  - Non-green Plants
  - Decomposers
  - Parasites
  - Animals
  - Man
- **Abiotic components**
  - Energy- Radiation
  - Temperature and Heat Flow
  - Water/ Rain
  - Atmospheric gases/wind
  - Topography/Soil
  - pH

Biotic and Abiotic Components eg. fish

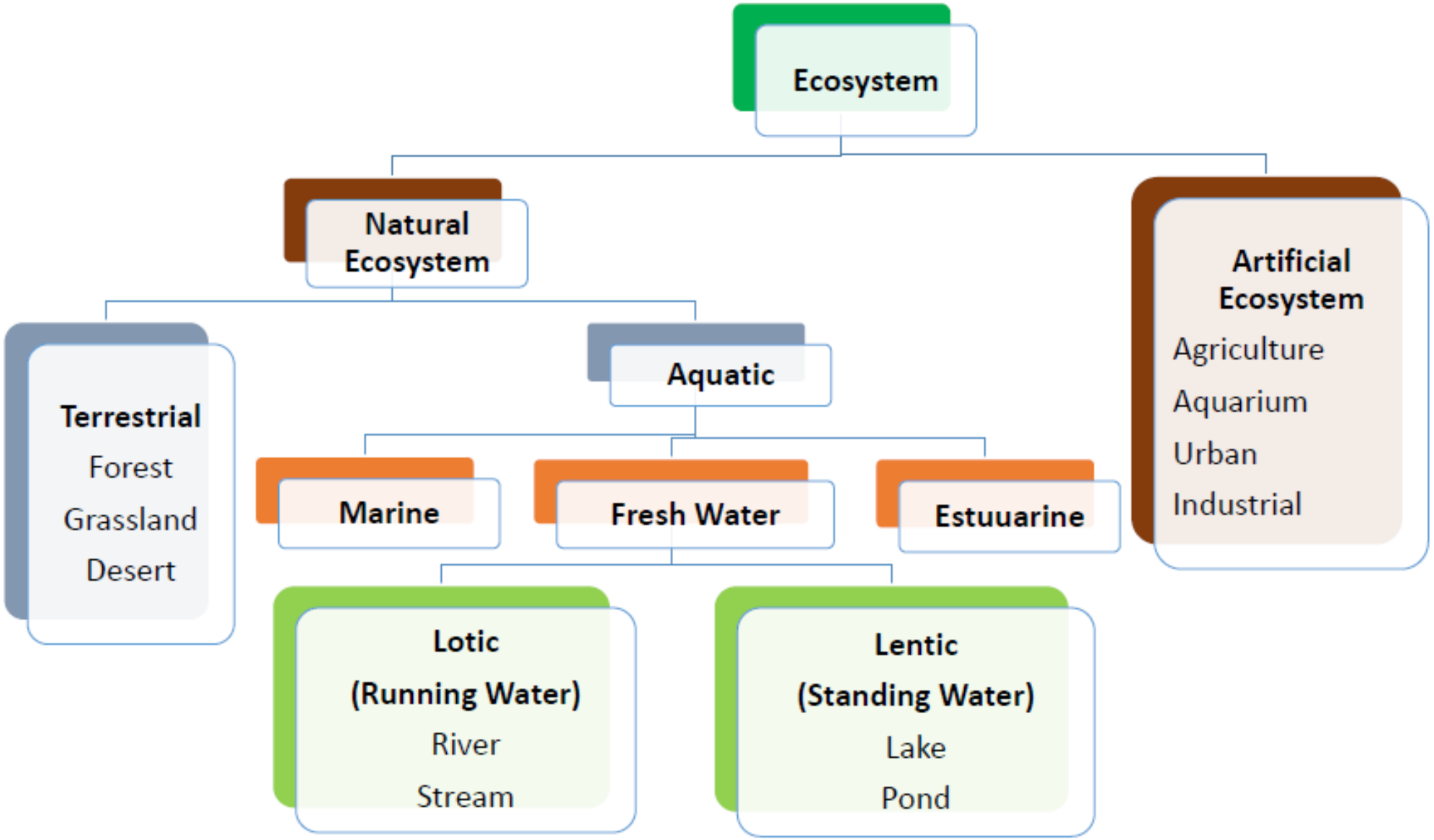
External environment of Fish

Abiotic environment- such as light, temperature, including nutrients in water, oxygen, and other organic matter

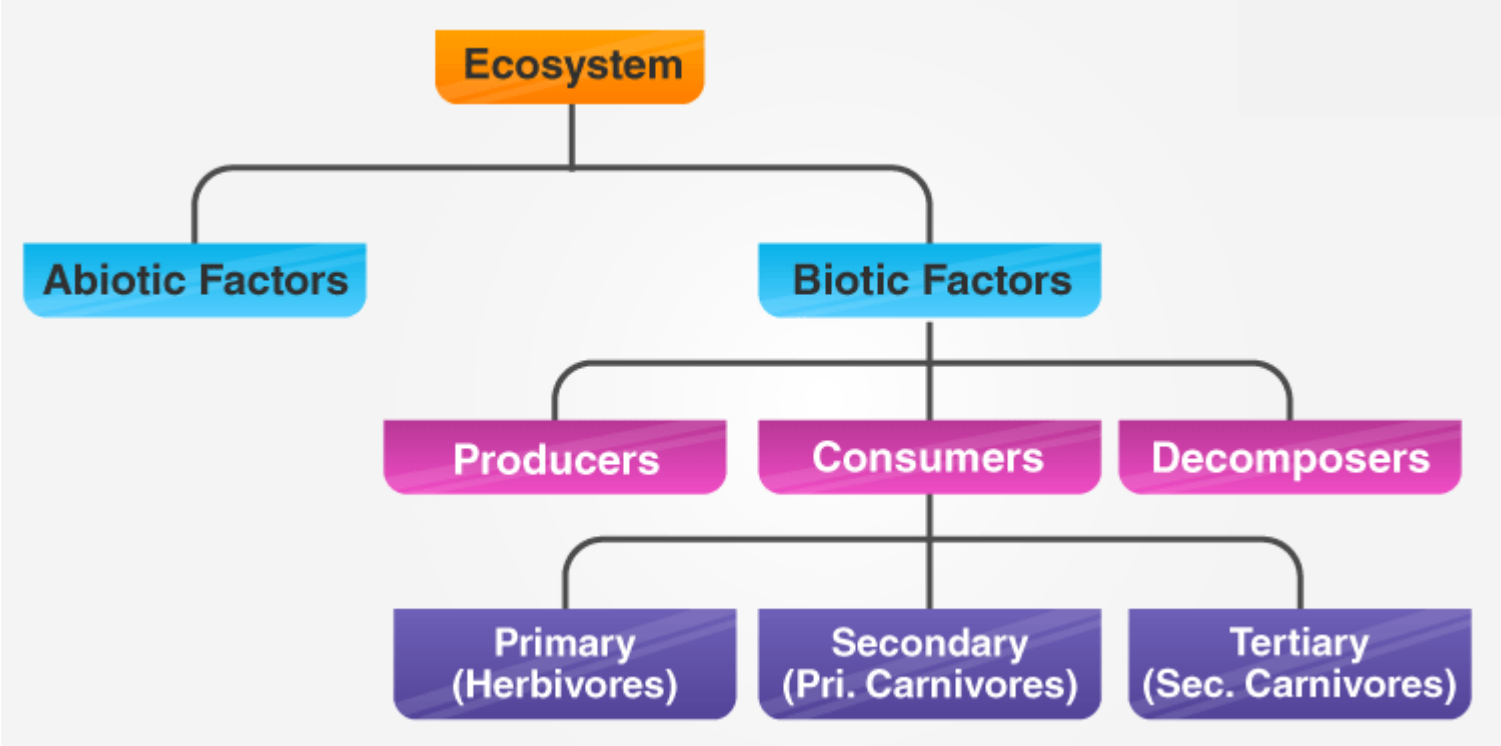
Biotic environment- microscopic organisms called as planktons, aquatic plants, animals and decomposers

Plankton are the diverse collection of organisms found in water (or air) that are unable to propel themselves against a current (or wind). The individual organisms constituting **plankton** are called plankters

Ecosystem

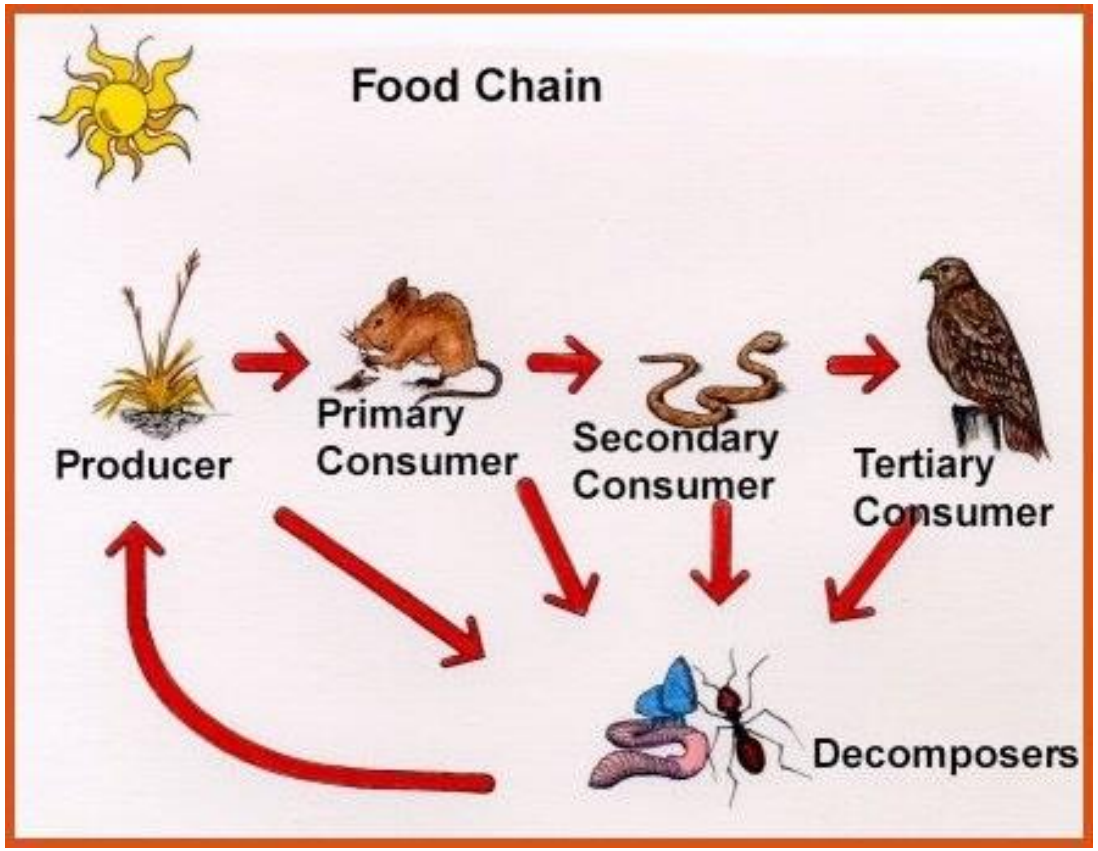

Ecosystem
Natural Ecosystem
Artificial Ecosystem
Agriculture
Aquarium
Urban
Industrial
Terrestrial
Forest
Grassland
Desert
Aquatic
Marine
Fresh Water
Estuuarine
Lotic
(Running Water)
River
Stream
Lentic
(Standing Water)
Lake
Pond

Structure and Function of Ecosystem



Food Chain

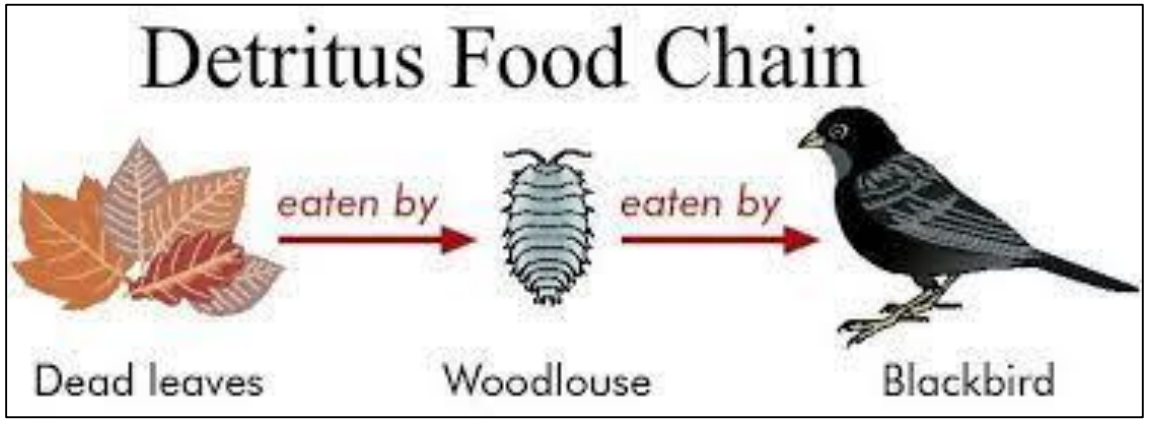
- A food chain shows a single pathway from the producers to the consumers and how **the energy flows in this pathway**. In the animal kingdom, food travels around different levels
- Example of Food Chain



Types of food chain

There are basically two different types of food chains in the ecosystem, namely –

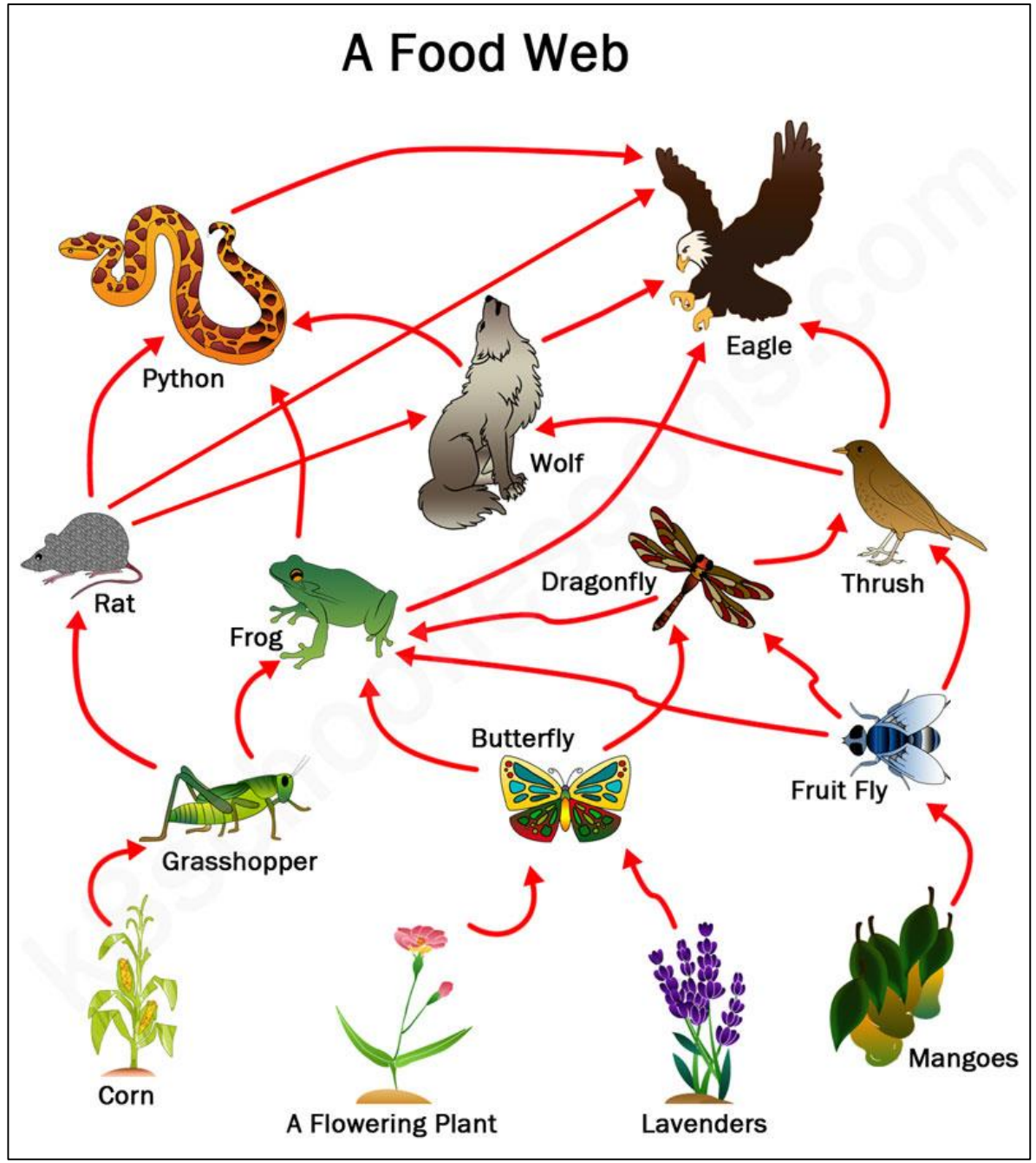
1. **Grazing food chain (GFC)** – This is the normal food chain that we observe in which plants are the producers and the energy flows from the producers to the herbivores (primary consumers), then to carnivores(secondary consumers) and so on.
2. **Saprophytic or Detritus food chain (DFC)** – In this type of food chain, the dead organic matter occupies the lowermost level of the food chain, followed by the decomposers and so on.
3. **Parasitic food chains (PFC) –** In this type of food chain, large organisms either the producer or the consumer is exploited and therefore the food passes to the smaller organism



Cuscuta vine (a parasitic plant)

Food Web

- Many interconnected food chains make up a food web
- Sometimes, a single organism gets eaten by many predators or it eats many other organisms. This is when a food chain doesn't represent the energy flow in a proper manner because there are many trophic levels that interconnect. This is where a food web comes into place.
- It shows the interactions between different organisms in an ecosystem.


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

Structure and Function of Ecosystem

1. Species Composition- figuring out the number and type of species
2. Stratification – vertical alignment of species in relation to their trophic levels
3. Trophic Structure or levels- is arrangement of species in order of their consumption
4. Functional Group in ecosystem- a biological category composed of organisms that perform mostly the same of kind of function in the ecosystem eg. Plants (all plants perform photosynthesis)

Trophic levels

- The feeding levels from producers to consumers is called trophic level. The energy flows only one way through various trophic levels.
- First trophic level- Producers – Autotrophs
- Second trophic level – Primary consumers – Herbivores
- Third trophic level – Secondary consumers – Carnivores
- Fourth trophic level – Tertiary consumers – Top level carnivorous

Function of Ecosystem

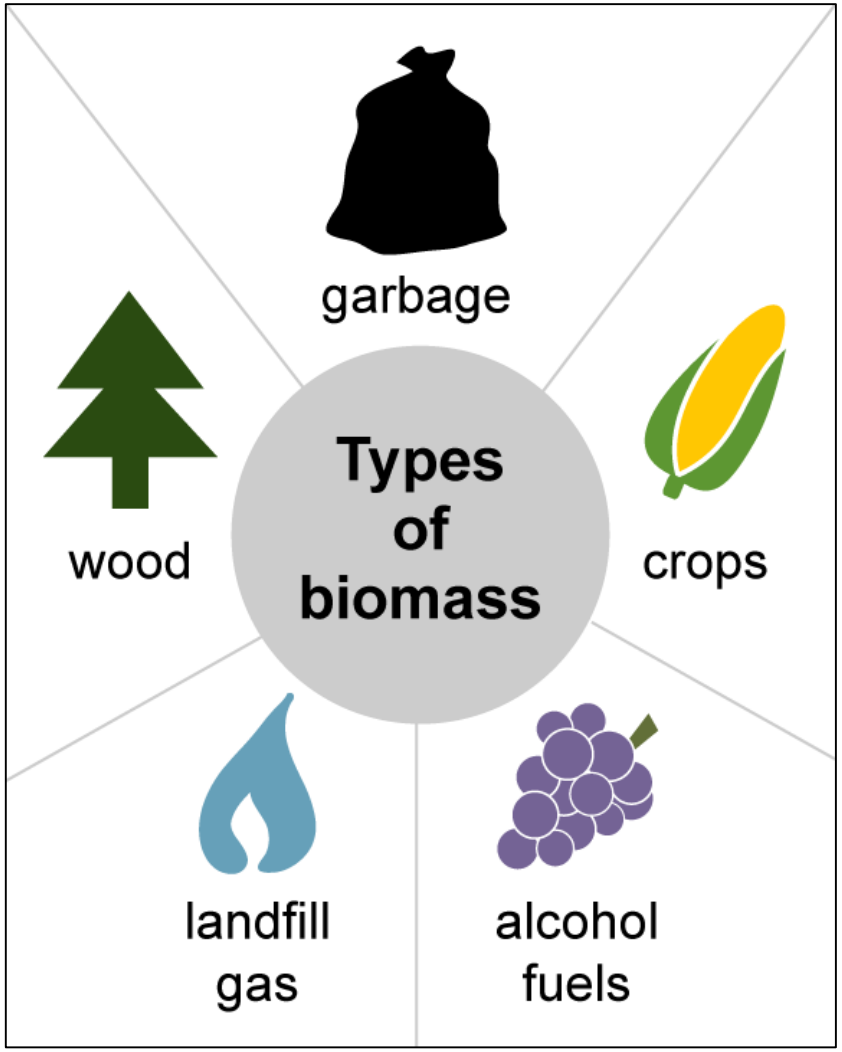
- **Function of Ecosystem**
- An ecosystem is a discrete structural, functional and life sustaining environmental system.
- The environmental system consists of biotic and abiotic components in a habitat.
- Biotic component of the ecosystem includes the living organisms; plants, animals and microbes whereas the abiotic component includes inorganic matter and energy.

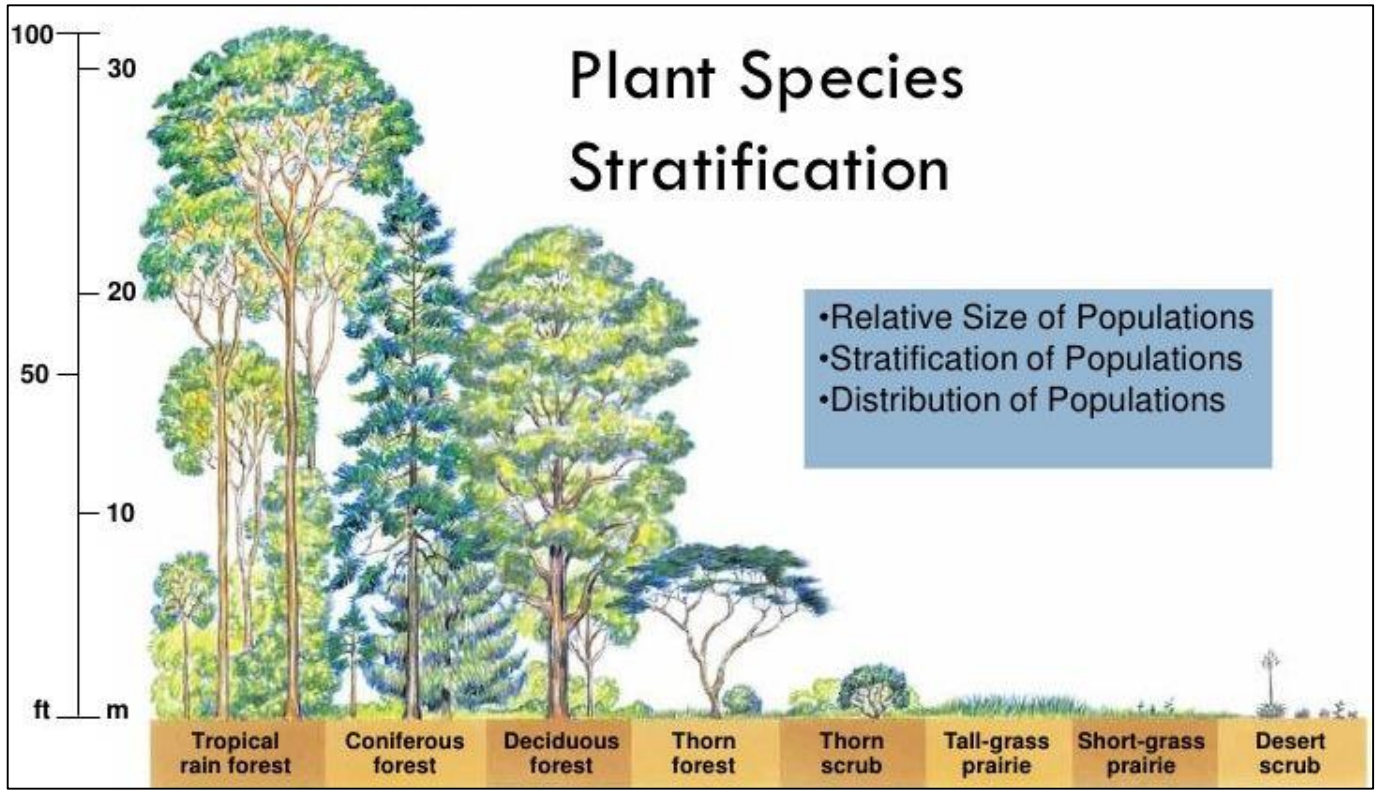
Producers, Consumers and Decomposers

- A biotic system is divided into three main categories:
- Producers- algae, plants

$CO_2 + H_2O \rightarrow$ Glucose

- The glucose can used as a primary or secondary source of energy, where it combines with other molecules to form a biomass
- What is Biomass?
- Biomass is plant or animal material used as fuel to produce electricity or heat. Examples are wood, energy crops and waste from forests, yards, or farms


garbage
wood
Types of biomass
crops
landfill gas
alcohol fuels


Plant Species Stratification
100
30
20
50
10
ft
m
•Relative Size of Populations
•Stratification of Populations
•Distribution of Populations
Tropical rain forest
Coniferous forest
Deciduous forest
Thorn forest
Thorn scrub
Tall-grass prairie
Short-grass prairie
Desert scrub

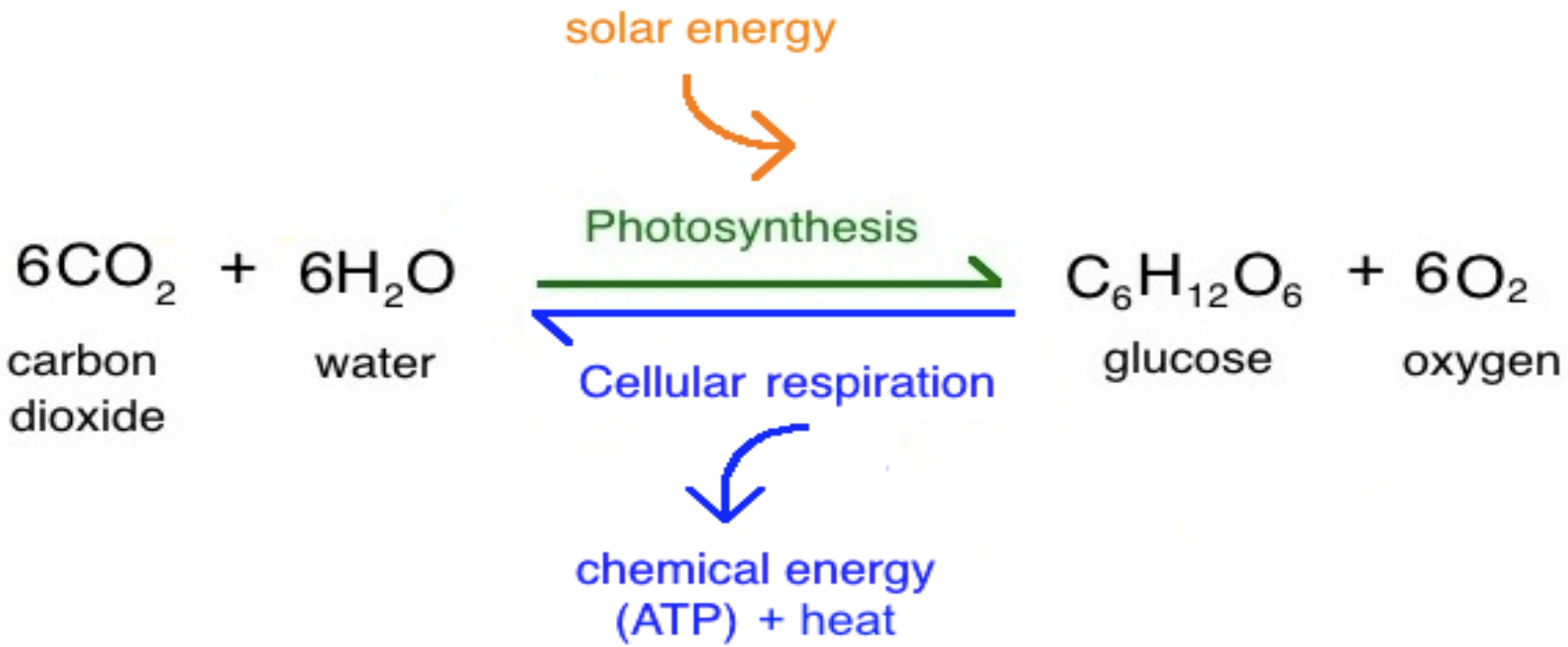
Biotic Components- Producers, Consumers and Decomposers

- The living organisms (or) living members in an ecosystem collectively form its community called biotic components (or) biotic community. Examples- Plants (producers), animals (consumers), microorganisms (decomposers)
- **Consumers** –heterotrophs, these are the organisms which obtain organic molecules and energy by consuming other organisms or plant matter
- **Decomposers**- final link in a food web, which breaks down dead organic matter from producers and consumers to produce energy which is returned to atmosphere
- **Energy flow through the ecosystem-** energy flow from one organism to other, when one organism consumes the other one. Any energy remaining in the dead organism is consumed by decomposers

Producers

- They are autotrophs and represent 1st trophic level which can synthesize the food using light energy
- They produces food for all other organisms of ecosystem.
- They are largely green plants and photosynthetic prokaryotes which converts inorganic substrate into organic food by the process of photosynthesis
- The rate at which the radiation energy is stored by the process of photosynthesis in the green plant is called gross primary productivity (GPP)
- Photosynthesis (Autotrophs)- It is a process used by plants and other organisms to convert light energy into chemical energy that, through cellular respiration, can later be released to fuel the organism's metabolic activities

Photosynthesis and Cellular Respiration



Consumers

- Consumers (heterotrophs):Examples : Plant eating species: Insects, rabbit, goat, deer, cow, etc.,
- Classification of consumers: Consumers are further classified as:
- Primary consumers (Herbivores) (Plant eaters)- Primary consumers are also called herbivores, they directly depend on the plants for their food. So they are called plant eaters. Examples : Insects, rat, goat, deer, cow, horse, etc.
- Secondary consumers(primary carnivores) (meat eater)- Secondary consumers are primary carnivores, they feed on primary consumers. They directly depend on the herbivores for their food. Example: Frog, cat, snakes, foxes, etc.,
- Tertiary consumers (Secondary carnivores) (Meat-eaters)- Tertiary consumers are secondary carnivores, they feed on secondary consumers. They depend on the primary carnivores for their food. Examples: Tigers, lions, eagle etc.

Decomposers

- They feed on dead and decayed plants or animals
- They make up the final trophic level in food chain
- They decompose the dead and decay matter and helps in recycling the nutrients.
- During the decomposition inorganic nutrients are released. The inorganic nutrients together with other organic substances are then utilized by the procedures (plants) for the synthesis of their own food
- Decomposers attack the dead bodies of producers and consumers and decompose them into simpler compounds
- They are classified into two class:
  - Micro-decomposers: Bacteria, Fungi, Protozoa
  - Macro-decomposers: Earth worm, Nematodes, Mollusca's

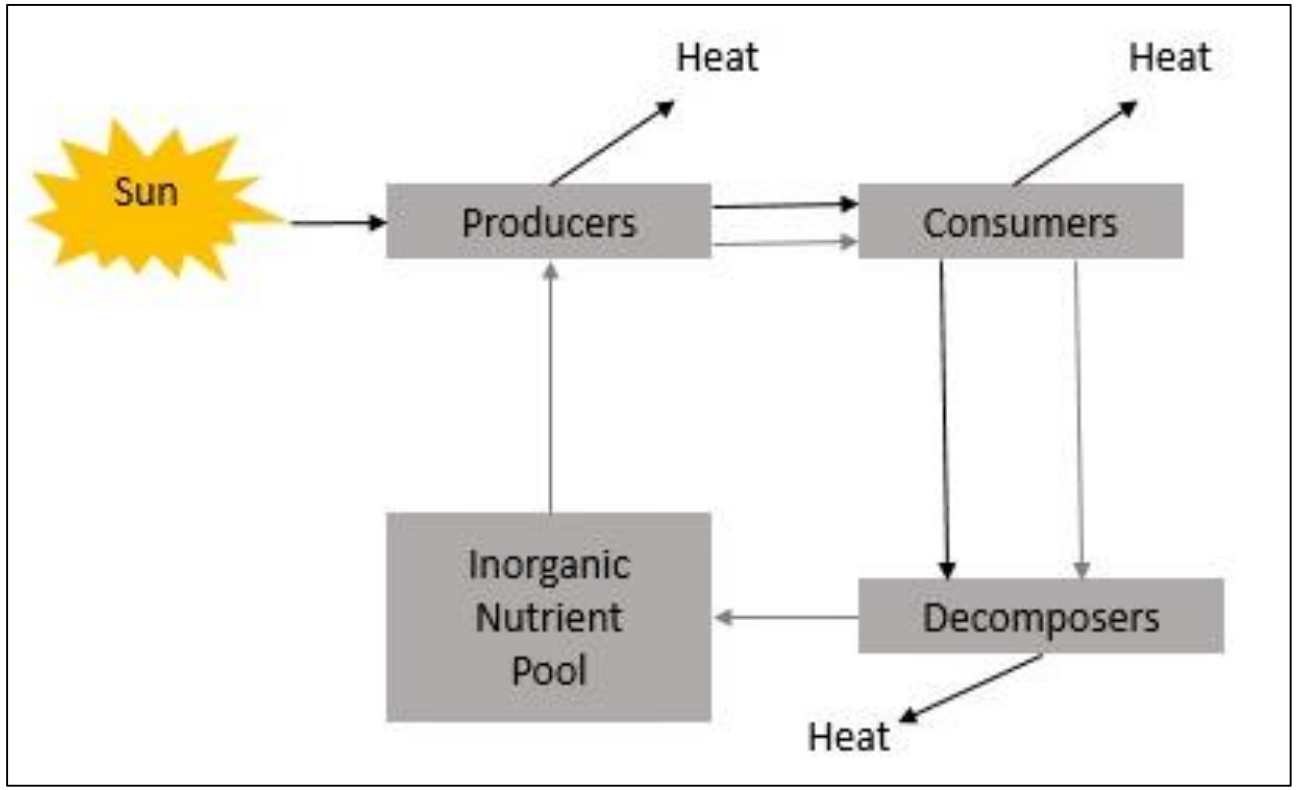
Concept of Energy Flow in Ecosystem

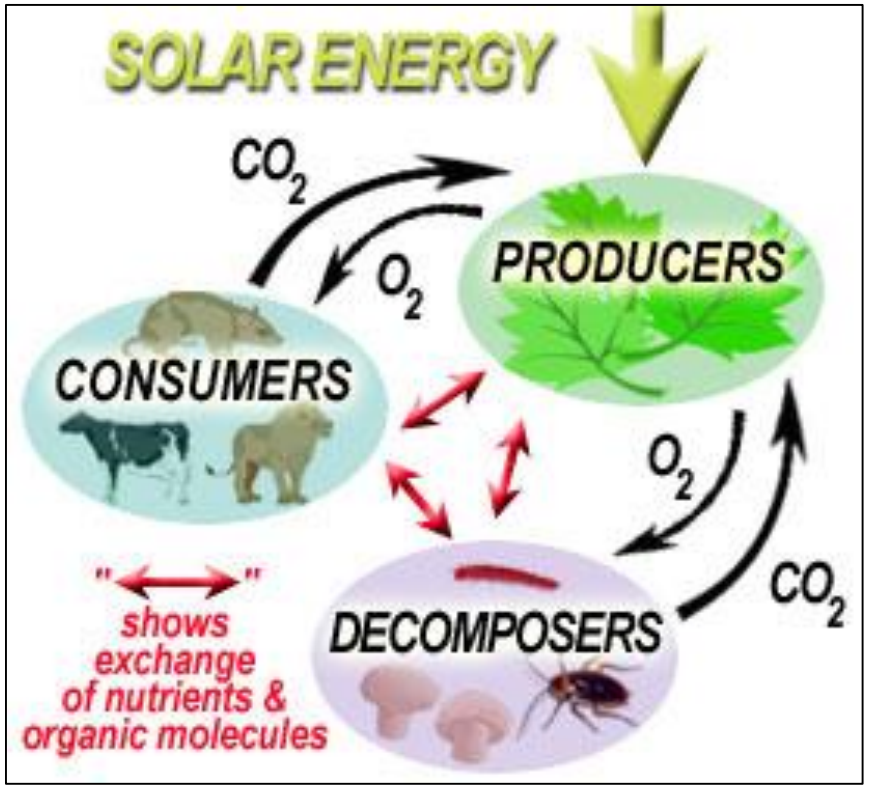
- The process of transfer of energy to various trophic level of food chain is known as flow of energy
- Energy is the most essential requirement for all living organism. Solar energy is the only source to our planet earth. Solar energy is transformed to chemical energy in photosynthesis by the plants (called as primary producers). Though a lot of sunlight falls on the green plants, only 1% of it is utilized for photosynthesis
- Thus the energy enters the ecosystems through photosynthesis and passes through the different tropic levels feeding levels

Principal steps in the operation of ecosystem

- The flow of energy is unidirectional
- The two ecological processes—energy flow and mineral cycling which involve interaction between biotic and abiotic components lie at the heart of ecosystem dynamics
- The energy flow is best described by net primary productivity(NPP) = Gross primary productivity (GPP)- Respiration (Rp)
- At each energy step in food chain, the energy received by the organisms is used for its own metabolism and maintenance. The left over energy is passed to next higher trophic level. Thus the energy flow decreases with successive trophic level
- Flow of energy follows the ecological rule of 10%.

Flow of energy in ecosystem





Ecological Pyramids

- The concept was first introduced by Charles Elton, the pioneer British Ecologist
- It is a graphic representation of the relationship between organisms at various trophic levels in a food chain
- The basis of an ecological pyramid is the biomass, energy, and number. Just as the name suggests ecological pyramids are in the shape of a pyramid
- The bottom of an ecological pyramid is the broadest and is occupied the producers, which form the first trophic level

Ecological Pyramids

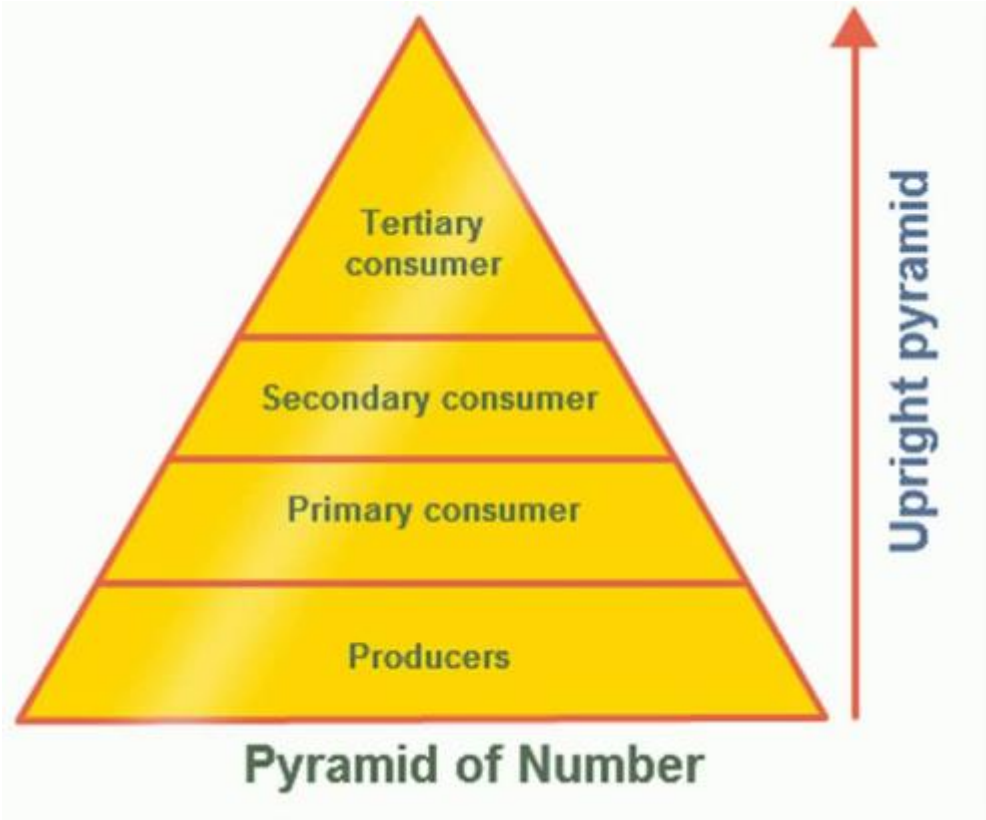
- Producers are at the lowest level
- The producers are consumed by the primary consumers, in an ecological pyramid
- A pyramid-shaped diagram representing quantitatively the numbers of organisms, energy relationships, and biomass of an ecosystem; numbers are high for the lowest trophic levels (plants) and. low for the highest trophic level

Types of Ecological Pyramids

- ***Pyramid of numbers***
- ***Pyramid of biomass***
- ***Pyramid of energy***

Pyramid of Numbers

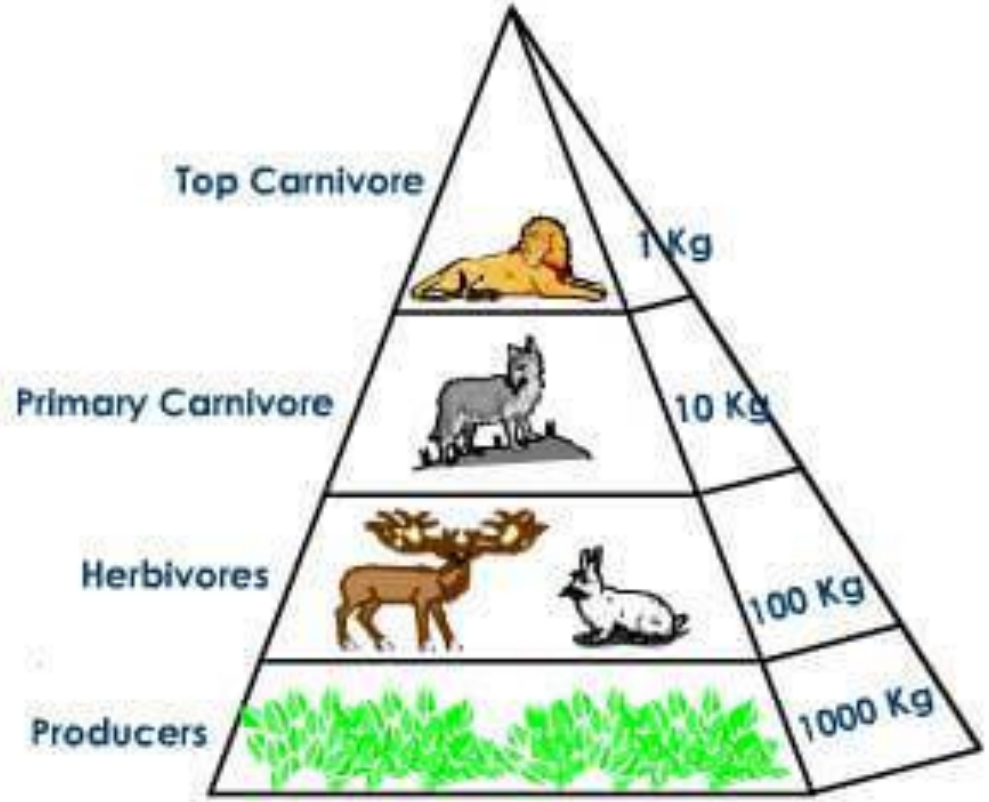
- It depicts the number of individual organisms at different trophic levels of food chain
- This pyramid points out the difference in number of organisms as we go up the trophic levels
- Producers are found as the lowest trophic levels and therefore larger in number
- <u>If the producers have the broadest platform…it shows ecological balance</u>



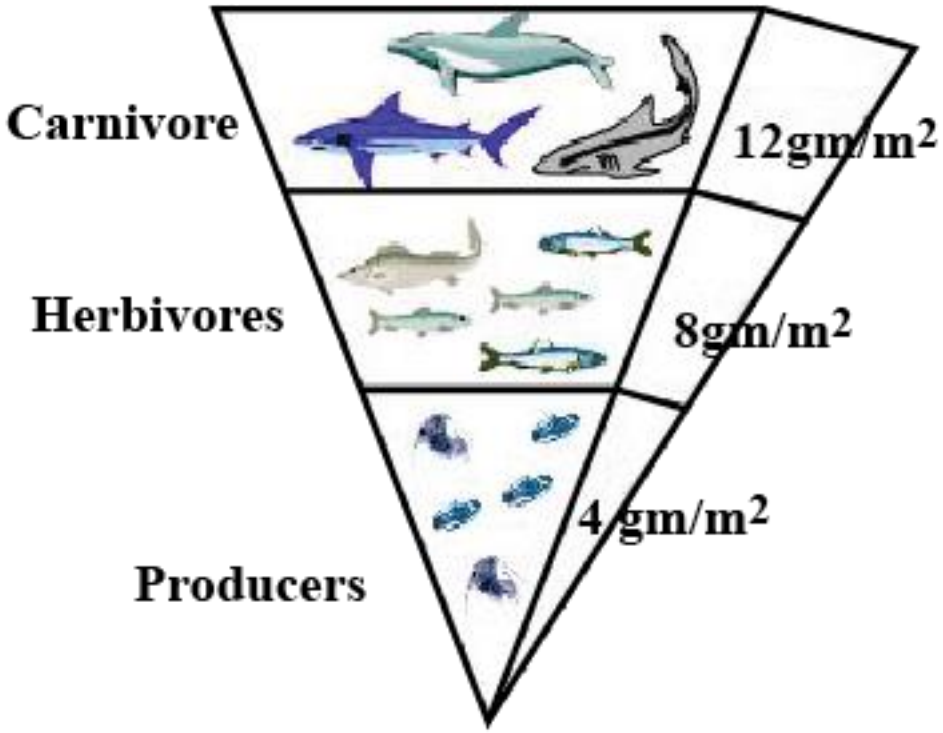
Pyramid of Biomass

- This pyramid represents the amount of biomass of the organisms present at each trophic level.
- Biomass is nothing but the weight of the organisms at each trophic level
- Pyramid of biomass for terrestrial (grassland) region is upright
- Pyramid of biomass for oceans (aquatic ecosystem) in inverted

Pyramid of biomass



Upright Pyramid of biomass in a Terrestrial Ecosystem



Inverted Pyramid in an Aquatic Ecosystem

Pyramid of Energy

- This is an upright pyramid that represents the flow of energy from the producers to the final consumers
- When production is considered in terms of energy, the pyramid indicates not only the amount of energy flow at each level, but more important, the actual role the various organisms play in the transfer of energy
- An energy pyramid illustrates how much energy is needed as it flows upwards to support the next trophic level
- Energy pyramids are always slopping because less energy is transferred from each level than was paid into it by previous trophic level
- Raymond Lydnman – a scientist who illustrated the energy flow and stated that only 10% of the energy is transferred from one trophic level to another, rest is consumed by the organism for its own metabolic process

Pyramid of Energy