

# Introduction to Environmental Studies

## B. Tech 3<sup>rd</sup> Semester



# Ecosystem

Department: Chemistry  
Subject: IES (CHM 2041)



# Topic to be discussed

- Introduction
- Types of ecosystem
- Structure of ecosystem
- Function of ecosystem
- Food chain and Food web
- Energy flow in a ecosystem
- Primary production and secondary production
- Ecological Pyramids
- Nutrient flow, Nitrogen cycle, carbon cycle, hydrological cycle

# Ecology

❑ The term Ecology was coined by Earnst Haeckel in 1869.

It is derived from the Greek words **Oikos- home** + **logos- study**. So ecology deals with the **study of organisms in their natural home and interacting with their surroundings**

**According to Tansley (1935):** An ecosystem is a group of biotic communities of species interacting with one another and with their non-living environment exchanging energy and matter.

Ecology is the study of interactions among organism or group of organisms with their environment. The environment consists of both biotic components (living organisms) and abiotic components (non – living organisms). or Ecology is the study of ecosystems.

## POPULATIONS



Total individuals belonging to **ONE SPECIES** in a habitat

## COMMUNITIES

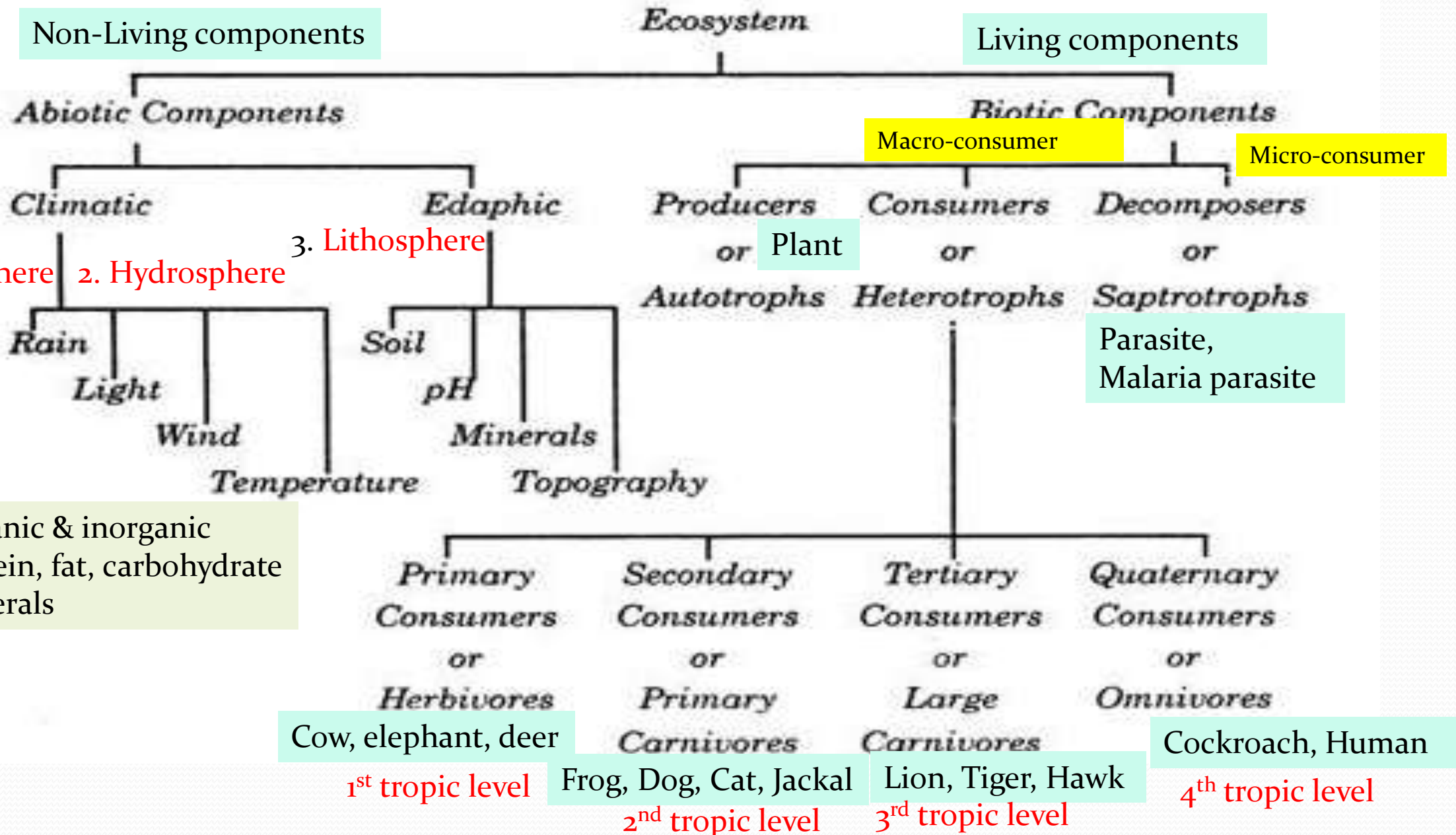


All the combined populations in a habitat

# Structure of Ecosystem

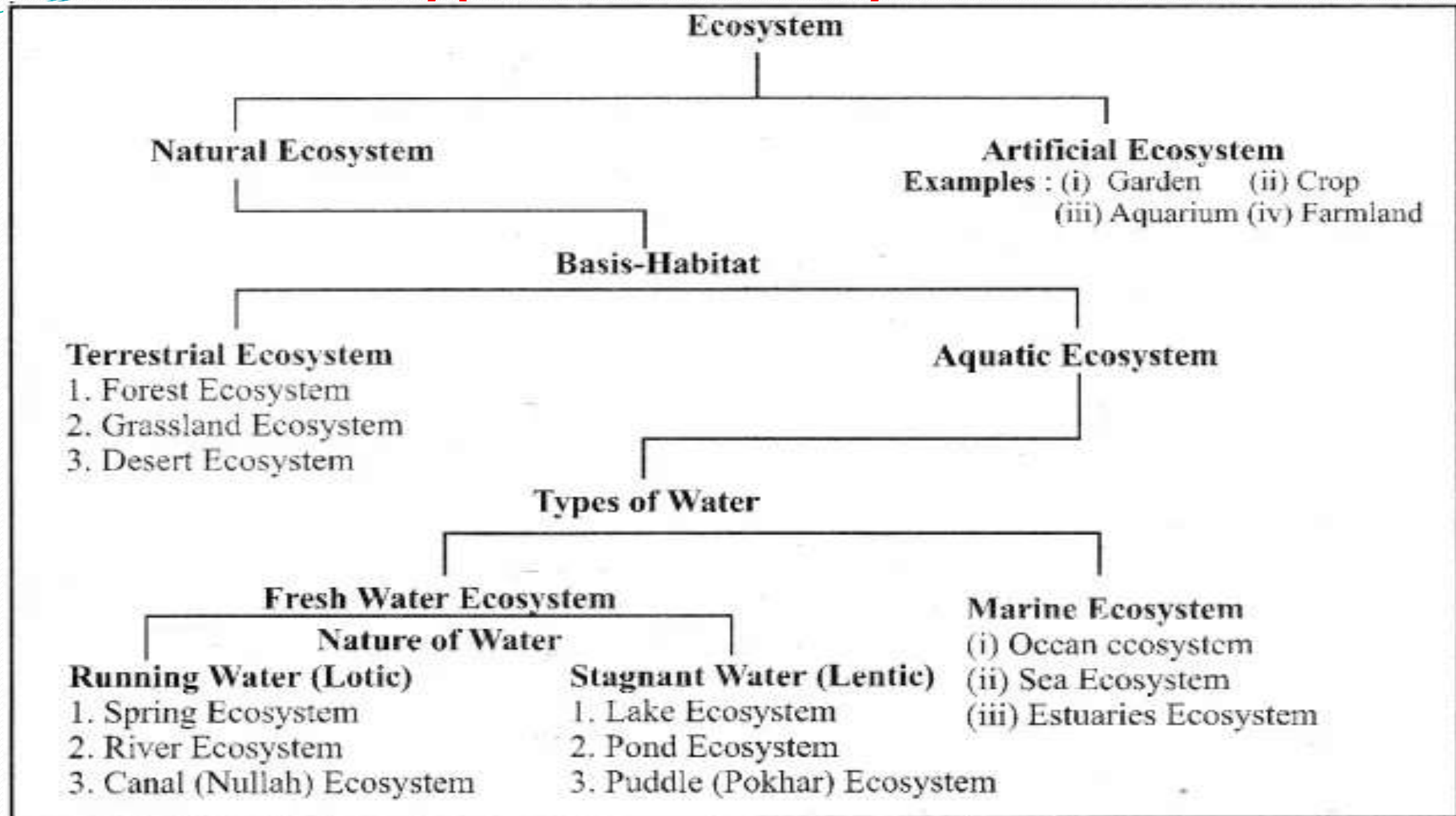
Non-Living components

Living components





# Types of Ecosystem



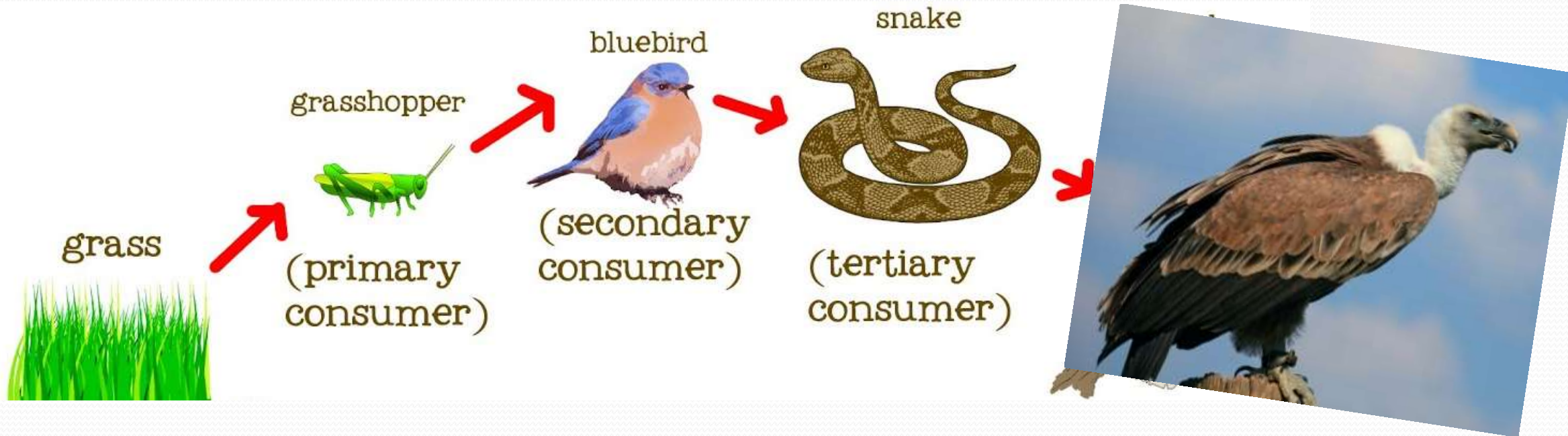
# Function of Ecosystem

The major functional of ecosystems are as follows:

- (i) **Primary function**: Photosynthesis
- ii) **Secondary function**: Transfer of energy (Energy flow) to all consumer
- Iii) **Tertiary function**: Food chain, food webs and trophic structure
- (ii) Nutrients flow (Biogeochemical cycles)
- (iii) Primary and Secondary production
- (iv) Ecosystem development and regulation
- (v) Control species gradient
- (vi) Pollution control such as CO<sub>2</sub> by plant, Nitrogen fixation by *Rhizobium* bacteria

# Food Chains

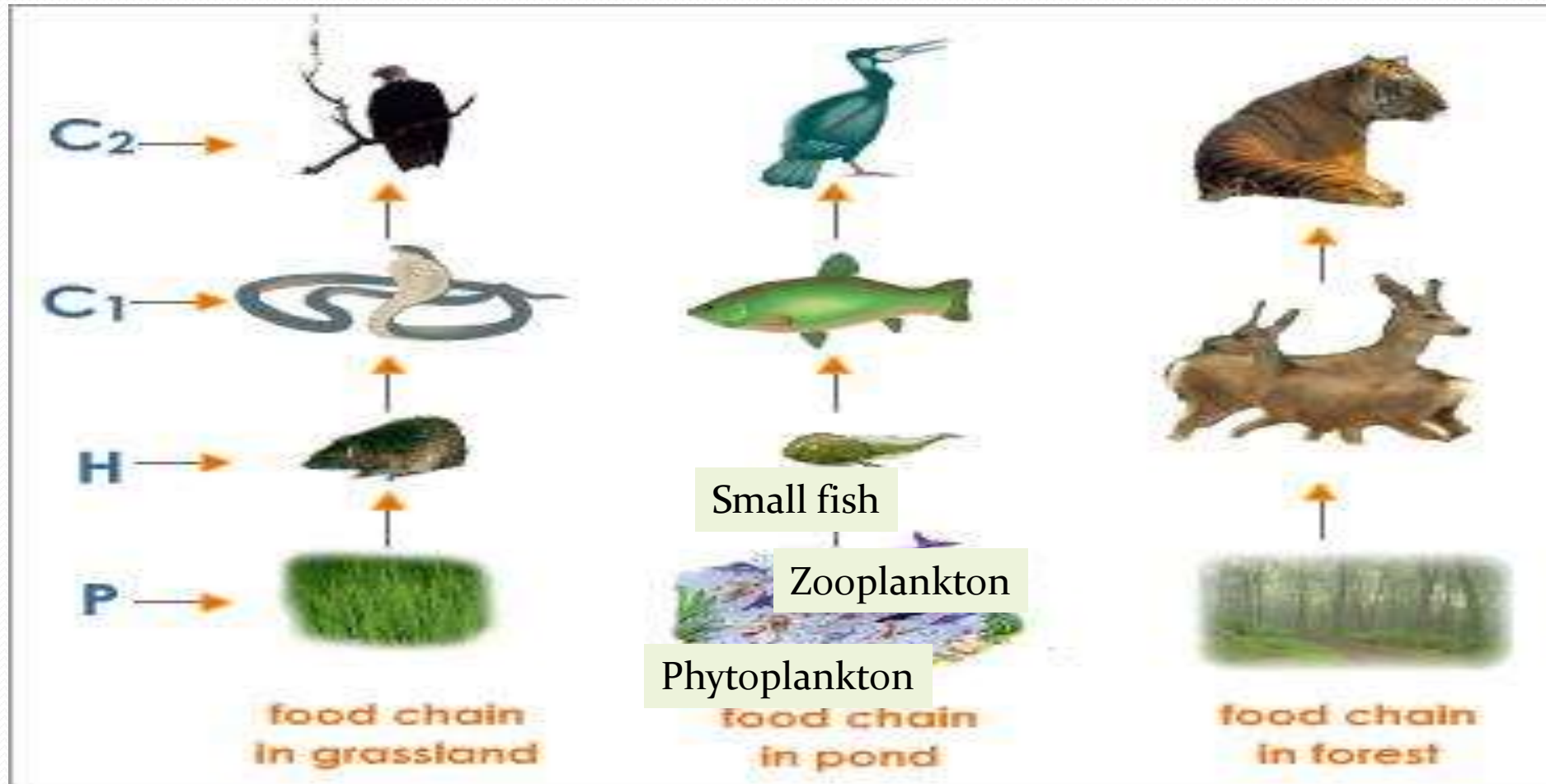
**Food chain:** Transfer of food energy/ chemical energy from producer/plant to higher successive trophic level by eating and being eaten.



# Types of Food Chains

## Types of Food Chain

i) **Grazing/ predator food chain:** Food chain Start with grazing or killing as shown in figure





# Types of Food Chains

ii) **Detritus Food chain:** Start with dead and decaying material



iii) **Parasitic Food Chain:** Parasite is taking food from living host

Plant → Fruit eating bird → Lice and Bug → Bacteria/ Fungi

## Consumers

**Detritivores** eat dead plants and animals (also called **decomposers**)

### Detritivore Examples:

- Worms
- Beetles
- Bacteria
- Fungi

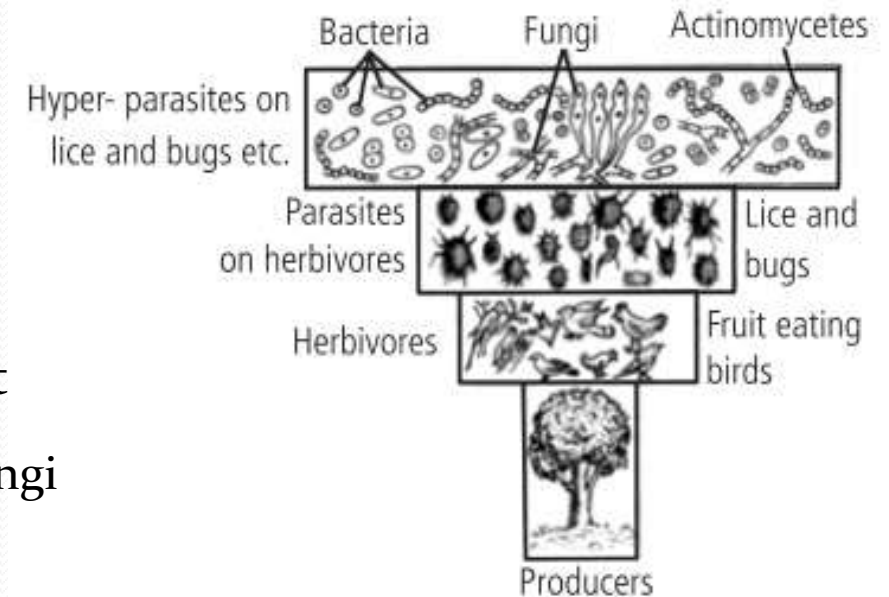
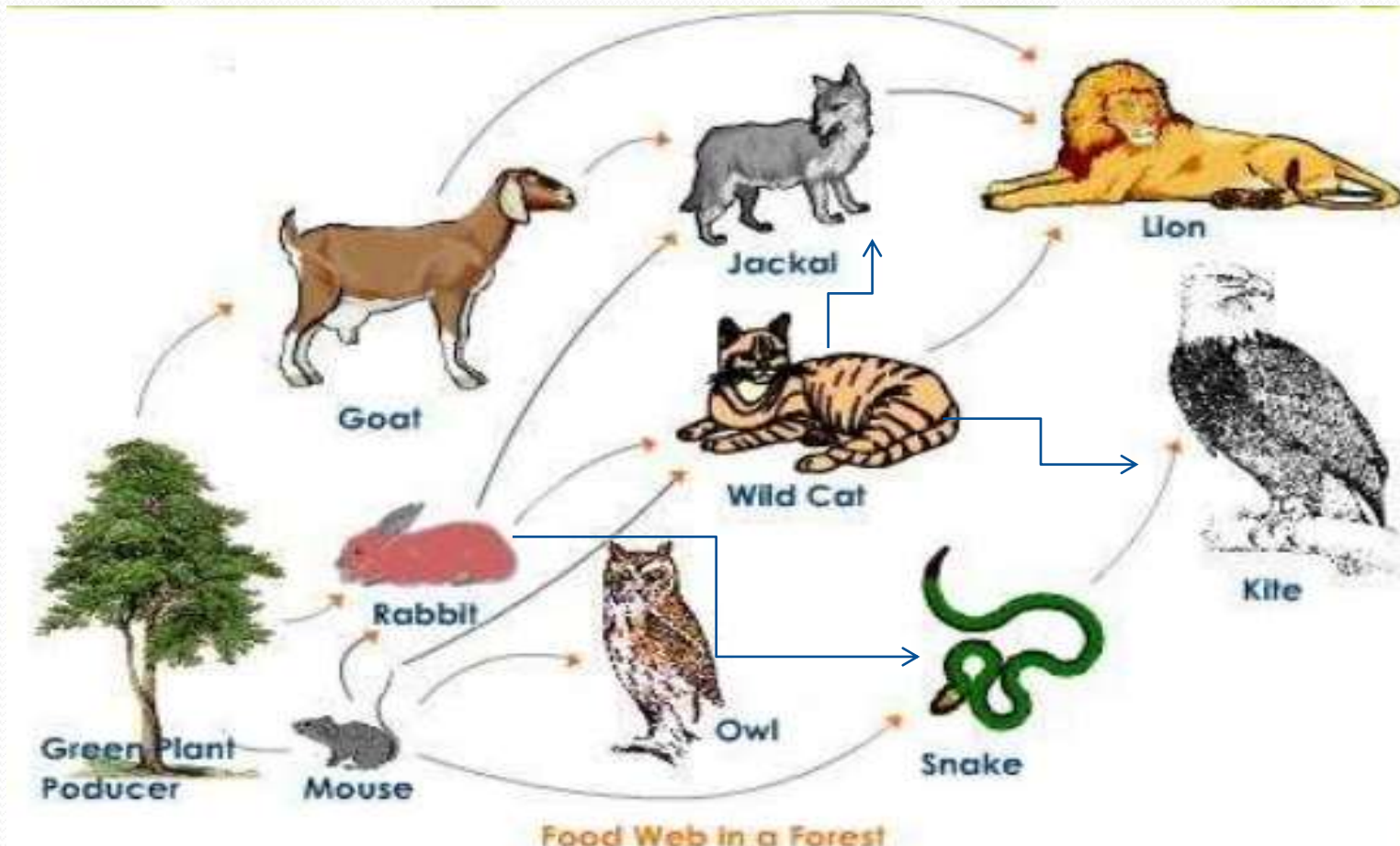


Fig.: Pyramid of numbers in parasitic food chain

# Food web

**Food web:** The interconnection of different types of food chain in a ecosystem by different types of organisms at different tropic levels, forming a web like structure collected Food web. Where different types of organisms are connected at different tropic levels

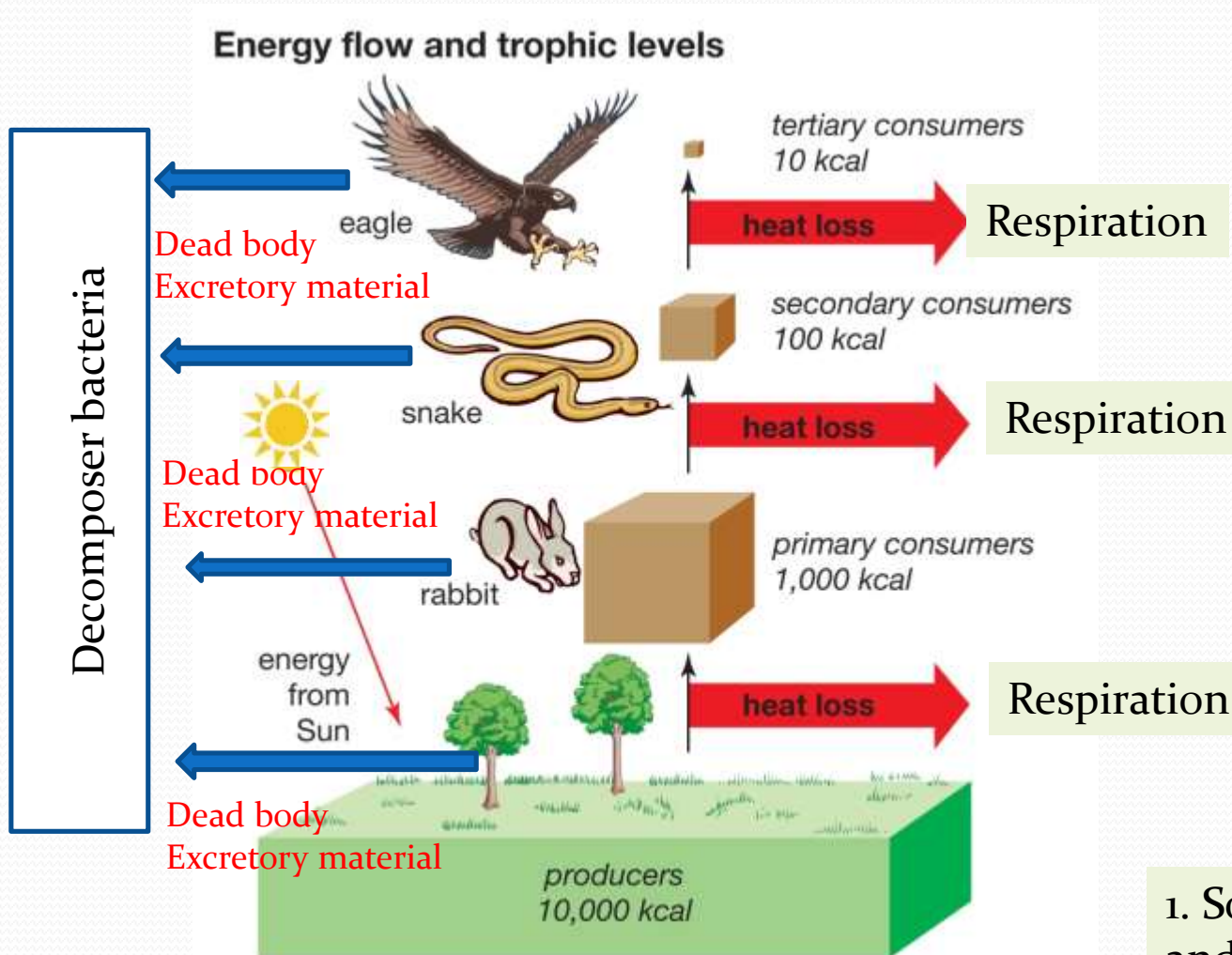




# Significant of Food chains and Food webs

1. Food chains and food webs play a very important role in the ecosystem. Energy flow and nutrient
  2. cycling takes place through them.
  3. They maintain and regulate the population size of different trophic levels, and thus help in maintaining ecological balance.
  4. They have the property of bio-magnification. The non – biodegradable materials keep on passing from one trophic level to another. At each successive trophic level, the concentration keep on increasing. This process is known as bio-magnification.
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# Energy flow in a Ecosystem



Energy flow is unidirectional but nutrient flow is cyclic

4. Some food energy stored in consumer system & plant (excretory Material) move to (flow) **decomposer bacteria** and stop the flow of energy

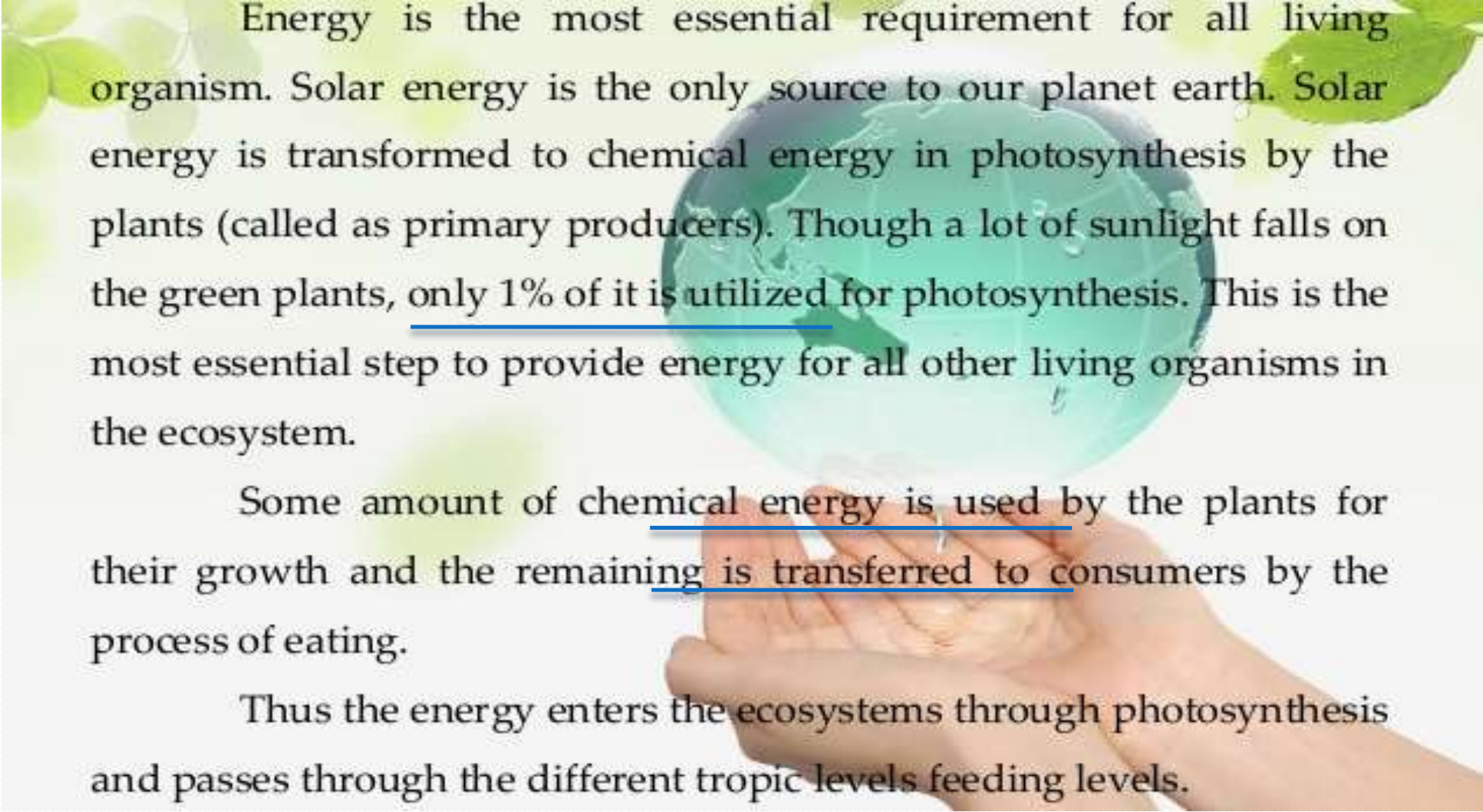
3. Some food energy is utilized for metabolism of food material in the consumer system called **respiratory Energy**

2. Plants biochemical energy (Food energy) consumed by primary, secondary and tertiary consumer where food energy is converted to mechanical energy, heat energy, sound energy, potential energy etc energy. Follow 2nd law of thermodynamics. Each step **90% energy loss** in the form of heat, sound, respiration energy.

1. Solar **radiation energy** is trapped by plants and in photosynthesis and converted to **biochemical energy (Food energy)**. Follow 1<sup>st</sup> law of thermodynamics.



# Energy Flow



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. This is the most essential step to provide energy for all other living organisms in the ecosystem.

Some amount of chemical energy is used by the plants for their growth and the remaining is transferred to consumers by the process of eating.

Thus the energy enters the ecosystems through photosynthesis and passes through the different tropic levels feeding levels.

# Primary production

- **Primary productivity:** The rate at which radiant energy (light energy) is converted into chemical energy and stored in a plant by photosynthesis process **per unit area per unit time** called **Gross Primary Production (GPP)**
- **Respiration energy:** When organic matter is produced by the primary producers (mainly green plants and some microorganisms), **fraction of chemical energy is oxidized or used in the metabolic process of photosynthesis inside their body and converted into carbon-dioxide** which is released during respiration called respiration energy and is accompanied by loss of energy. (R)
- Thus **Net Primary Production (NPP)** = Gross Primary Production (GPP) – Respiratory energy (R).  
$$\text{NPP} = \text{GPP} - \text{R}$$

**Secondary Production:** The energy stored at consumer level for use by the next trophic level is thus defined as secondary production

# Ecological Pyramids

## Definition

“Graphical representation of structure and function of trophic levels of an ecosystem, starting with producers at the bottom and each successive trophic levels forming the apex is known as an ecological pyramids.”

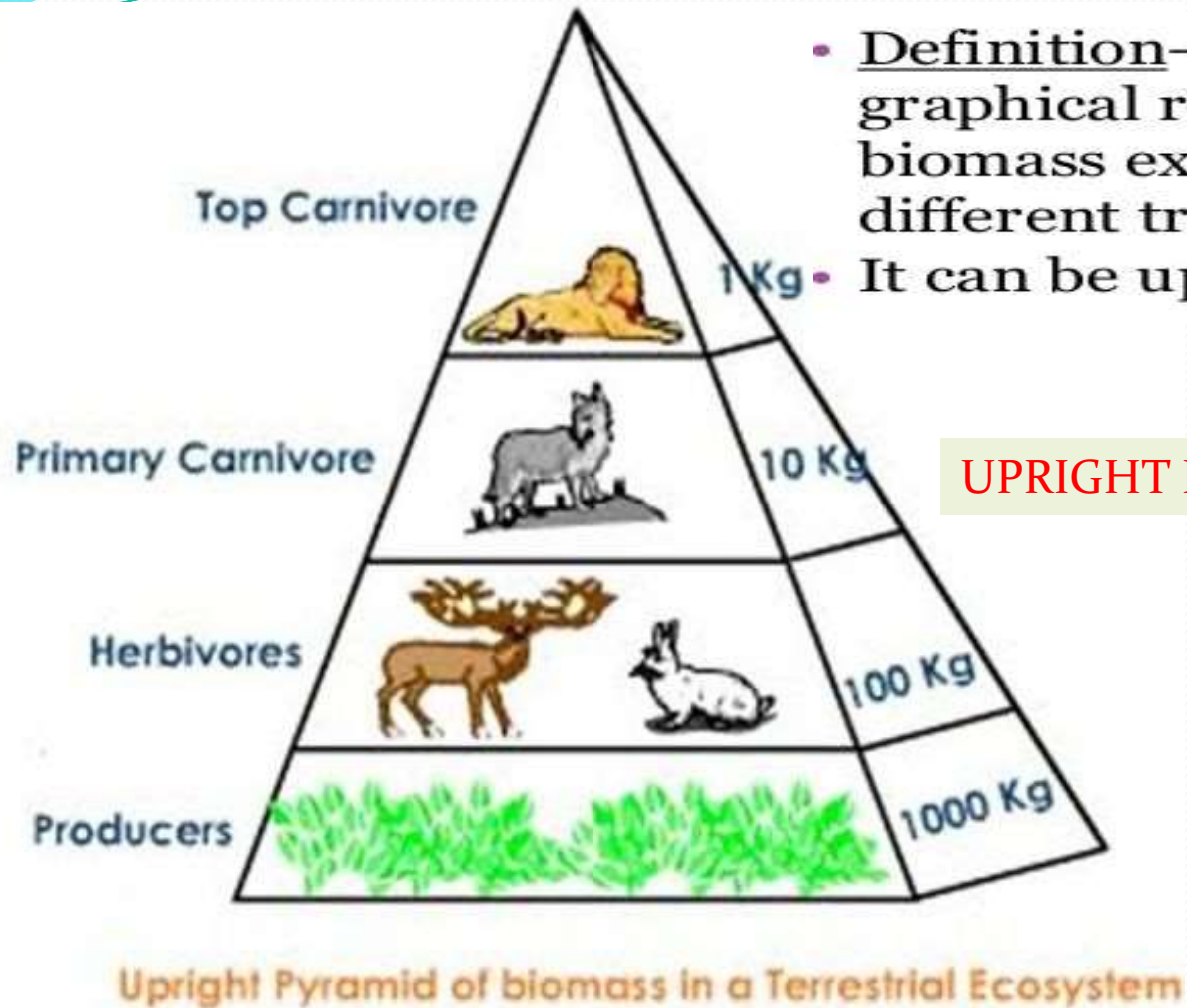
In food chain starting from the producers to the consumers, there is a regular decrease in the properties (ie., biomass and number of the organisms). Since some energy is lost as heat in each trophic levels, it becomes progressively smaller near the top.

## Types of Ecological pyramids

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



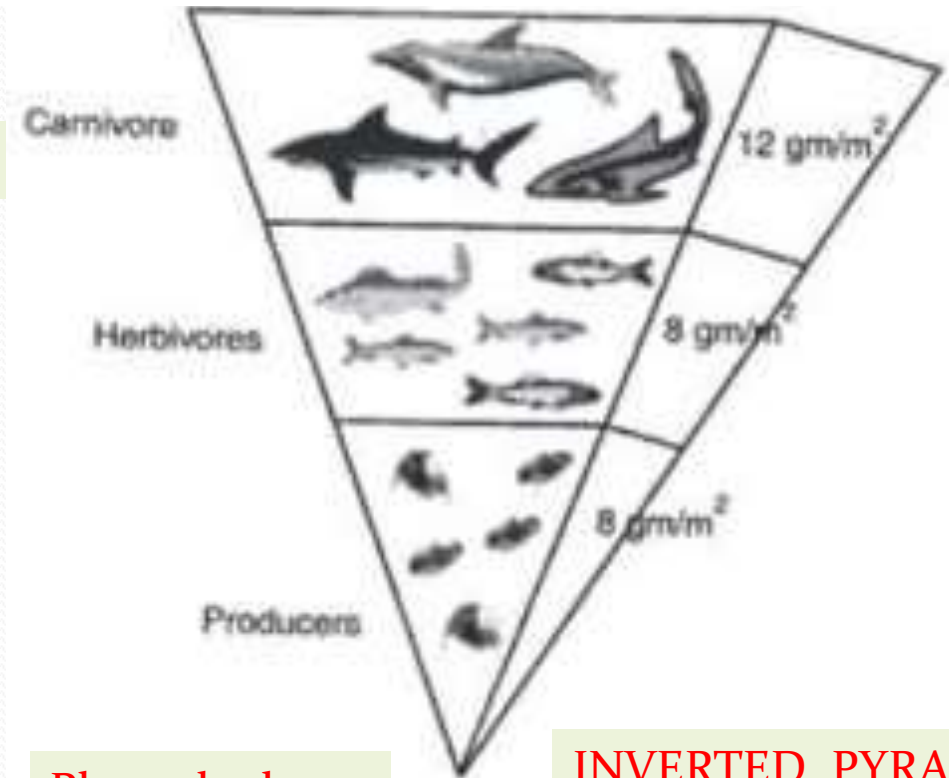
# Pyramids of Biomass



- Definition– The pyramid of biomass is a graphical representation that depicts the biomass existent in per unit area in all the different trophic level of the ecological system.
- It can be upright and inverted.

UPRIGHT PYRAMID

A pyramid of biomass shows the weight of biomass/organism  
At stages of food chain



Phytoplankton

INVERTED PYRAMID

A pyramid of biomass in aquatic system



# Pyramid of Biomass

It represents the total amount of biomass (mass or weight of biological material or organism) present in each trophic level.

A forest ecosystem

The above figure shows that there is a decrease in the biomass from the lower trophic level to the higher trophic level. This is because the trees (producers) are maximum in the forest, which contribute a huge biomass. The next trophic levels are herbivores (insects, birds) and carnivores (snakes, foxes). The top of the trophic level contains few tertiary consumers (e.g. tigers), the biomass of which is very low.

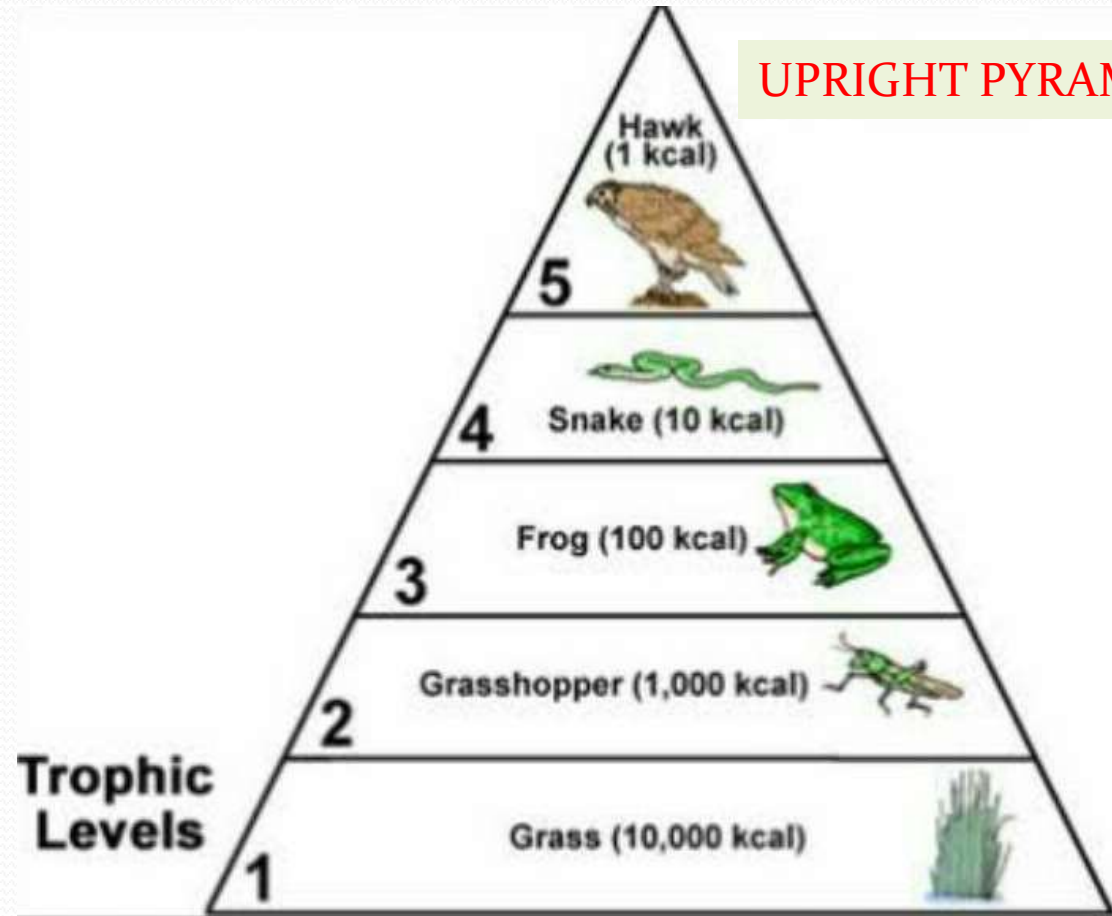
# Pyramid of Number

Definition– the number of organisms in a food chain can be represented graphically in a pyramid. Each bar represents the number of individuals at each trophic level in the food chain.

It can be upright and inverted.

A pyramid of numbers can be used to show the **number** of organisms at **each stage** of a food chain.

## UPRIGHT PYRAMID



- Pyramid of Number in grass land ecosystem

## INVERTED PYRAMID

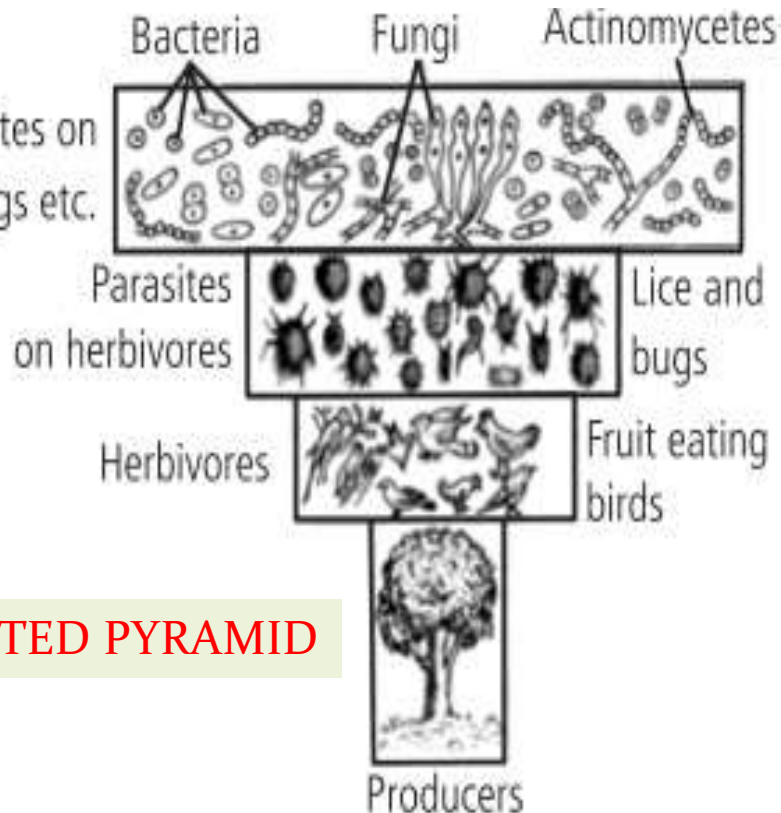
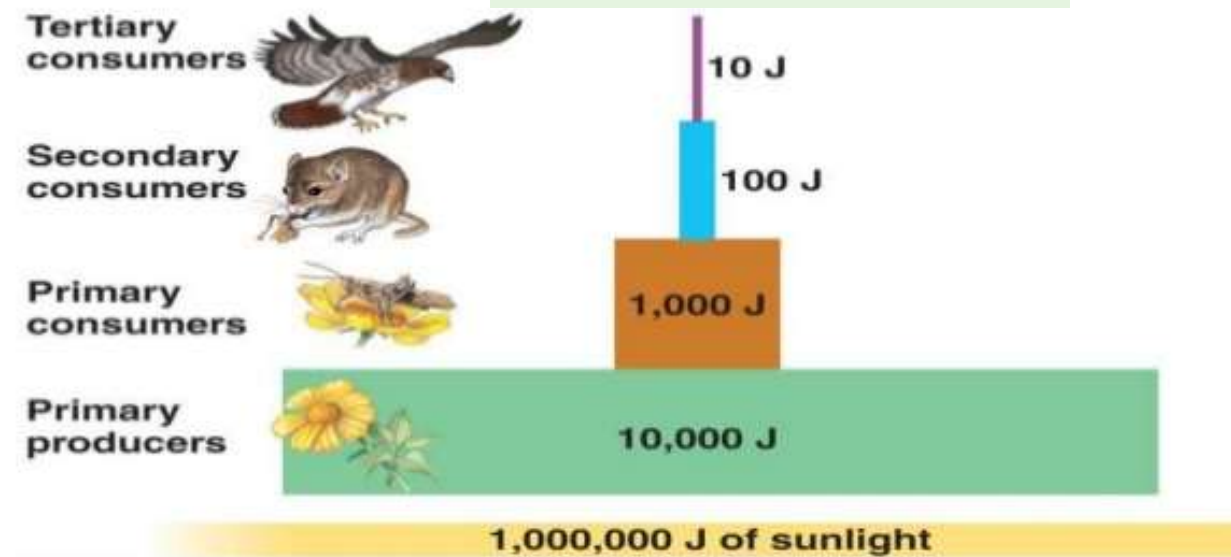


Fig.: Pyramid of numbers in parasitic food chain



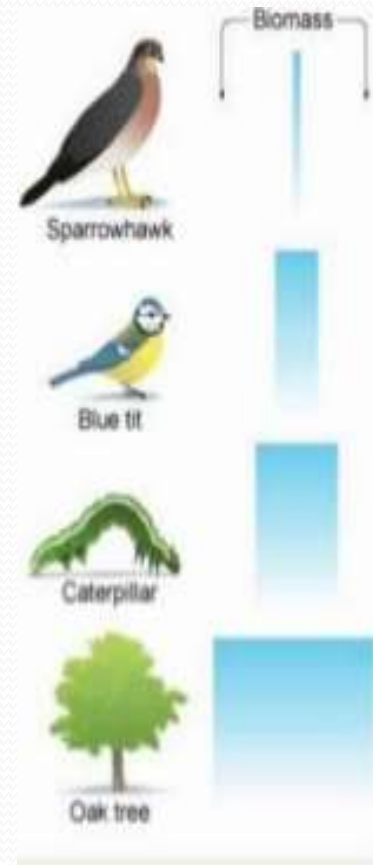
# Pyramid of Energy

- Definition- An energy pyramid is a graphical model of energy flow in a community. The different level represent different group of organism that might composed of food chain.
- Pyramid of energy is always upright as it follows the second law of thermodynamics which states that as energy is transferred or transformed, more and more of it is transferred to other form



- Only 10% of the energy is available to next trophic level (as per Lindemann's ten percent rule)

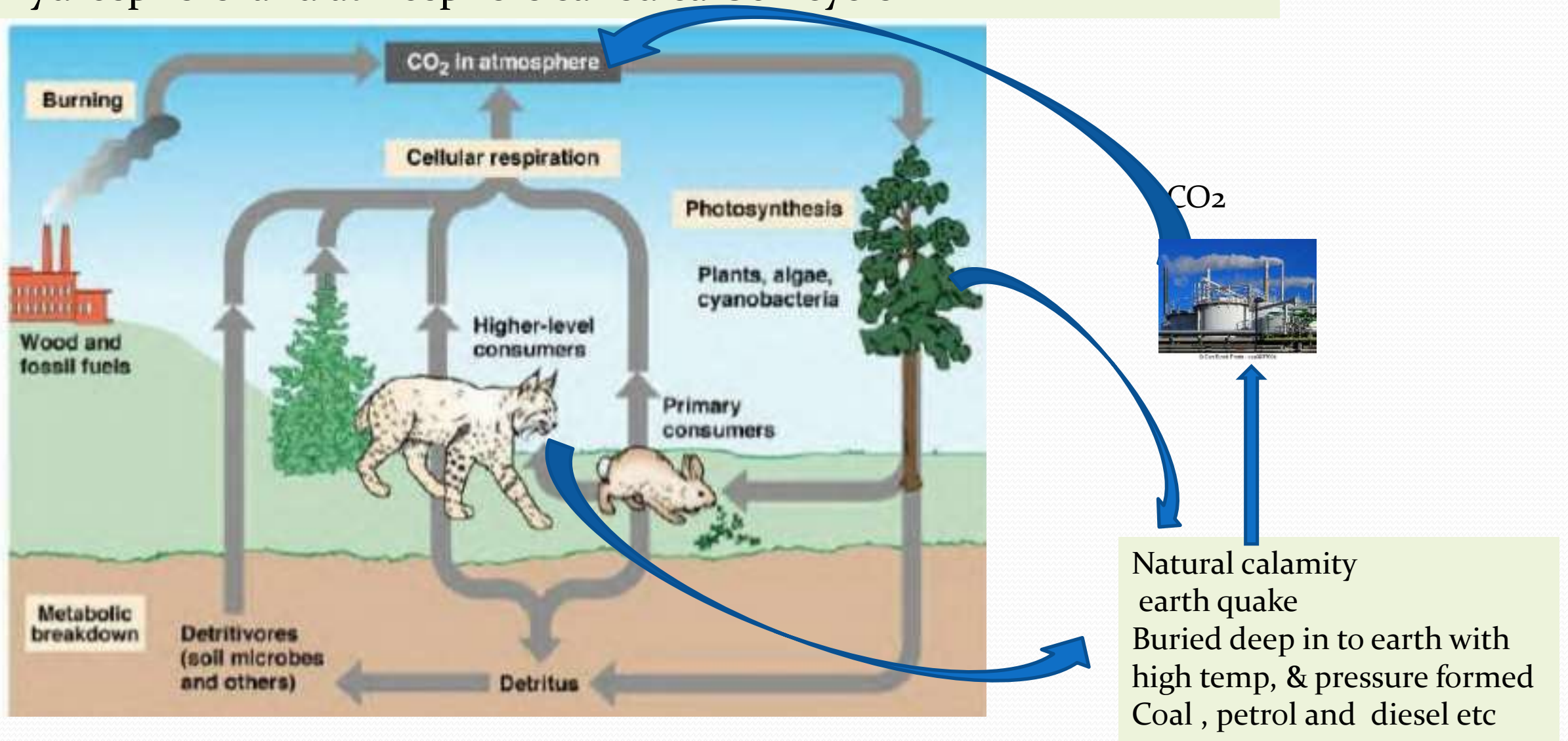
- The energy level of each trophic level has two parts i.e. Net Production (NP) and Respiration (R) and measured in  $\text{KJ m}^{-2} \text{yr}^{-1}$



- Energy moves from one trophic level to the next.
- So energy moves from oak tree to caterpillars.
- Energy is lost at each stage due to it being lost to the environment by
  - respiration (heat energy)
  - faeces (poo)

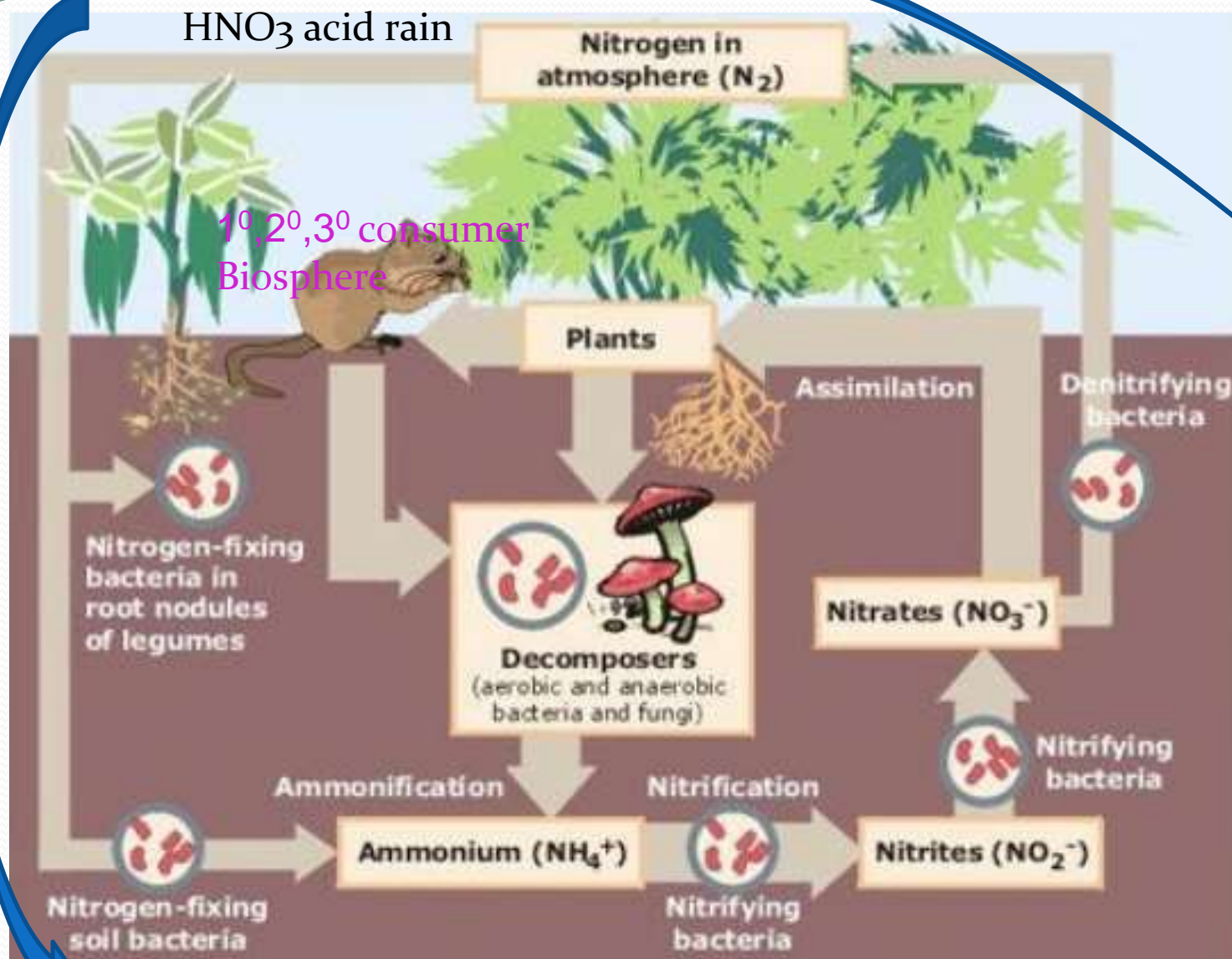
# Carbon cycle

Cyclic movement of carbon from biosphere through lithosphere, hydrosphere and atmosphere called carbon cycle





# Nitrogen cycle



- ❑ Nitrogen fixation- nitrogen gas in atmosphere to ammonia (bacteria in soil, lightning)
- ❑ Nitrification- ammonia to nitrate (bacteria in soil)
- ❑ Assimilation- absorption of ammonia and nitrate by plants
- ❑ Ammonification- break down of dead organisms returns nitrogen to soil (bacteria and fungi) as ammonia.
- ❑ Denitrification- conversion of ammonia back to nitrogen gas (decomposers).

$NO_x$

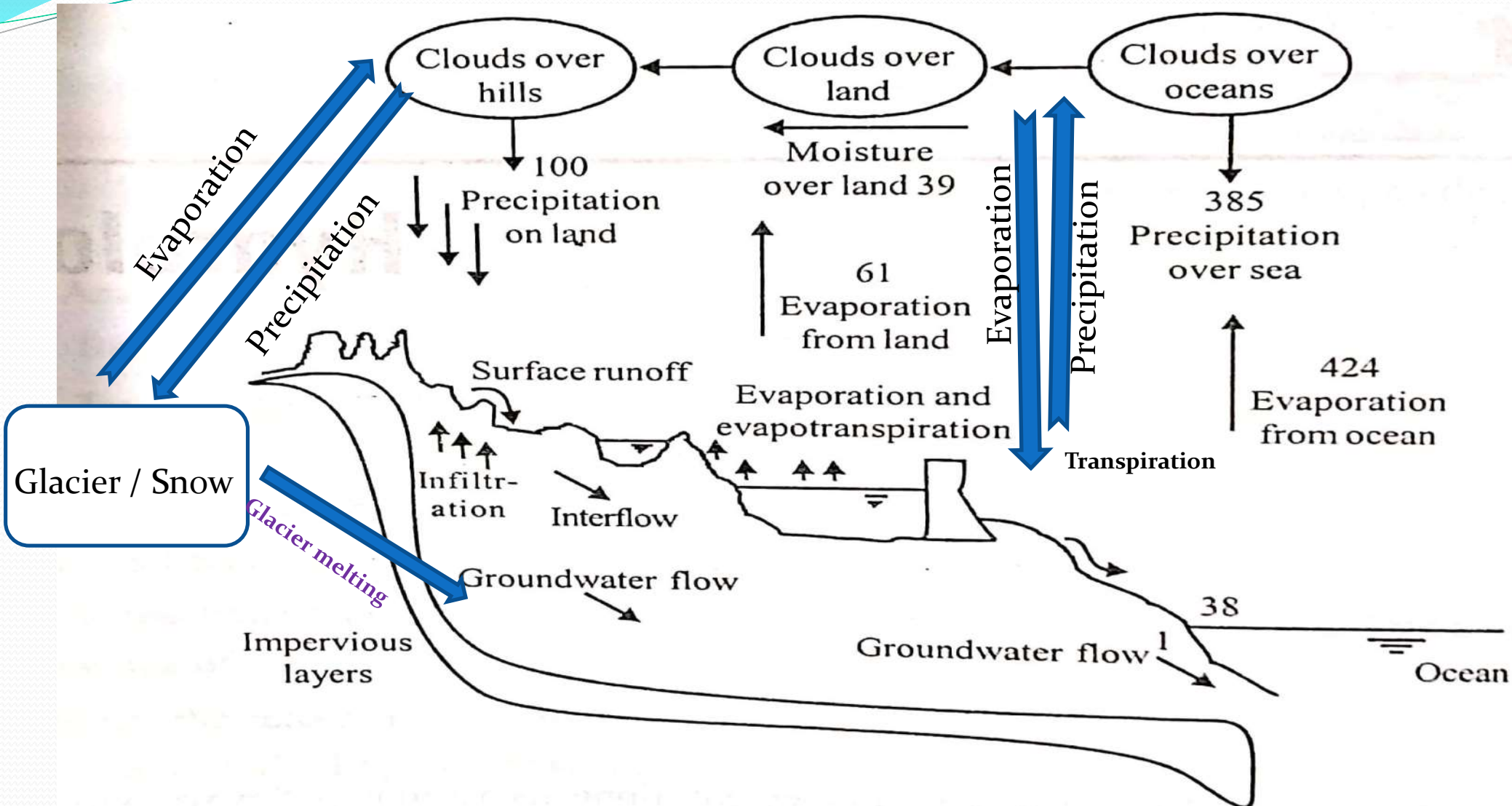


Fossil fuel etc



Lithosphere, hydrosphere, Biosphere, Industrial Nitrogen fixation

# Hydrological cycle



**Fig. 4.1** Hydrological cycle with global annual average water balance given in units relative to a value of 100 for the rate of precipitation on land.



I thank  
you!

