Ecosystem
Part 1

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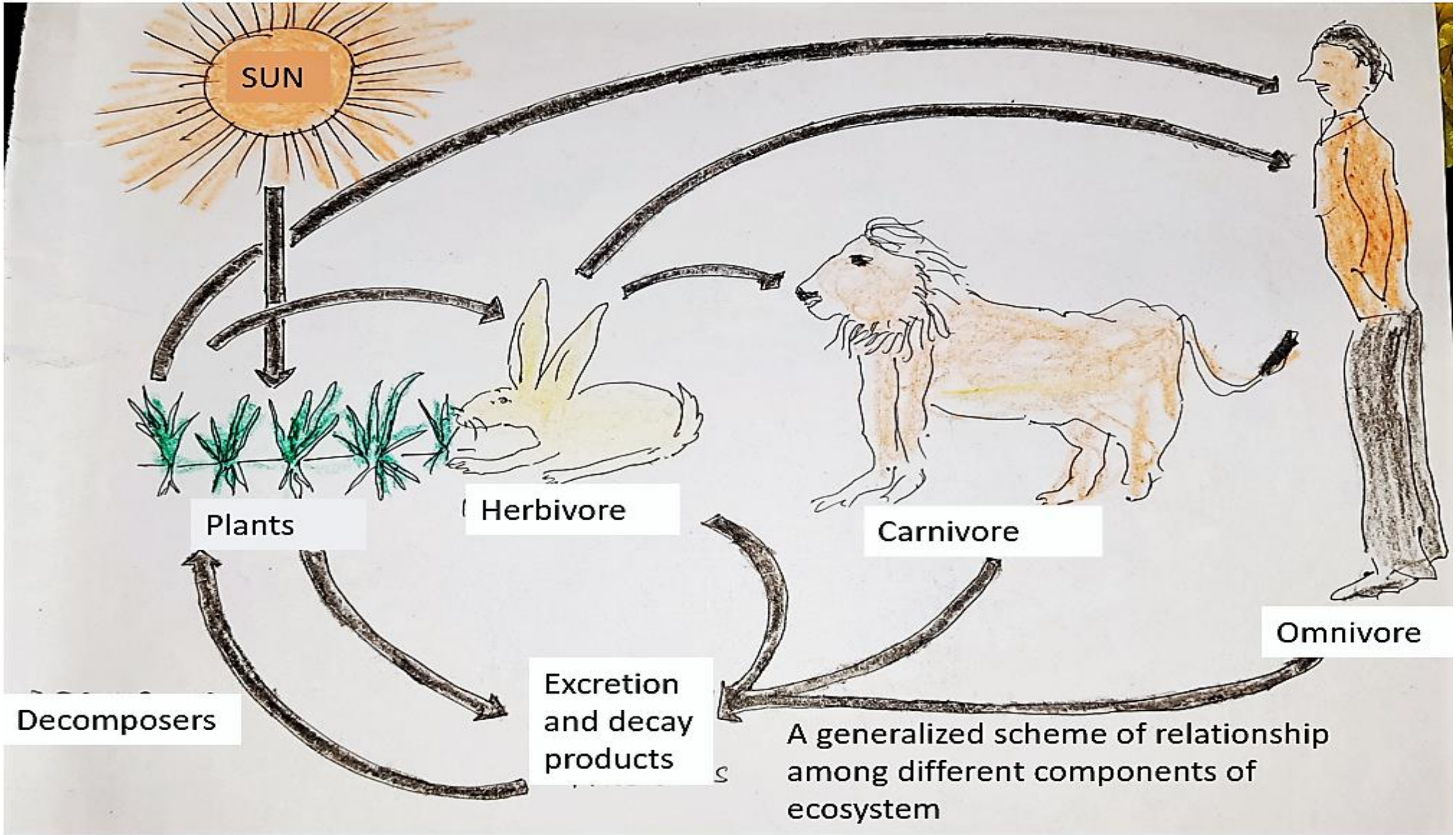
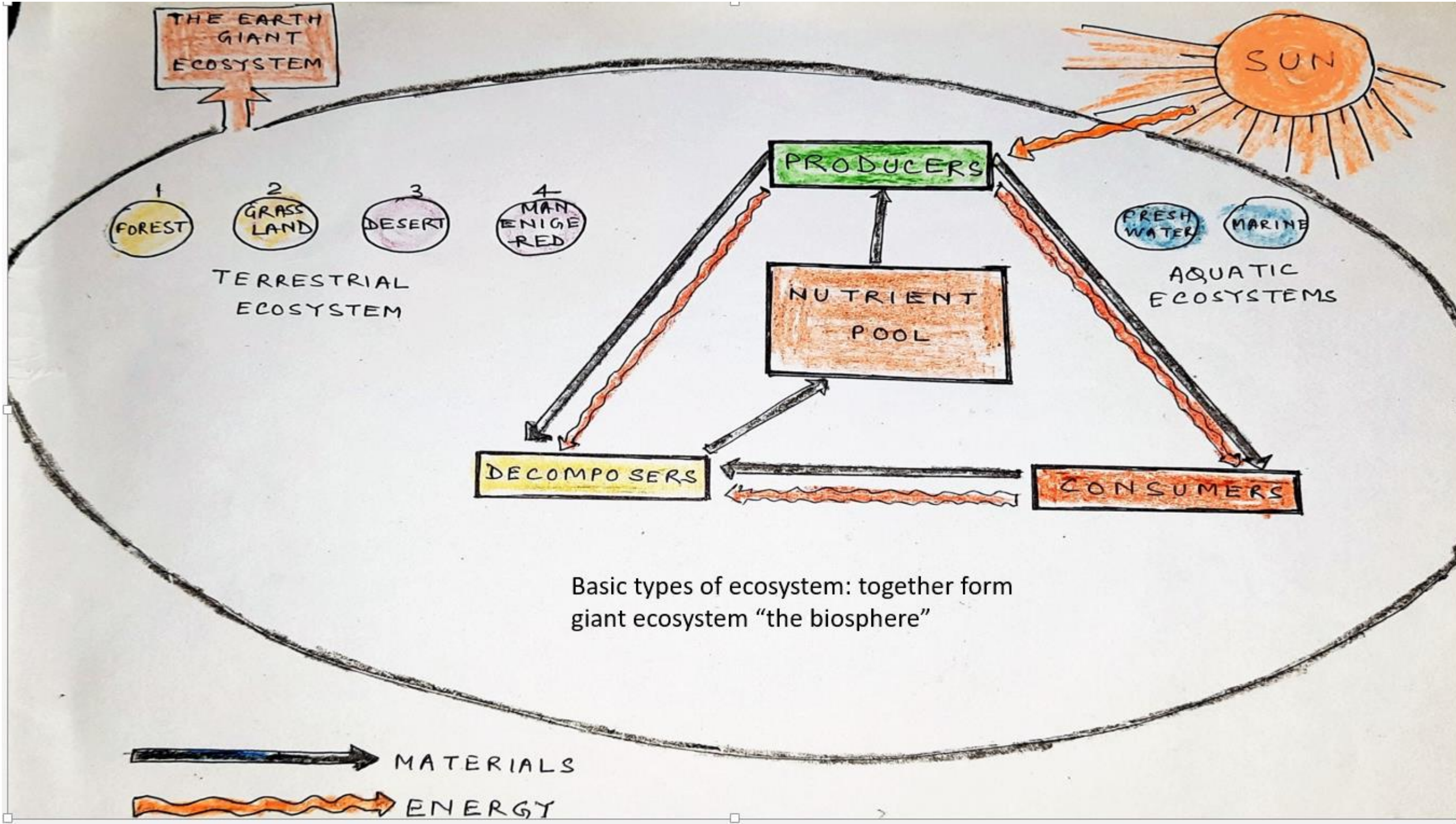
- **Ecosystem** – term was given by Tansley (1935)
- Study of ecosystem is **Synecological** approach.
- Parallel terms- **biocoenosis** (Karl Mobius, 1877) ; **microcosm** (S.A.Forbes, 1887) ; **geobiocoenosis** (V.V.Dokuchaev, 1846-1903) .
- **Biosphere -1** is our earth which is a giant ecosystem.
- **Biosphere-2** is a unique, self- sustaining man made artificial ecosystem (near Tucson, A in the Arizona desert (USA).

Definition

Any unit that includes all the organisms i.e. the community in a given area interact with the physical environment so that a flow of energy leads to clearly defined trophic structure, material cycle and biotic diversity within the system is called ecosystem.



A generalized scheme of relationship among different components of ecosystem



Basic types of ecosystem: together form giant ecosystem “the biosphere”

Types of ecosystem

1. **Natural ecosystem**

a) Terrestrial i - forest ecosystem ii - Grassland ecosystem iii - Desert ecosystem

b) Aquatic

i - freshwater ecosystem

LOTIC (running water) eg. River ecosystem

LENTIC (standing water) eg. pond ecosystem

ii - marine ecosystem eg. Open Ocean ecosystem, deep sea ocean ecosystem, coastal marine ecosystem, estuary ecosystem

2. **Aartificial ecosystem eg. Cropland ecosystem (maize field, rice field) aquarium ecosystem**

Ecosystem components

Ecosystem consists of two components:

1. **Biotic/ living components** :

Autotrophs/producers = converters = transducers

Heterotrophs/macroconsumers i- primary or herbivores ii- secondary or carnivores and omnivores iii- top. consumers or top carnivores

Decomposers or microconsumers or reducers or transformers **include bacteria, fungi actinomycetes etc.**

2. **Abiotic/ non-living components** : Light, temperature, air, water, soil, nutrients, energy

Study of ecosystem

There are two aspects of study of ecosystem:

- **Structure of ecosystem** It includes:
  - Biotic component and Abiotic component
  - Ecological Pyramids
- **Function of ecosystem** It includes:
  - Food chain and Food Web
  - Energy flow
  - Nutrient cycling (Biogeochemical cycling)

Structure of ecosystem
(A) Biotic/living component

- **Autotrophic component:** green plants including photosynthetic bacteria.
- **Heterotrophic component:** in which utilisation, rearrangement and decomposition of complex materials occurs.

1- Macroconsumers herbivores (primary consumers), carnivores (and omnivores) also called phagotrophs.

2- Microconsumers/decompoers/ saprotrophs/ osmotrophs bacteria, fungi and actinomycetes.

(B) Abiotic component

- **Physical environment** eg. Light, temperature, water, soil etc.
- **Nutrients** organic and inorganic elements and compounds eg. Water, O, N, CO_2, Ca, S, P etc. The amount of inorganic substances present at any given time in an ecosystem is called the **standing state or standing quality.**
- **Energy solar energy, heat energy and stored energy in form of ATP.**

WHILE MATERIALS IN AN ECOSYSTEM ARE CYCLED, ENERGY FLOWS.

Ecolgical Pyramid: graphic representation of trophic structure

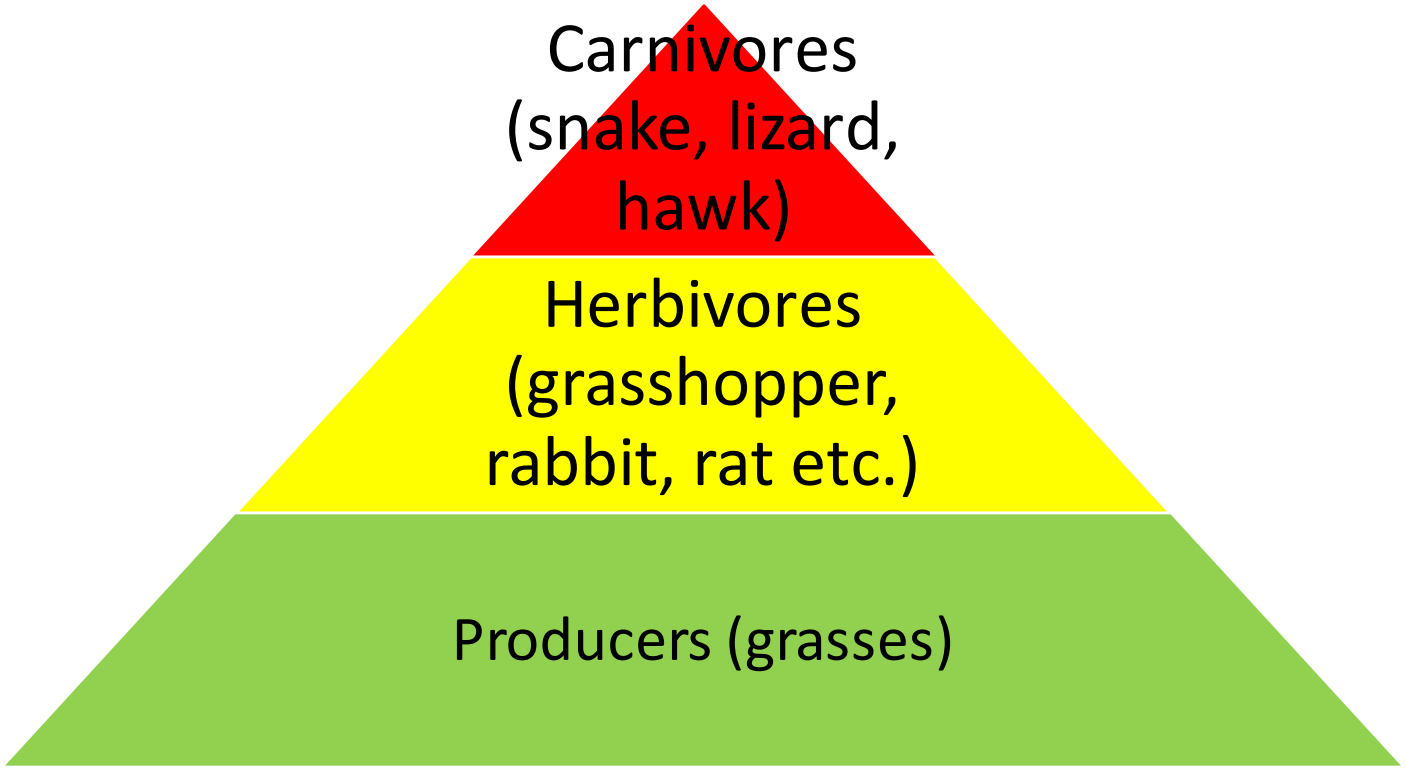
Ecological pyramid is the graphical representation of trophic structure and functions at successive trophic levels i.e. producers- herbivore-carnivore.

Ecological pyramids are of three main types:

1. Pyramid of number
2. Pyramid of biomass
3. Pyramid of energy

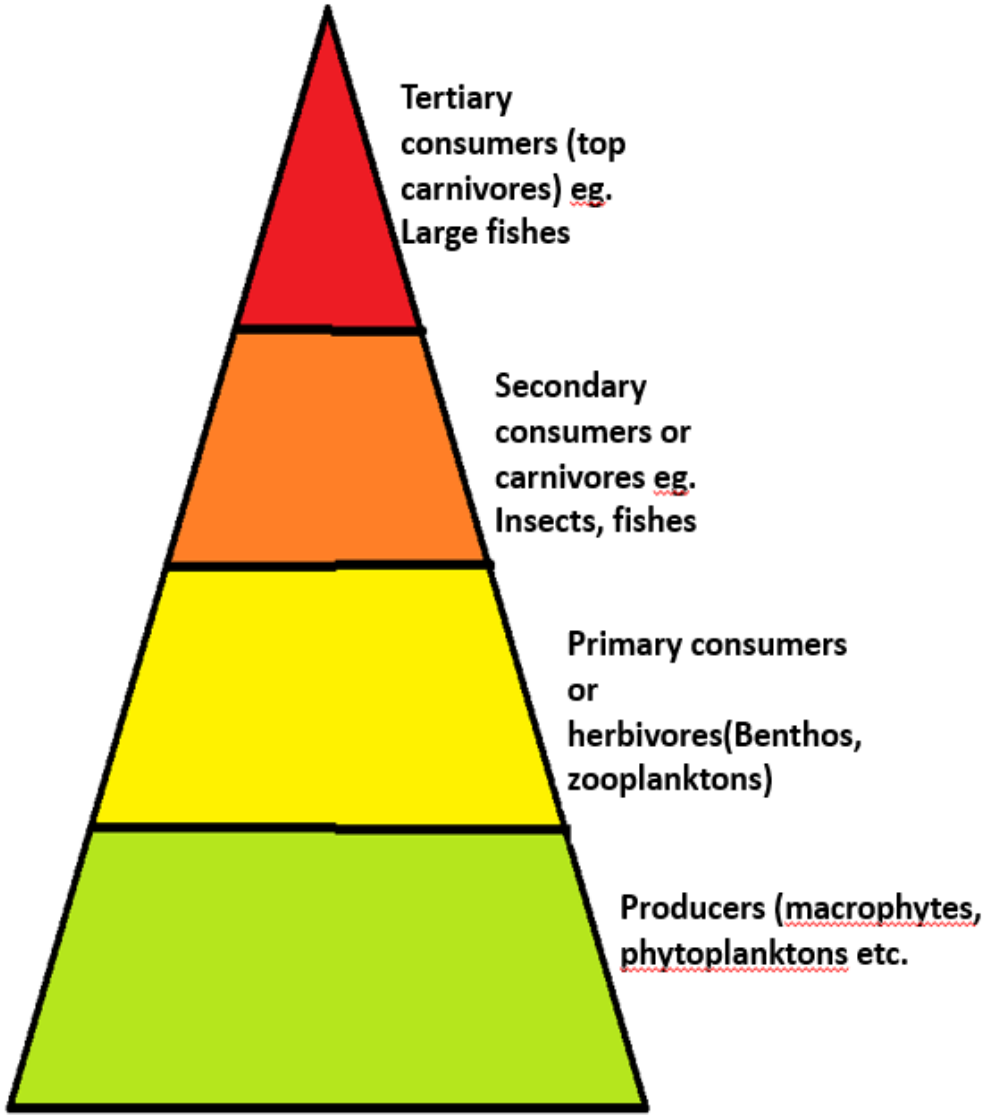
Pyramid of number

This type of pyramid represents the relationships at successive trophic levels i.e. producers, herbivores and carnivores taking into consideration their numbers.

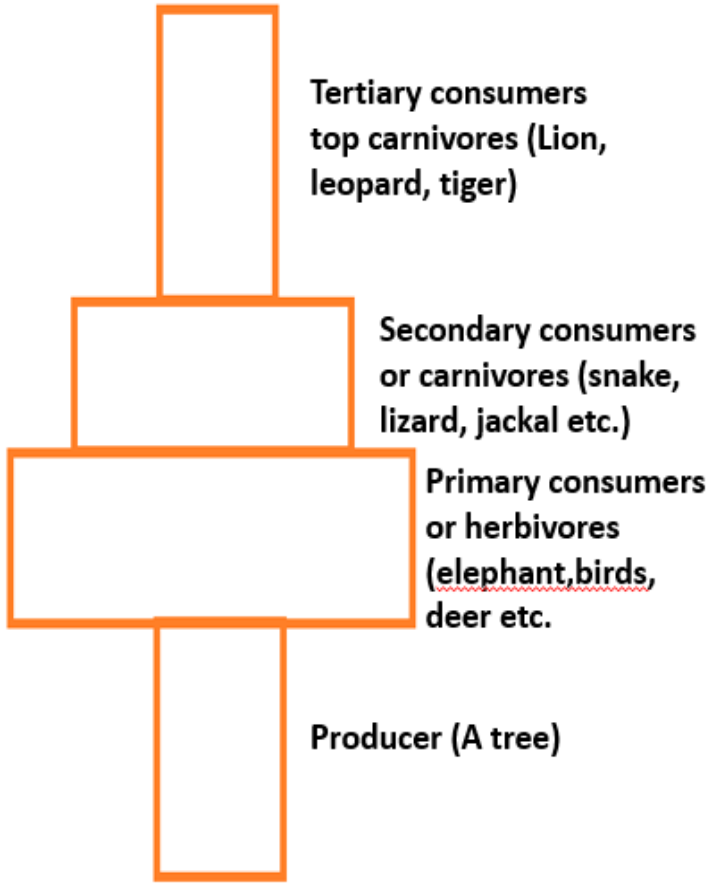


Grassland ecosystem

PYRAMID OF NUMBER

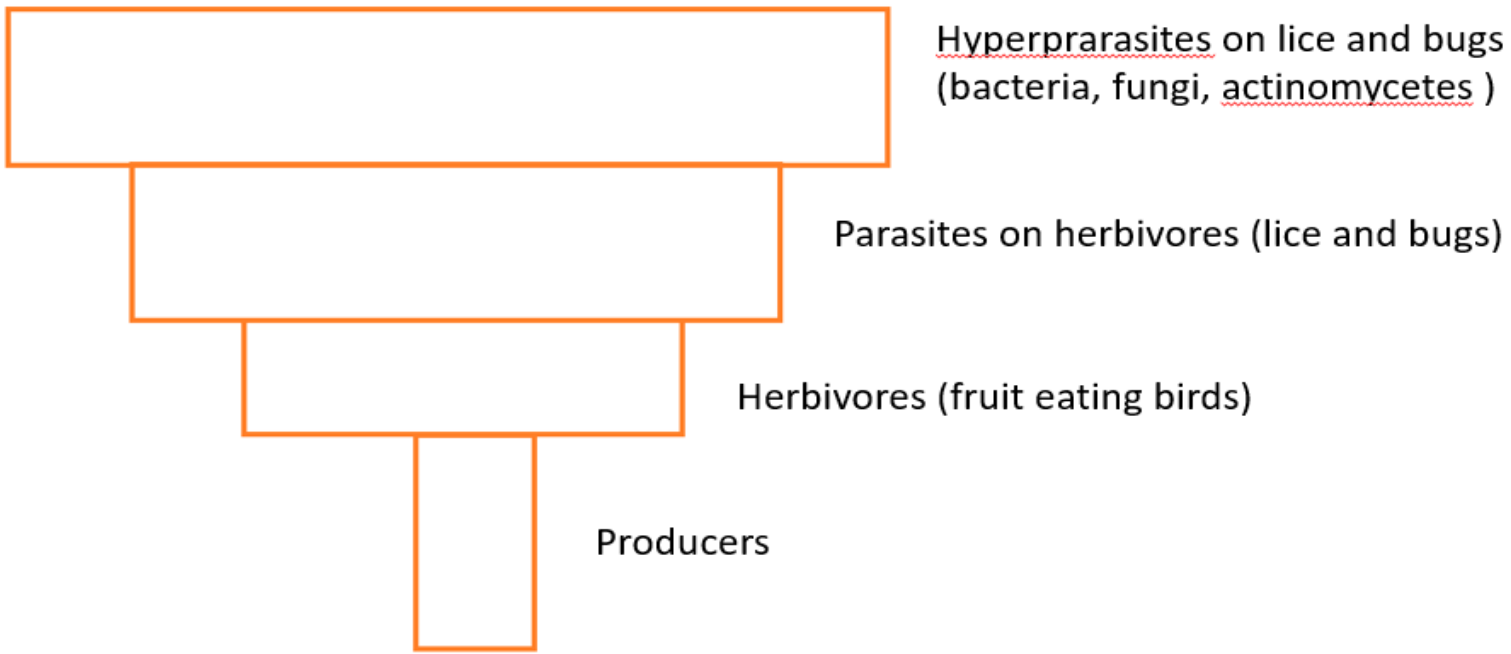


Pond Ecosystem



Forest Ecosystem

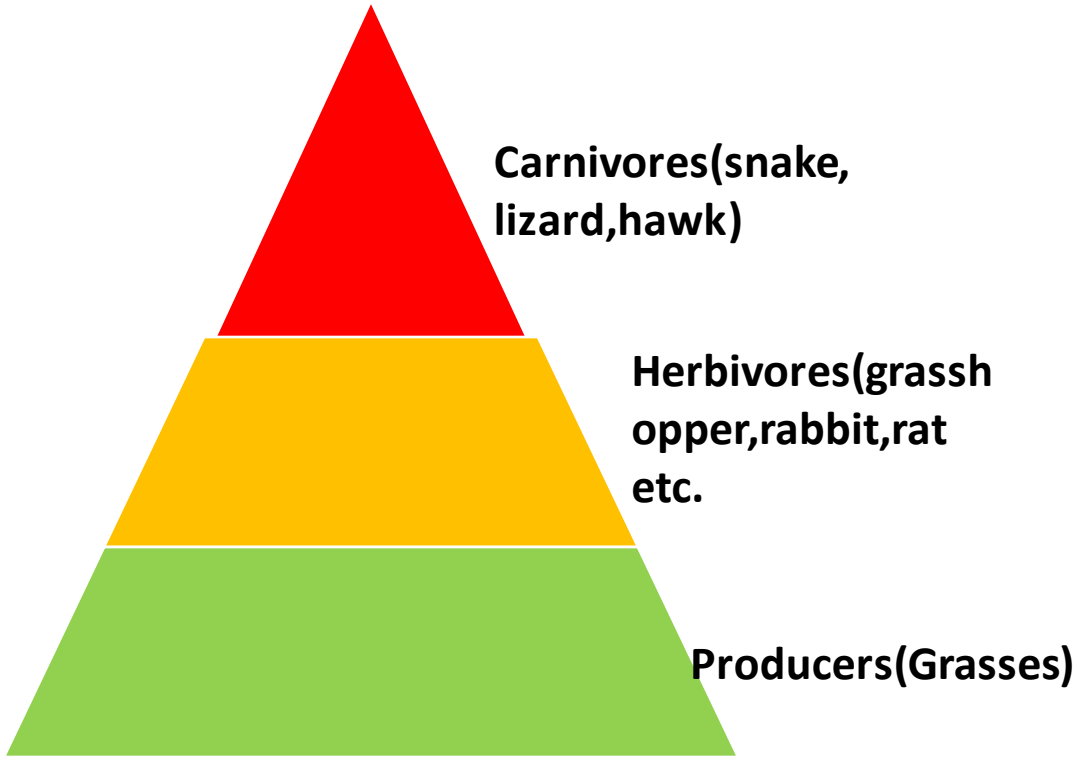
PYRAMID OF NUMBER



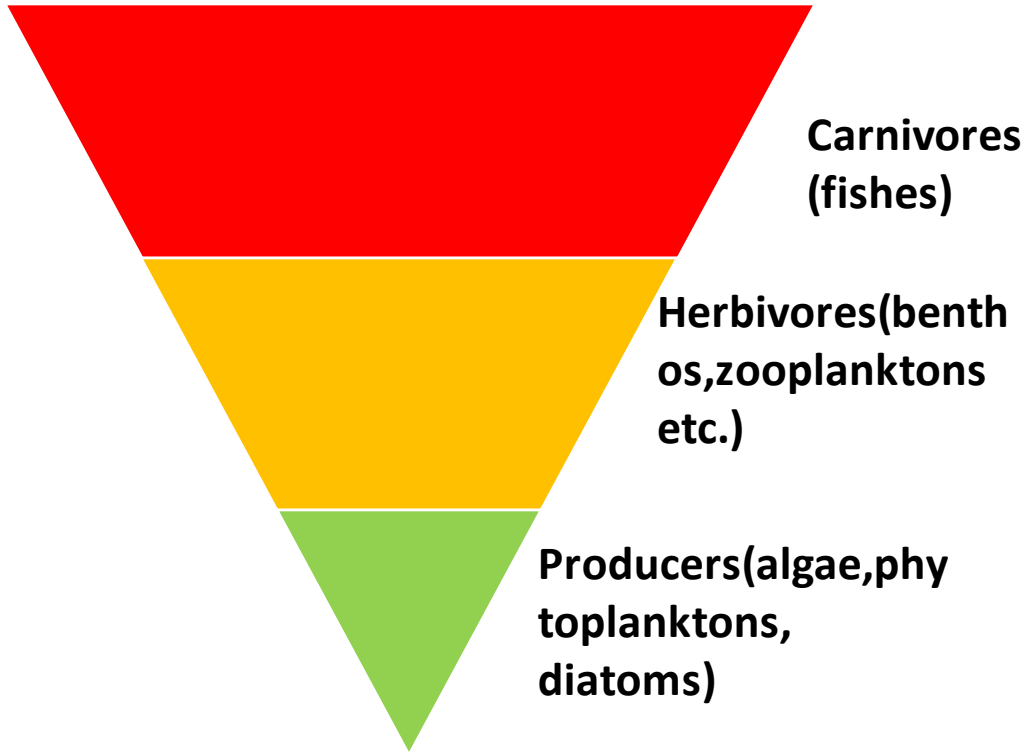
Parasitic food chain

Pyramid of biomass

This pyramid is more meaningful as instead of numerical strength its emphasis is on standing crop or biomass.



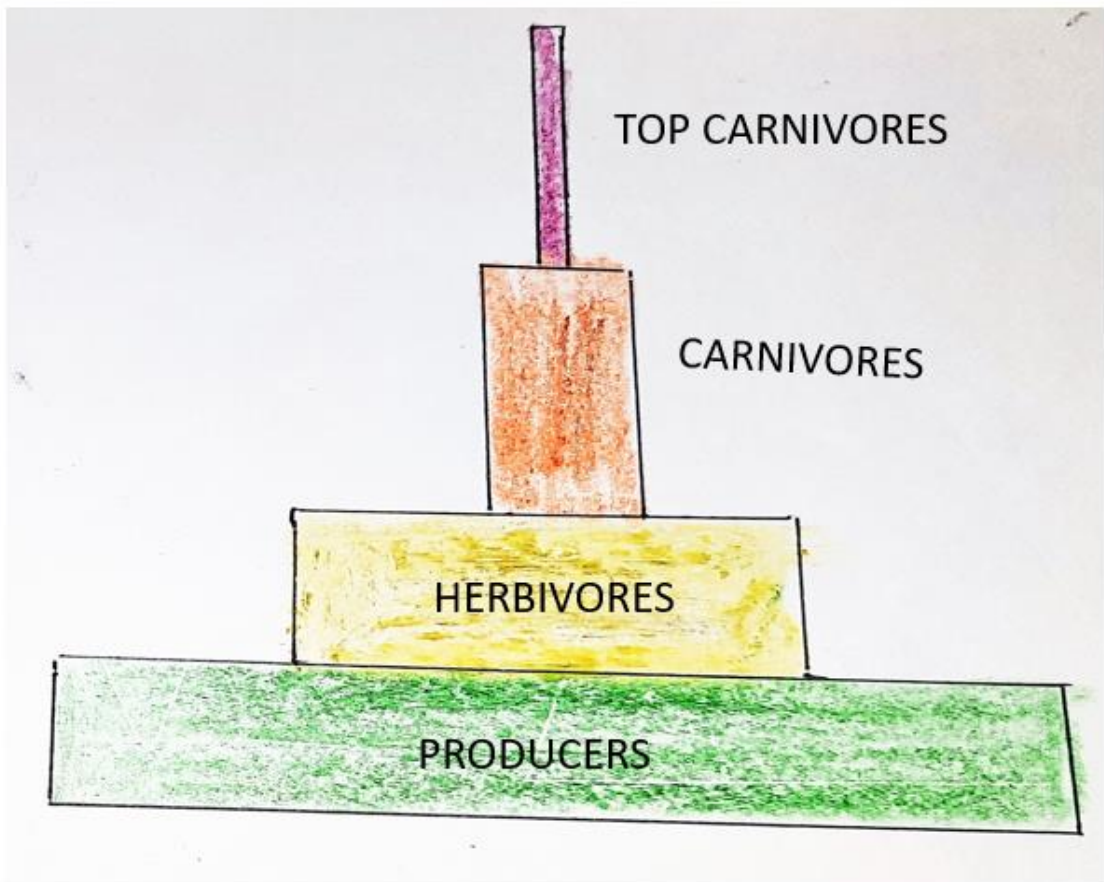
Grassland ecosystem



Pond ecosystem

Pyramid of energy

The most meaningful and illustrative picture of ecosystem is given by the pyramid of energy. It depicts the rate of passage of food mass through various trophic levels in the ecosystem. Energy pyramid is almost always upright as amount of energy conserved at successive trophic levels continuously decreases.

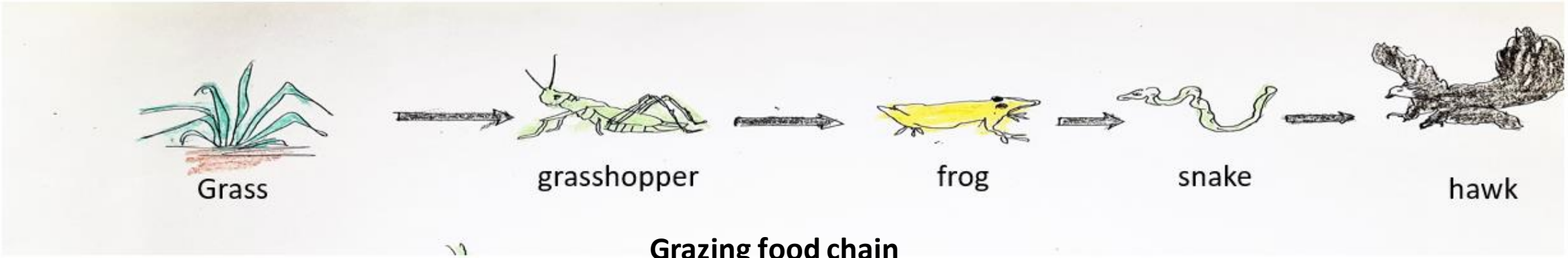


Food chain

Food produced by the autotrophs moves from one trophic level to another and in this way a chain is formed called the Food chain.

Types of Food chains:

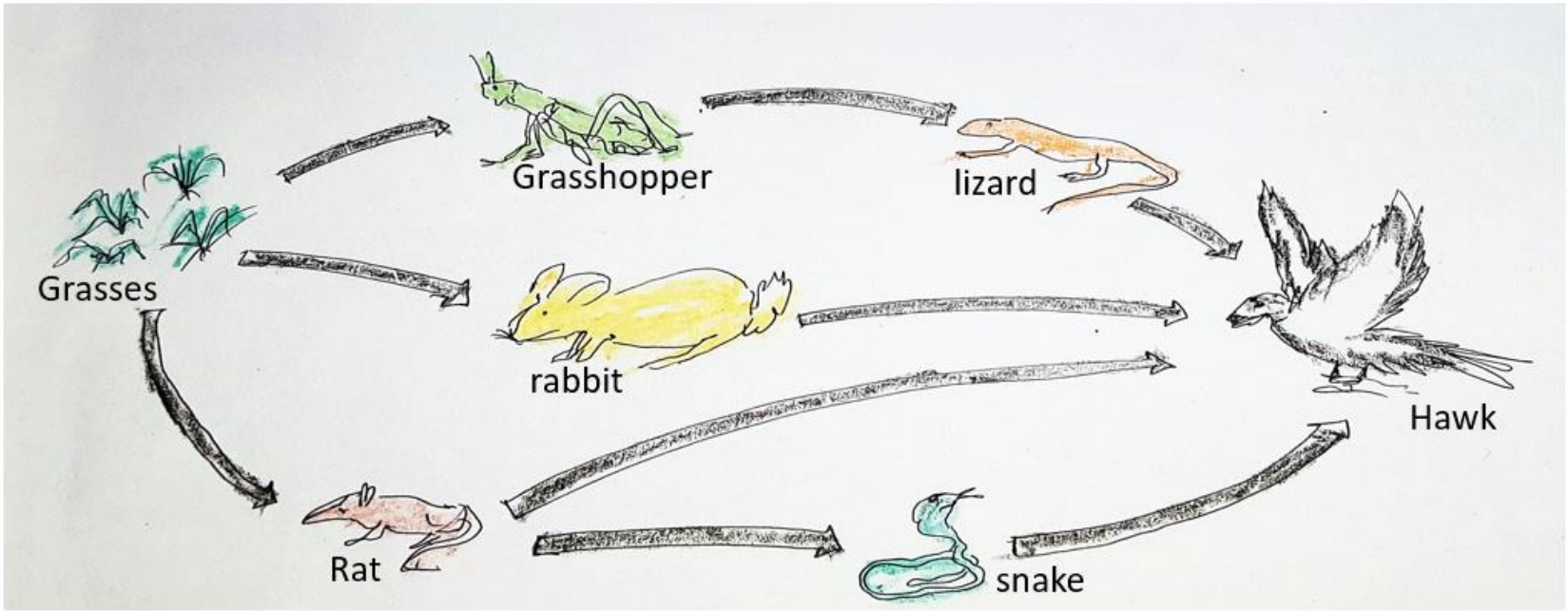
1. **Grazing Food chain**: begins from autrotrophs and is followed by herbivores, carnivores etc
2. **Detritus Food chain**: begins from detritus or dead organic matter and involves detrivores.
3. **Parasitic Food chain** : begins with host and ends in parasite.



Grazing food chain

Food web

In nature we usually don't find linear arrangement of food chains. The chains are found interconnected with each other through different organisms at various trophic levels. This results in the formation of a FOOD WEB.



Productivity of ecosystem

It is the rate of production i.e. The amount of organic matter accumulated in any unit time. Productivity is of following types:

1. **Primary productivity** it is the rate at which radient energy of Sun is stored by photosynthetic and chemosynthetic activity of producers. It is further divided into:

a) Gross Primary Productivity (GPP) : It is called gross photosynthesis or total assimilation. It is the total rate of photosynthesis including the organic matter used up in respiration during the measurement period.

b) Net primary productivity (NPP) it is called apparent photosynthesis or net assimilation. It is the rate of storage of organic matter in excess of respiratory utilisation by plants during the measurement period.

NPP = GPP – R(respiration)

2. Secondary Productivity: it refers to consumers or Heterotrophs. It is the rate of storage of energy at consumer level.

Odum (1971) prefers to use the term assimilation in place of production at consumer level.

3. Net Productivity: It refers to the storage of organic matter not used by Heterotrophs (consumers) i.e. NPP minus consumption by heterotrophs during the unit period as a season or year. It is thus the rate of increase of biomass of primary producers which has been left out by herbivores. Net Productivity is measured in C gm/m^2/day.

Energy Flow

Definition: It is the transfer of energy from the sun through successive levels (of organisms) in the ecosystem.

Each level is called the **trophic** (troph=food) level.

From the energy flow diagram, two points are clear:

First, the flow of energy is a **one way process** i.e. the energy once utilized by organisms cannot be reverted back eg. Energy used by plants cannot be returned to sun and similarly that utilized by herbivores cannot be given back to producers and so on and so forth.

Second, at each trophic level there is **successive decrease in energy level.** This is due to energy being dissipated as heat, used up in respiration and remaining unutilized.

Energy flow follows the **laws of thermodynamics**:

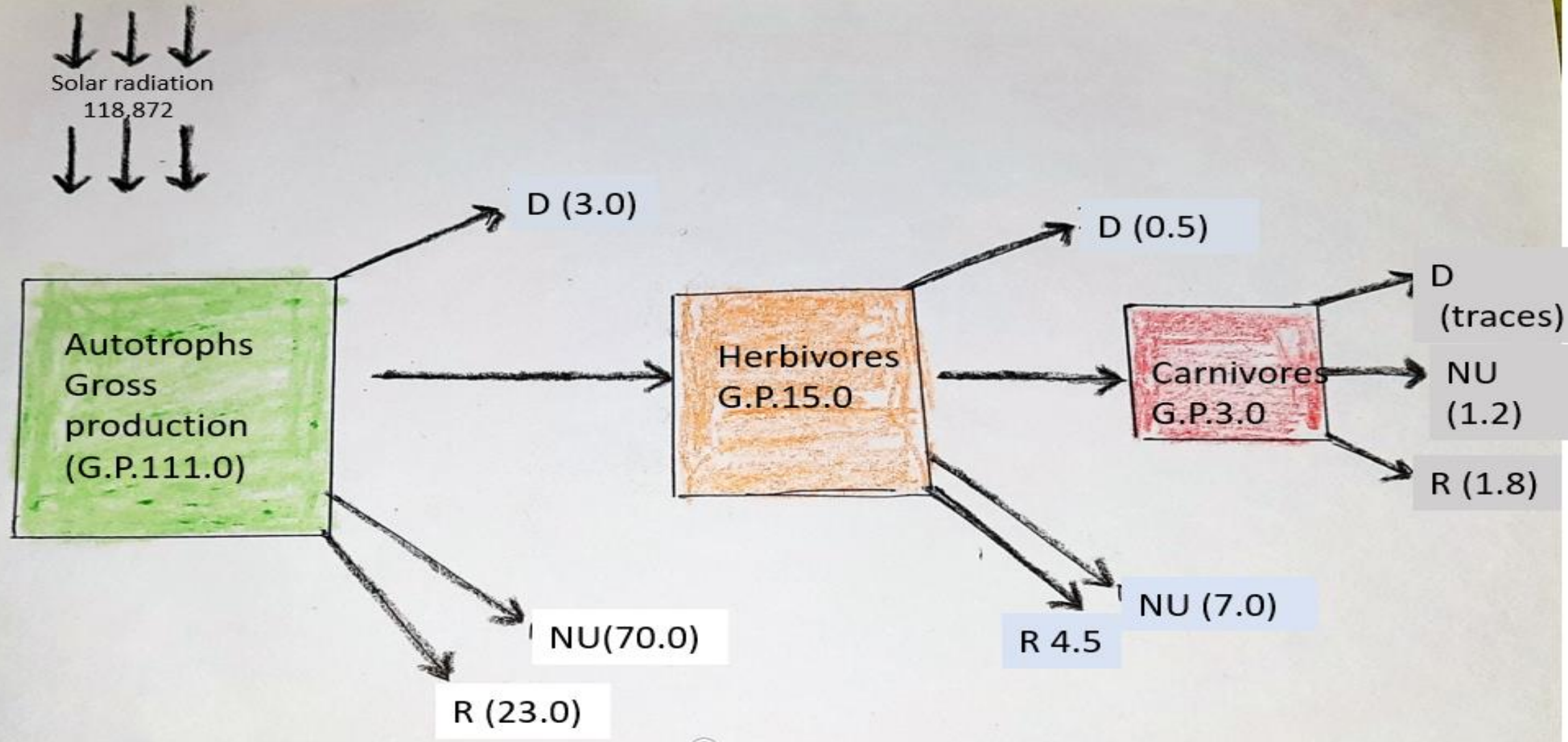
Energy inflow balances energy outflow i.e. energy can neither be created nor destroyed (**first law**).

Then with each transfer of energy, there is loss of energy as unavailable heat (**second law**).

Discription of figure given on next page:

Out of the total incoming solar radiation 118,872 g cal/cm2/yr, 118,761 g cal/cm2/yr remain unutilized. Only 111 g cal/cm2/yr i.e. 0.093% is utilized by green plants for photosynthesis.

23 g cal/cm2/yr or 21% is utilized by autotrophs in their metabolism. 15 g cal/cm2/yr i.e. 17% of net autotroph production is consumed by herbivores. In decomposition 3 g cal/cm2/yr or 3.4%of net production is utilized. 70 g cal/cm2/yr or 79.5% of net production totally remains unutilized.

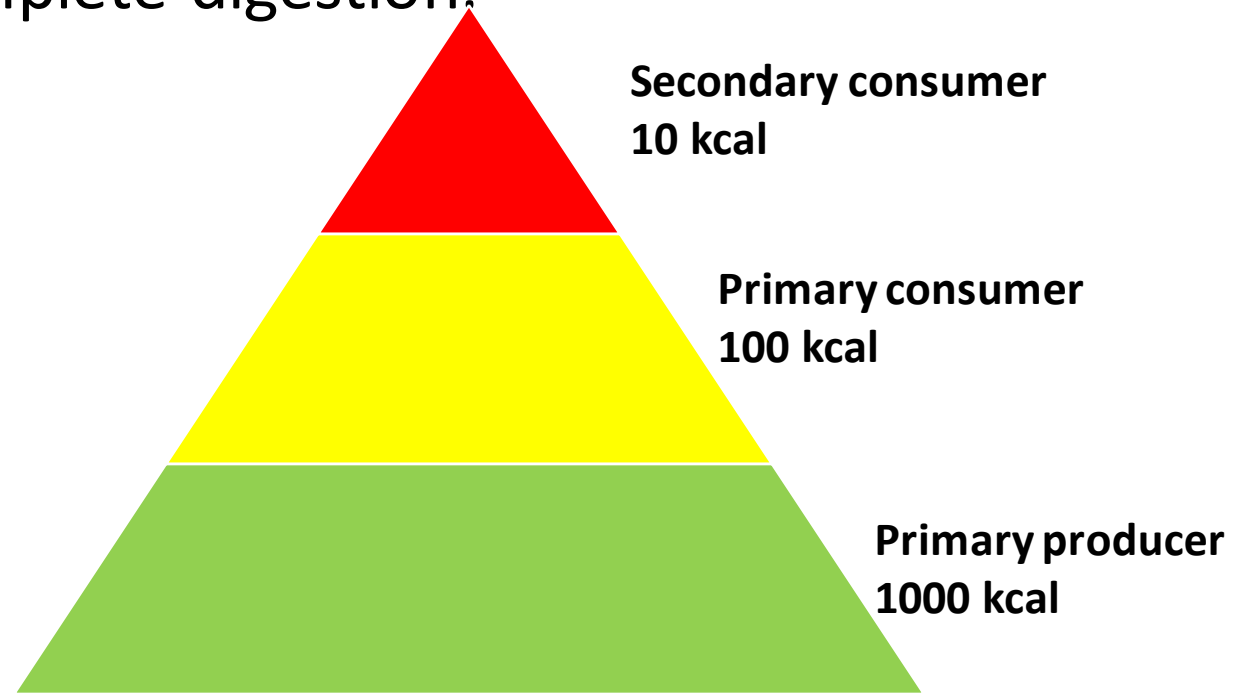


Energy flow diagram for a lake (fresh water ecosystem) in g cal/cm²/yr

D = Decomposition ; NU = Not utilised ; R = Respiration

Ecological efficiency: describes the efficiency with which energy is transferred from one trophic level to next in an ecosystem.

Ten Percent Law: The 10% law of transfer of energy is attributed to **Raymond Lindeman** (1942). According to this law during transfer of food energy from one trophic level to another in an ecosystem only about 10% is stored in form of biomass. The remaining energy is either lost as heat, or used in respiration or lost to incomplete digestion.



THANKS