# HS 26 Environmental Studies

## ENVIRONMENT, ECOLOGY AND BIODIVERSITY

# Environmental science

**Environmental= Living + Non-living things.**

- Study of the environment (Biotic and Abiotic components)

## TYPES OF ENVIRONMENT

- Natural environment

  Soil, water, air, trees, noise, etc.,
- Man-made environment

  House, road, park, etc.,

# Components of environment

- Abiotic or non-living components
- Biotic or living components
- Energy components

## ABIOTIC COMPONENTS

- Atmosphere
- Lithosphere
- Hydrosphere

# Functions of atmosphere

- It sustains life on the earth.
- It observes the cosmic rays and other electron magnetic radiation coming from the sun.
- It balances heat of earth by absorption of IR and UV rays.
- It plays important role in carrying water from the ocean to the land through hydrological cycle.
- Oxygen supports living beings, $CO_2$ is essential for photosynthesis of plants.

# Structure of atmosphere

- Troposphere (0 – 18kms)
- Stratosphere (18 – 50kms)
- Mesosphere (50 – 85kms)
- Thermosphere (or) ionosphere (85 – 500kms)
- Exosphere ( upto 1600kms)

# Energy components

- Energy flow across biotic and abiotic components.

  E.g:

  - solar energy,
  - nuclear energy,
  - geochemical energy,
  - thermo electrical energy, etc.,

# Scope of environmental studies

- To get awareness and sensitivity to the total environment.
- To motivate the active participation in environmental protection and improvement.
- To know the necessity of conservation of natural resources .
- To evaluate environmental programmes in terms of social, economic, ecological and aesthetic factors.

# Need for public awareness

- Man has overexploited the natural resource which leads to many environmental problems such as acid rain, ozone layer depletion, green house effect, landslides, cancer, and other health problems.
- Lack of awareness and less number of people participation leads to poor pollution management which leads to climate instability and unhealthy eco-system


ECO-SYSTEM
Siesta Lake, Yosemite National Park, California

# ECOSYSTEM

An ecosystem is formed by the interaction between all living and non-living things.

# BIOME

Set of ecosystem which are exposed to same climatic conditions with similar life cycle, climatic conditions and physical structure.

- Biome (**small ecosystem**).

# ABIOTIC COMPONENTS

- Solar energy provides practically all the energy for ecosystems.
- Inorganic substances, e.g., sulfur, boron, tend to cycle through ecosystems.
- Organic compounds, such as proteins, carbohydrates, lipids, and other complex molecules, form a link between biotic and abiotic components of the system.

# BIOTIC COMPONENTS

living organisms of an ecosystem.

Classification of Biotic components are:

## AUTOTROPHS

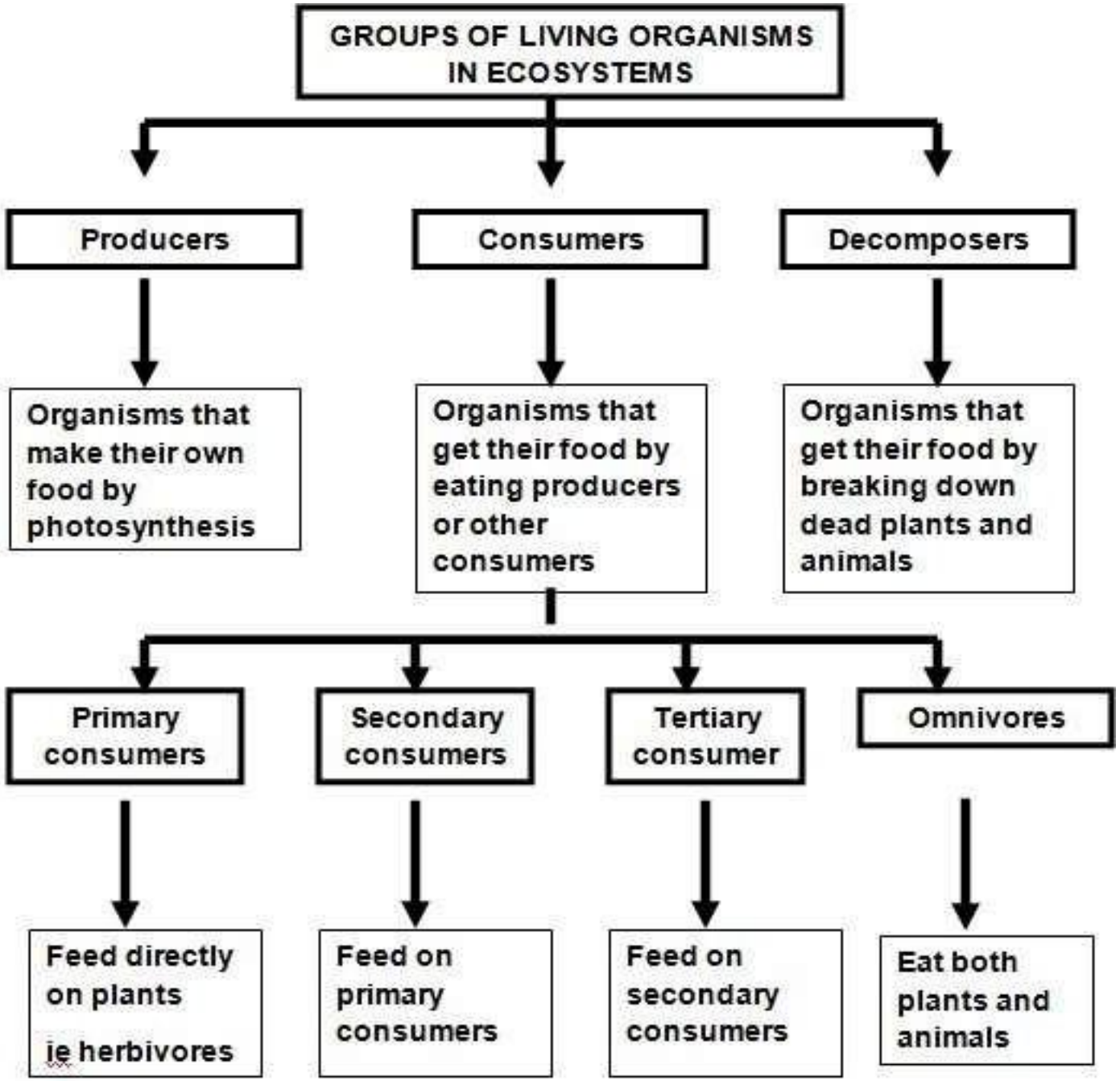
Organisms that produce their own food from an energy source, such as the sun, and inorganic compounds.

## HETEROTROPHS

Organisms that consume other organisms as a food source.

# MEMBERS OF BIOTIC COMPONENTS

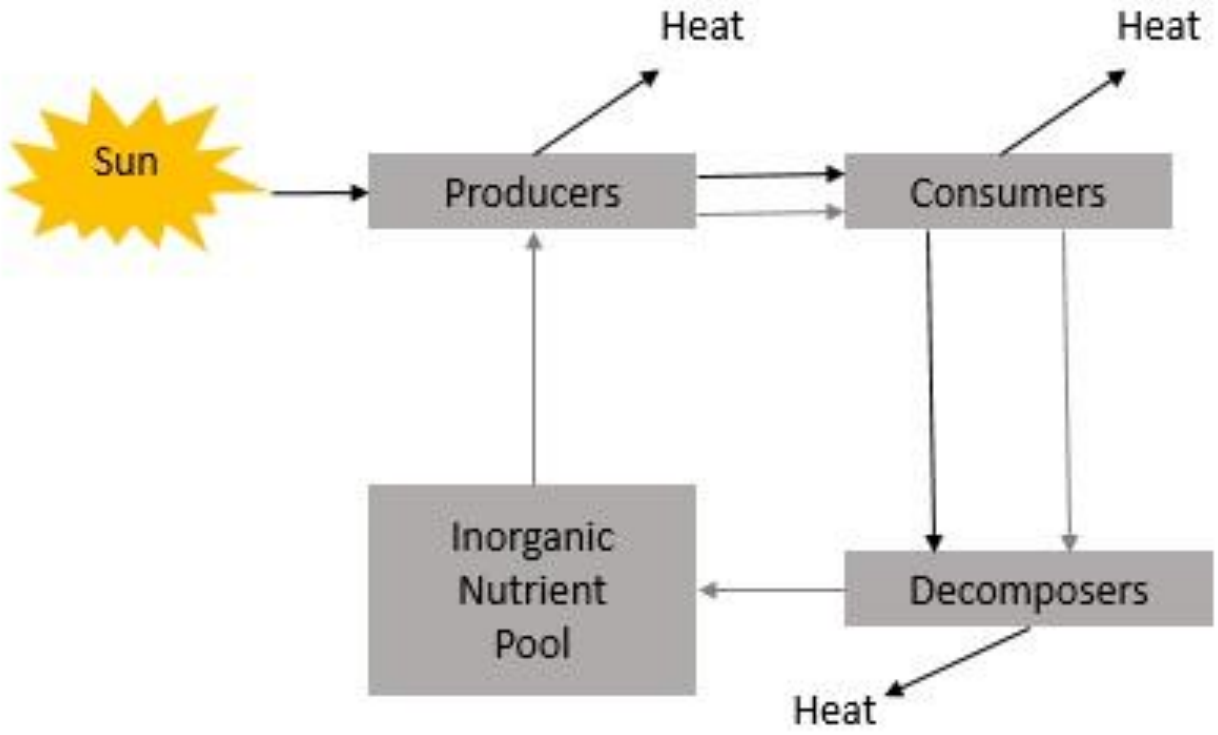
- PRODUCERS.
- CONSUMERS.
  - Primary Consumers
  - Secondary Consumers
  - Tertiary Consumers
- DECOMPOSERS.


GROUPS OF LIVING ORGANISMS IN ECOSYSTEMS
Producers
Consumers
Decomposers
Organisms that make their own food by photosynthesis
Organisms that get their food by eating producers or other consumers
Organisms that get their food by breaking down dead plants and animals
Primary consumers
Secondary consumers
Tertiary consumer
Omnivores
Feed directly on plants
ie herbivores
Feed on primary consumers
Feed on secondary consumers
Eat both plants and animals

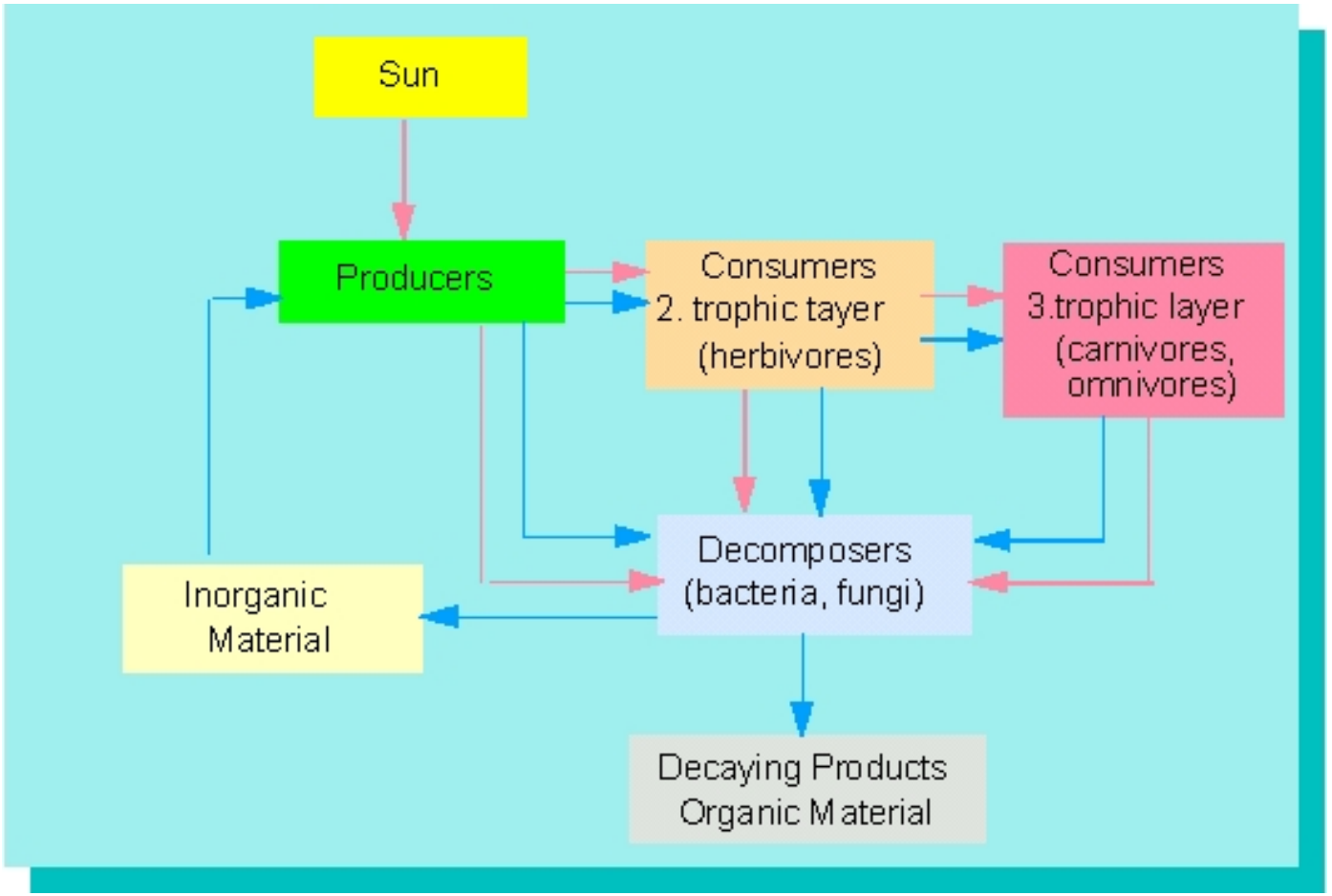
# ENERGY FLOW IN ECOSYSTEM

- Energy is defined as the capacity to do work. For living organisms, it is the basic force responsible for running all the metabolic activities. The flow of energy from producer level to top consumer level is called energy flow.
- The flow of energy in an ecosystem is unidirectional. It flows from producer level to consumer level.
- The process of energy flow involves transfer of energy from autotrophs to various components of heterotrophs and help in maintaining bio diversity.
- The main source of energy in the ecosystem is sunlight. About 80% of energy is lost during flow of energy from one tropic level to the next one.

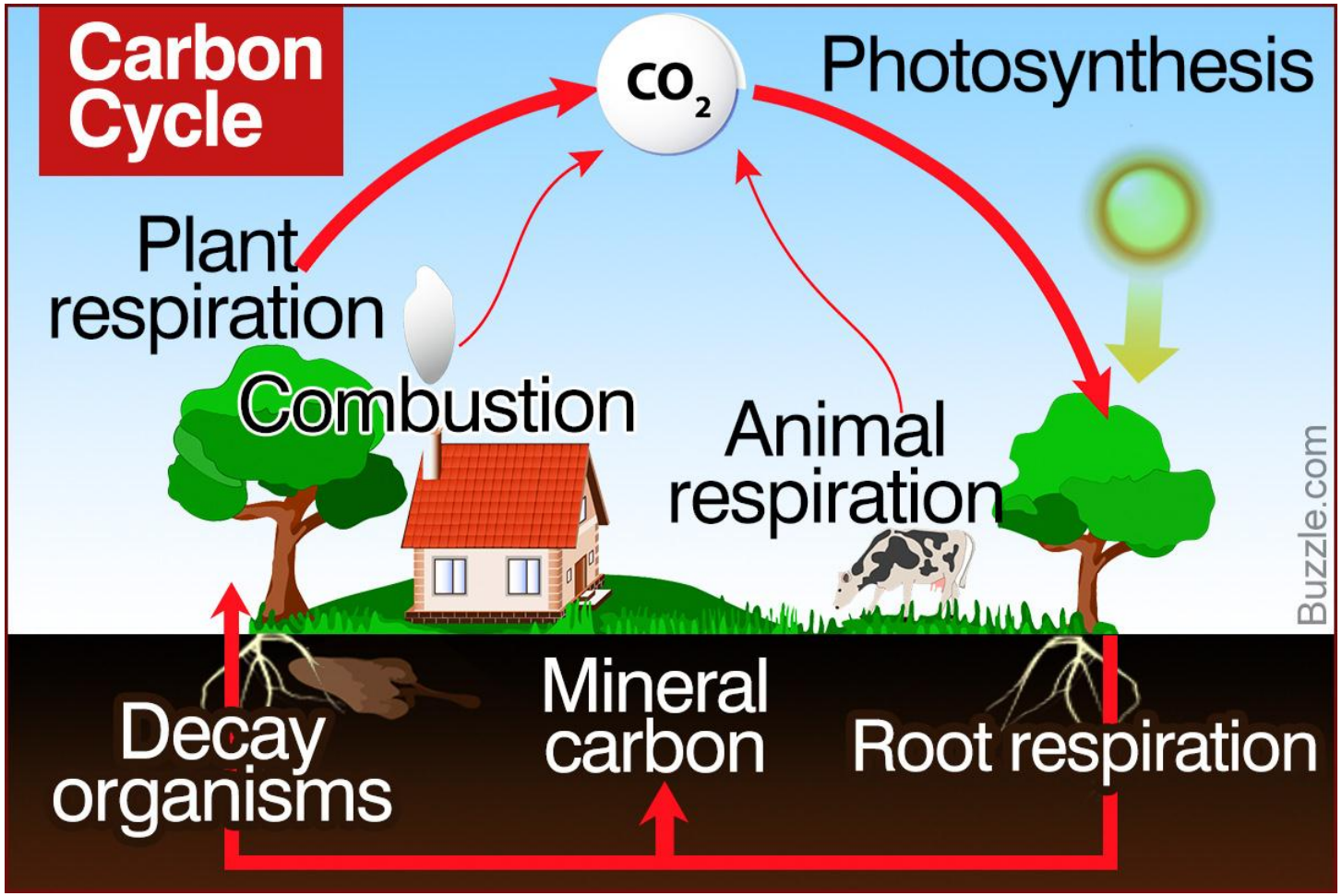
# ENERGY FLOW IN ECOSYSTEM



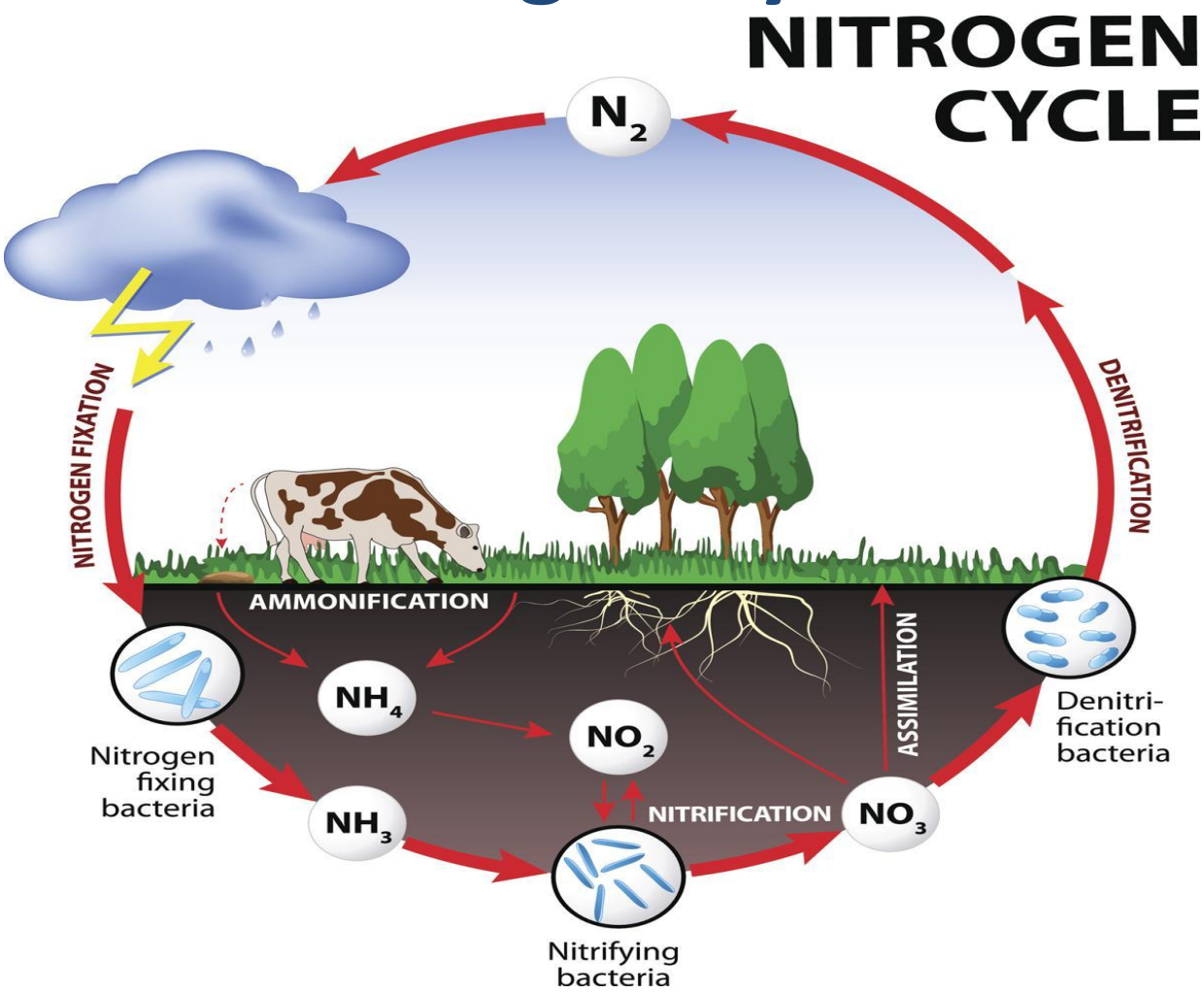
# MATERIAL FLOW IN AN ECOSYSTEM



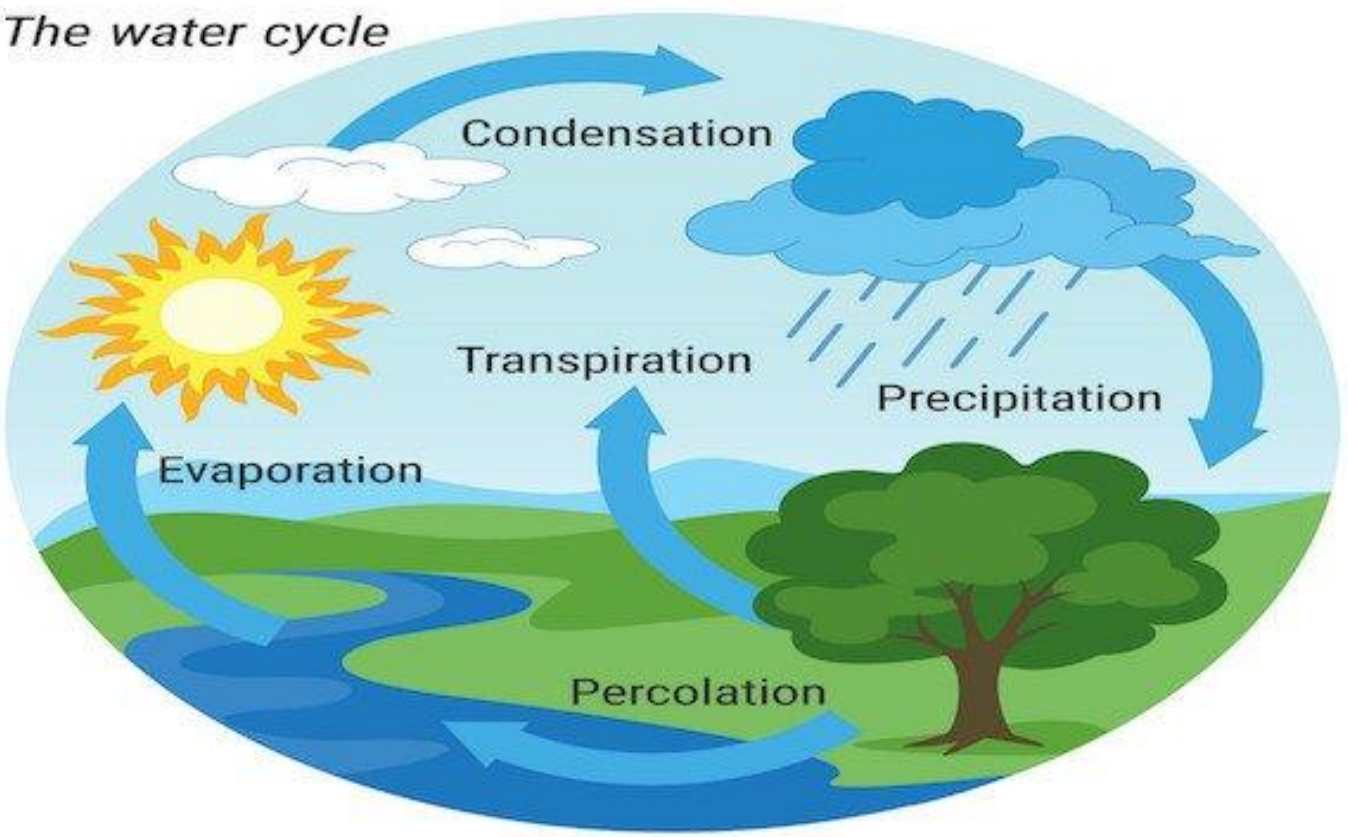
# Carbon Cycle



# Nitrogen Cycle



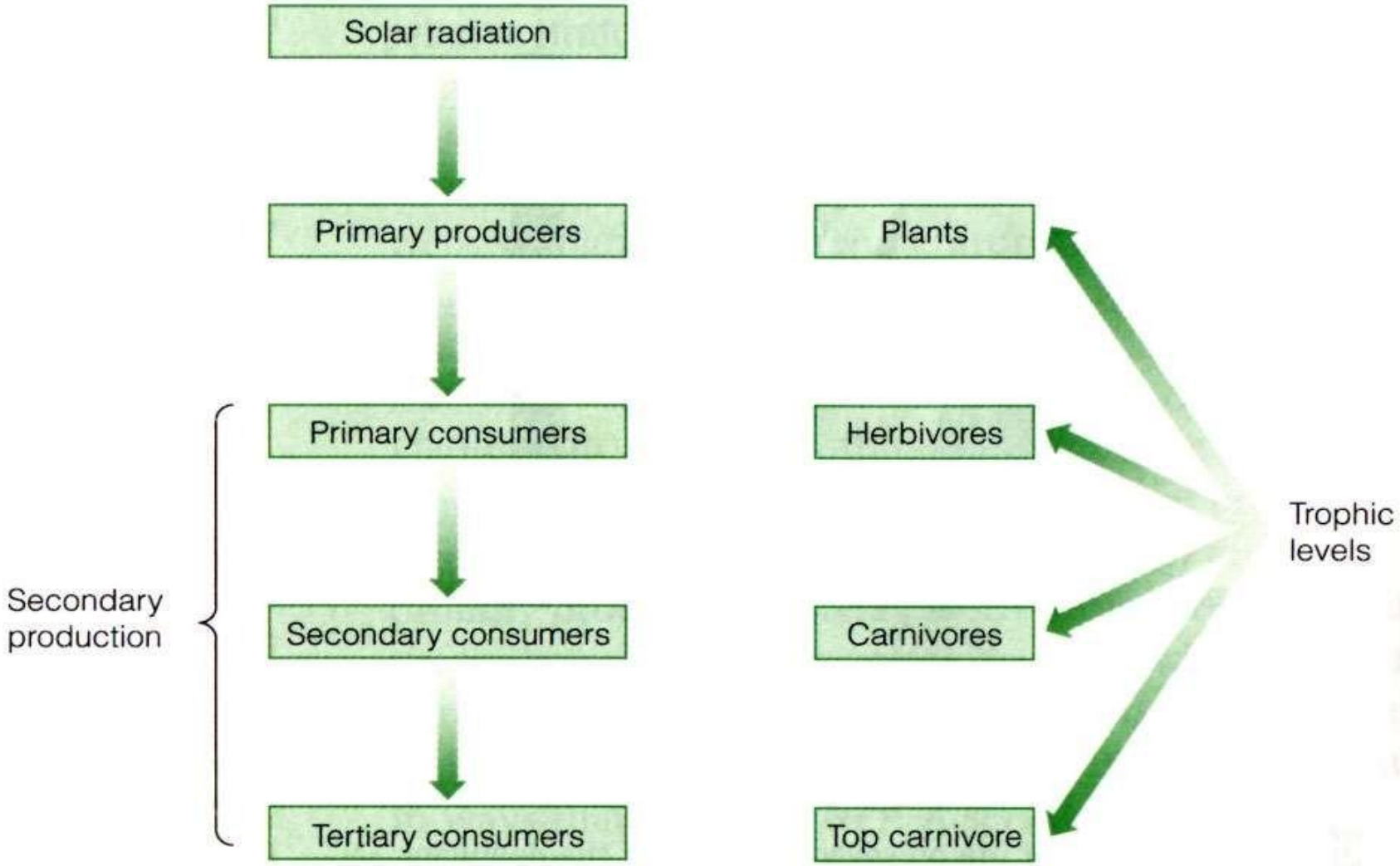
# Water Cycle


The water cycle
Condensation
Transpiration
Precipitation
Evaporation
Percolation

# Tropic Levels

**A tropic level is the position occupied by an organism in a food chain. Tropic levels can be analyzed on an energy pyramid.**

- **Producers - First tropic level.**
- **Primary consumers - Second tropic level.**
- **Secondary consumers - Third tropic level.**
- **Tertiary consumers - Top tropic level.**

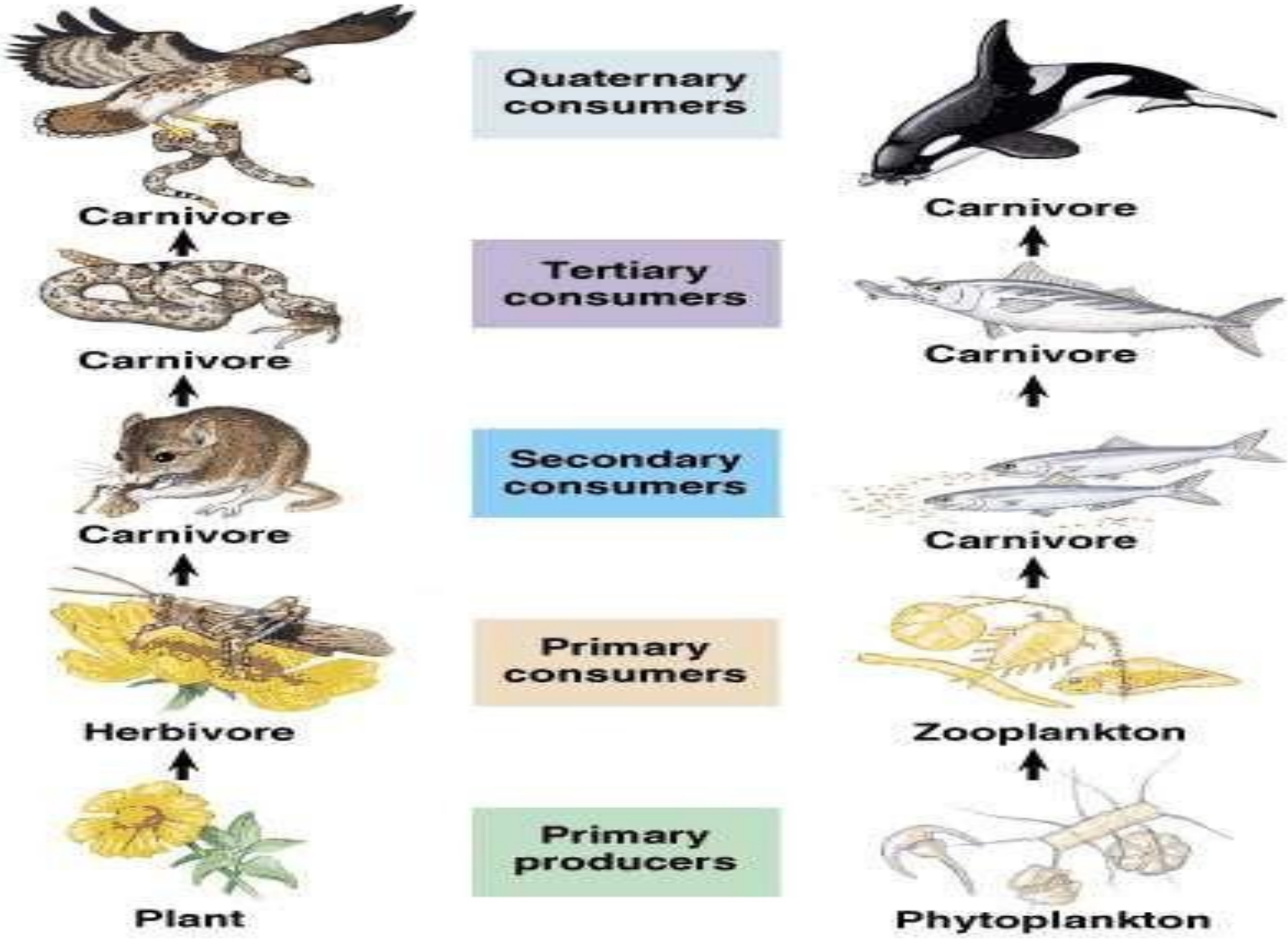



The schematic structure of a food chain. Each trophic level may contain many species.

# FOOD CHAIN IN ECOSYSTEM

- In an ecosystem one can observe the transfer or flow of energy from one tropic level to other in succession.
- A tropic level can be defined as the number of links by which it is separated from the producer, or as the which position of the organism in the food chain.
- Thus, primary producers trap radiant energy of sun and transfer that to chemical or potential energy of organic compounds such as carbohydrates, proteins and fats.
- When a herbivore animal eats a plant (or when bacteria decompose it) and these organic compounds are oxidized, the energy liberated is just equal to the amount of energy used in synthesizing the substances (first law of thermodynamics), but some of the energy is heat and not useful energy (second law of thermodynamics).

- If this animal is eaten by another one, along with transfer of energy from a herbivore to carnivore a further decrease in useful energy occurs as the second animal (carnivore) oxidizes the organic substances of the first (herbivore or omnivore) to liberate energy to synthesize its own cellular constituents.
- Such transfer of energy from organism to organism sustains the ecosystem and when energy is transferred from individual to individual in a particular community, as in a pond or a lake or a river, we come across the food chains.



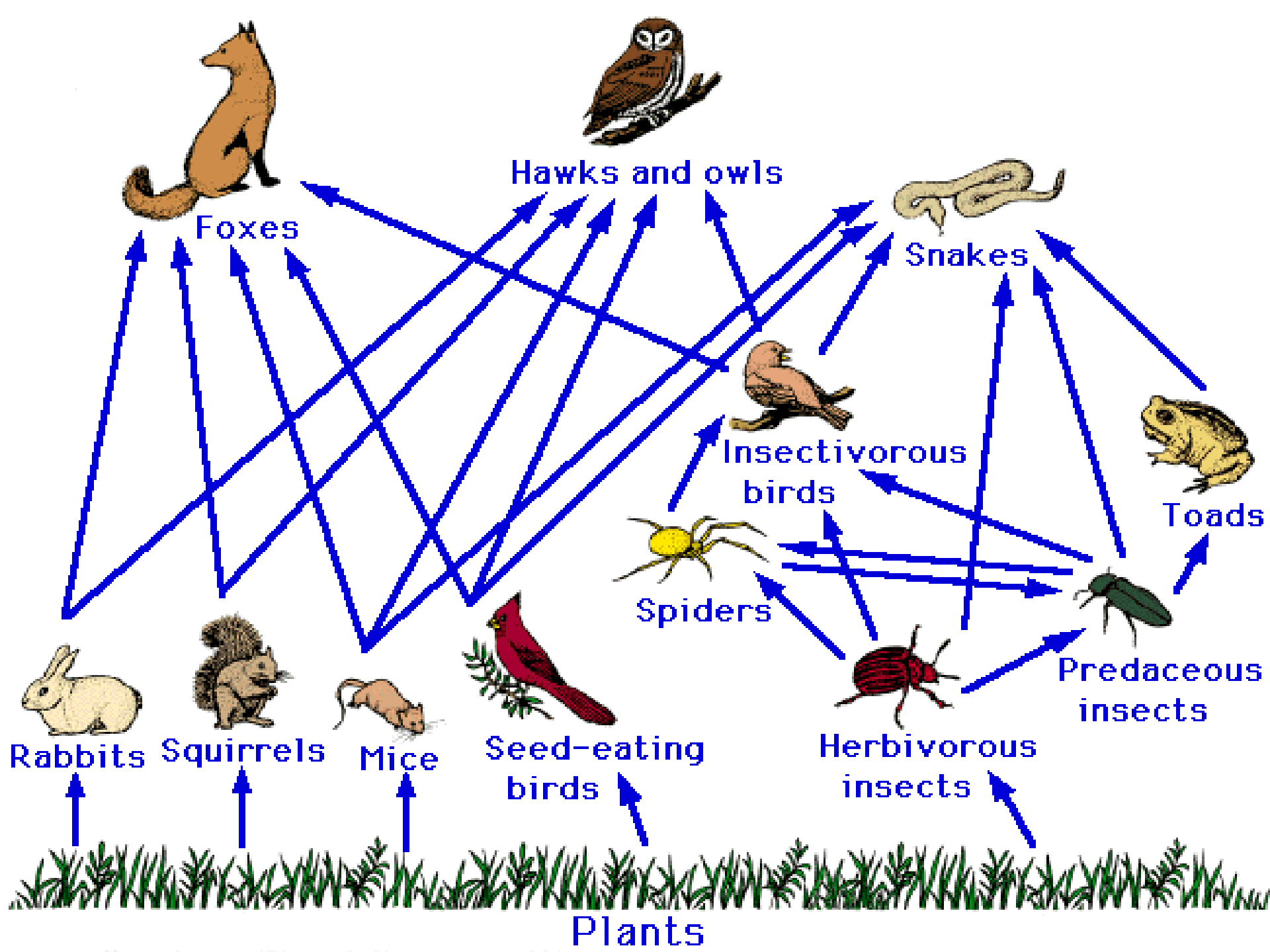

**A terrestrial food chain** **A marine food chain**

# FOOD WEB

A food chain is a linear sequence of organisms through which nutrients and energy pass as one organism eats another.

In a food chain, each organism occupies a different trophic level, defined by how much energy transfers separate it from the basic input of the chain.

Food webs consist of many interconnected food chains and are more realistic representation of consumption relationships in ecosystems.


Hawks and owls
Foxes
Snakes
Insectivorous birds
Toads
Spiders
Predaceous insects
Rabbits
Squirrels
Mice
Seed-eating birds
Herbivorous insects
Plants

# Significance of food chains and food webs

1. Energy flow and nutrient cycling takes place through them.
2. They maintain and regulate the population size of different tropic levels, and thus help in maintaining ecological balance.

Bio magnification: The non-biodegradable materials keep on passing from one tropic level to another. At each successive tropic level, the concentration keep on increasing. This process is known as bio magnification.

# Ecological Pyramids

In the successive steps of grazing food chain-photosynthetic autotroph, herbivorous heterotroph, carnivores heterotroph, decay bacteria-the number and mass of the organisms in each step is limited by the amount of energy available. Since some energy is lost as heat, in each transformation the steps become progressively smaller near the top. This relationship is sometimes called **"ecological pyramid".** The ecological pyramids represent the tropic structure and also tropic function of the ecosystem.

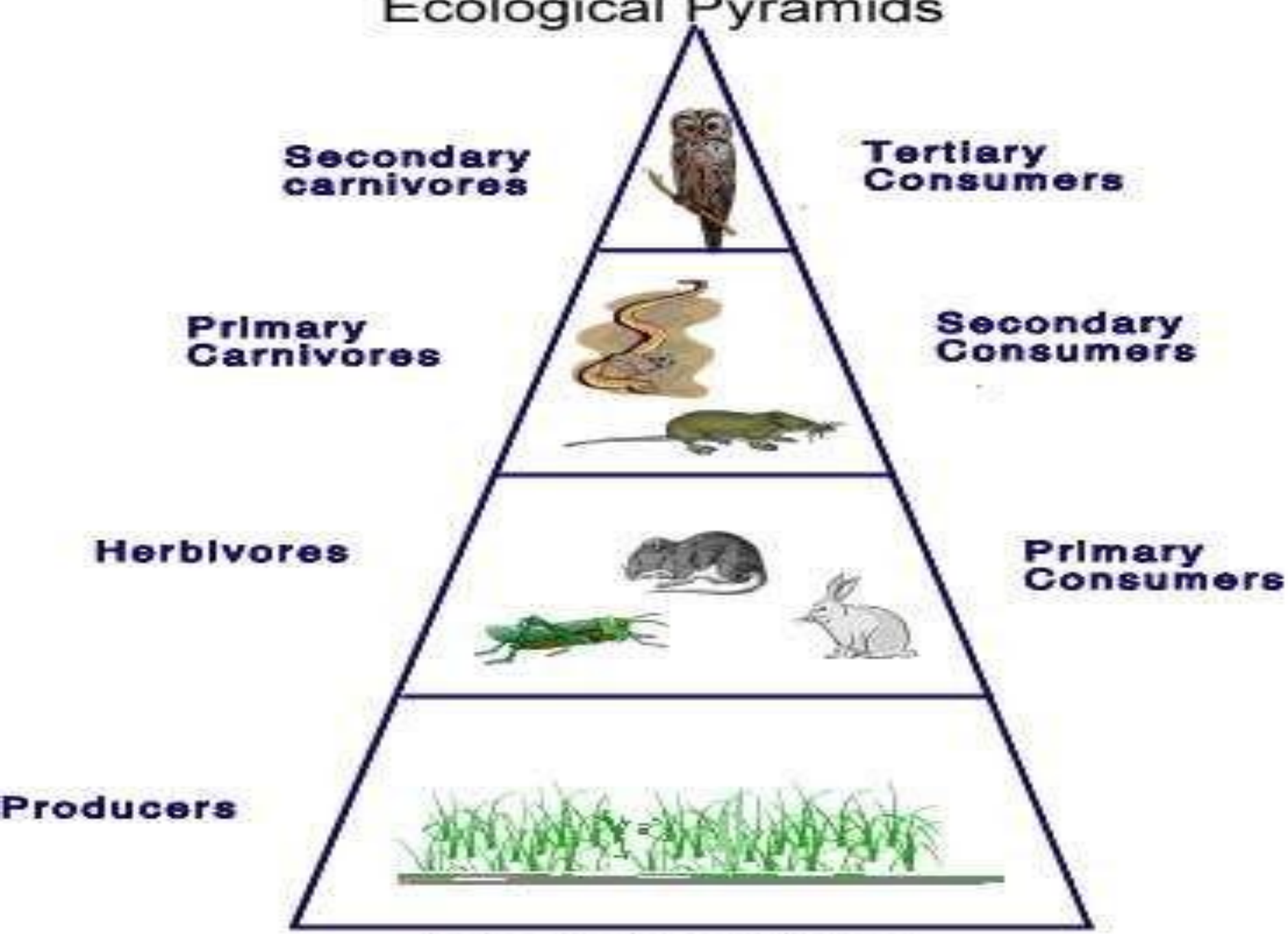
# Types of Ecological Pyramids

- The ecological pyramids may be of following three kinds
- **Pyramid of number.**
- **Pyramid of biomass.**
- **Pyramid of energy.**

# Pyramid of number

- It depicts the number of individual organisms at different tropic levels of food chain.
- The animals at the lower end (base of pyramid) of the chain are the most abundant. Successive links of carnivores decrease rapidly in number until there are very few carnivores at the top.
- The pyramid of number ignores the biomass of organisms and it also docs not indicate the energy transferred or the use of energy by the groups involved. The lake ecosystem provides a typical example for pyramid of number.

# Ecological Pyramids




http://www.eelsinc.org/id64.html

# Pyramid of biomass

- The biomass of the members of the food chain present at any one time forms the pyramid of the biomass.

- Pyramid of biomass indicates decrease of biomass in each tropical level from base to apex. For example, the total biomass of the producers ingested by herbivores is more than the total biomass of the herbivores in an ecosystem. Likewise, the total biomass of the primary carnivores (or secondary consumer) will be less man the herbivores and so on.

BIOMASS ($g/m^2$)

TROPHIC LEVEL

10

Tertiary consumers (snakes)

100

Secondary consumers (toads)

1,000

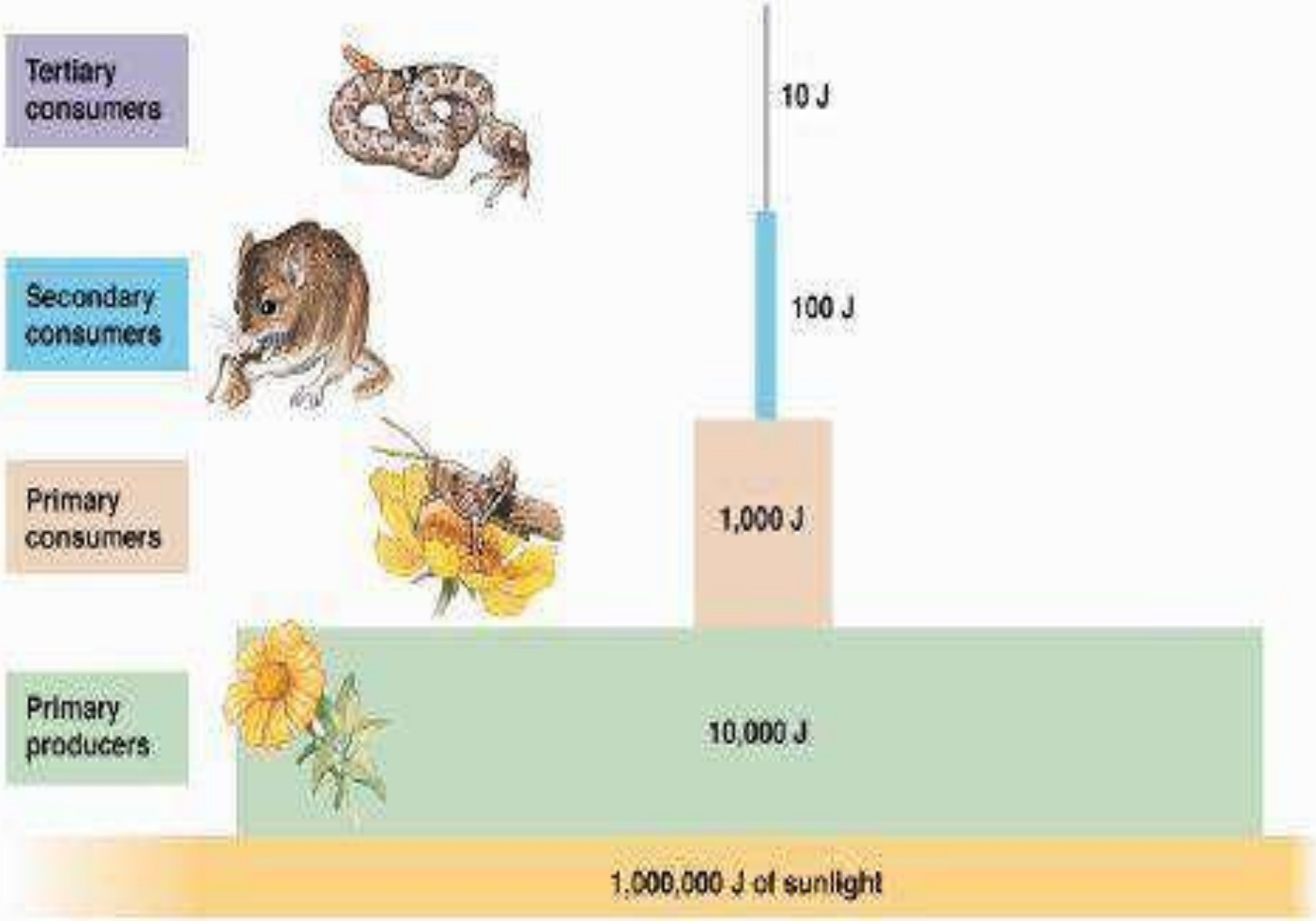
Primary consumers (grasshoppers)

10,000

Producers (grass)

# Pyramid of energy

- When production is considered in terms of energy, the pyramid indicates not only the amount of energy flow at each level the actual role the various organisms play in the transfer of energy.



# Classification of Ecosystems

- Terrestrial Ecosystems -which encompass the activities that take place on land
- Aquatic ecosystems - the system that exists in water bodies

Terrestrial ecosystem

- Forest ecosystem
- Desert ecosystem
- Grassland ecosystem

Aquatic ecosystem

- Marine ecosystem
- Fresh water ecosystem
- Estuarine ecosystem

# FOREST ECOSYSTEM

Undisturbed areas with moderate to high average annual rain precipitation tend to be covered with forest, which contains various species of trees and smaller forms of vegetation.

## Structure (components) and function of forest ecosystem

**I. Abiotic components**:

The abiotic components are physical ( inorganic and organic substances) components found in soil and atmosphere. (E.g. Temperature, light, rain fall)

**II. Biotic components**:

1. **Producers**: The plants absorb sunlight and produce food through photosynthesis.(e.g. Trees, shrubs and ground vegetation)
2. **Consumers**: a) *Primary consumers*: They directly depend on the plants for their food.(e.g.. Ants, flies, insects, mice, deer)
   - *b) Secondary consumers*: They directly depend on the herbivores for their food. (e.g. Snakes, birds, fox)
   - *c) Tertiary consumers*: They depend on the primary carnivores for their food.(e.g. .Tiger, lion)
3. **Decomposers**: Rate of decomposition in tropical and subtropical forests is more rapid than in the temperate forests. (e.g. Bacteria and fungi).

# GRASSLAND ECOSYSTEM

- Grasslands are regions with enough average annual rain precipitation to allow grass to grow extensively. But drought and fire does not allow trees to grow taller.
- Grasslands are rich biological communities of grasses, seasonal flowering plants and open savannas.
- Great Plains of central North America, Russia, and South American are some of the important grasslands in the world

## Structure and function of the grassland Ecosystems:

**I.Abiotic components**: These abiotic components are supplied by $CO_2$ (Nutrients C,H,O,N,P,S,etc.)

**II. Biotic components**:

**1. Producers**: They produce food.(Grasses, forbs and shrubs)

**2. Consumers**:

a) **primary consumers:** They depend on grasses for their food.(Cows, buffaloes, deer, sheep, etc.,)

b) **secondary consumers:** They feed on herbivores.(Snakes, lizards, birds, jackals, fox, etc.,)

c) **Tertiary consumers**: They feed on secondary consumers.(Hawks, eagles, etc.,)

**3. Decomposers**: Fungi andbacteria (decompose the dead organic matter.

# DESERT ECOSYSTEM

- Deserts are dry places with unpredictable and infrequent precipitation. A desert is an area where evaporation exceeds precipitation.

- Daily and seasonal temperature of the desert will vary since desert has very little moisture to absorb and store sun radiation.

- A combination of low rainfall and different average temperatures creates tropical, temperate and cold deserts.

**Structure and functions of the desert ecosystems**:

I. **Abiotic components**: Temperature water, sunlight, rainfall, etc. The temperature is very high and low rain fall & low nutrient cycling.

**II Biotic components**:

1. **Producers**: Shrubs, bushes

In deserts mostly Succulent (e.g., cacti) plants are found

available. They have water inside them to stay alive.

2. **Consumers**: Squirrels, mice, rabbits, reptiles.

These animals dig holes in the ground to live in. Most of the animals can extract water from the seeds they eat.

3. **Decomposers**: Fungi and bacteria

Desert has poor vegetation with a very low amount of dead organic matter.

# Aquatic Ecosystems

# Structure and function of aquatic ecosystem

I. Abiotic components: Temperature, light proteins, $O_2$

II. Biotic components:

1. **Producers**: They are green plants, may be submerged, free floating and amphibious plants. phytoplanktons, algae and flagellates
2. **Consumers**:

a) **Primary Consumers** ( Zooplanktons) Cilictes, protozoans, etc., - They feed on phytoplankton.

b) **Secondary consumers** (carnivores)Insects and small fishes. – They feed on zooplankton.

**c) Tertiary consumers**: Large fishes like game fish - They feed on smaller fish.

**3. Decomposers**: Bacteria, fungi and actinomycetes.- They decompose the dead plants and animals

# Biodiversity and its conservation

- Biodiversity is the variety of life on earth.
- The concept reflects the inter-relatedness of genes, species and ecosystems. Because genes are the components of species, and species are the components of ecosystems
- Diversity may be defined as the number of species present in a community, a measure termed as species richness

# GENETIC DIVERSITY

- It refers to the total genetic information contained in the genes of individuals of plants, animals and microorganisms.

- When the genes within the same species show different versions due to new combinations, it is called genetic variability.

# SPECIES DIVERSITY

- A species generally consists of all the individual organisms of a natural population which are able to interbreed, generally sharing similar appearance, characteristics and genetics. A species is one of the basic units of biodiversity.
- Species richness is the simplest measure of biodiversity and is simply a count of the number of different species in a given area.

# ECOSYSTEM DIVERSITY

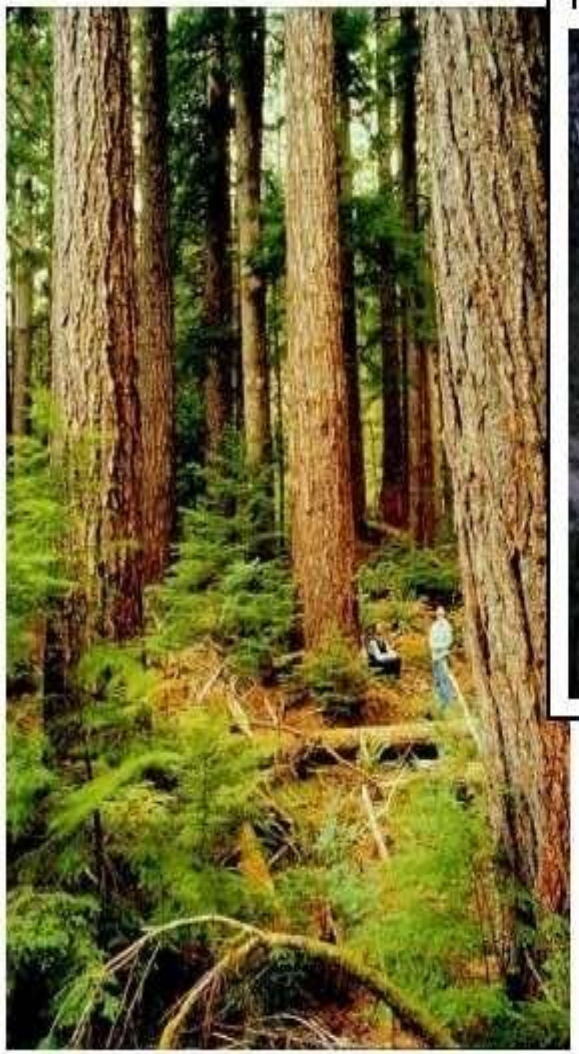
This is the diversity of ecological variations in

- tropic structure,
- food-webs,
- nutrient cycling etc.

The ecosystems also show variations with respect to physical parameters like

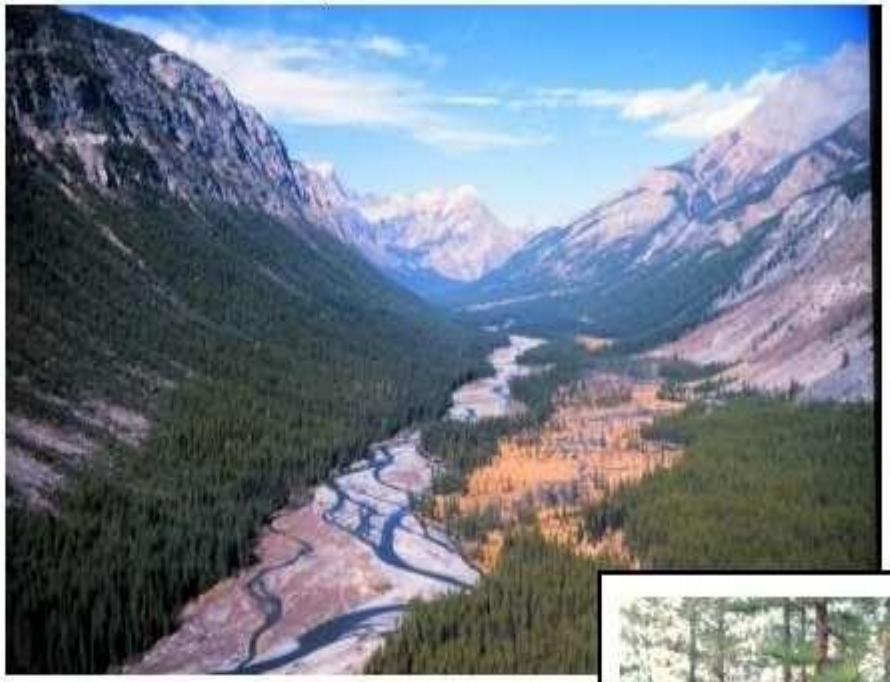
- moisture
- temperature
- altitude
- precipitation etc.,

- We cannot even replace the diversity of one ecosystem by that of another. Coniferous trees of boreal forests cannot take up the function of the trees' of tropical deciduous forest lands and vice versa



Coastal forest

Palliser River Valley



Dry open forest

# 3 types of Biodiversity

**Genetic Diversity**

**Species Diversity**

Alaska

**Ecosystem Diversity**

Peru

# Value of Bio-Diversity

**Consumptive value:**

These are direct use values where the biodiversity product can be harvested and consumed directly e.g. fuel, food, drugs, fibre etc.

## Drugs and medicines:

- About 75% of the world's population Depends upon plants or plant extracts for medicines. The wonder drug Penicillin used as an antibiotic is derived from a fungus called "Penicillium.
- we get Tetracyclin from a bacterium. Quinine, the cure for malaria is obtained from the bark of Cinchona tree,
- Digitalin is obtained from foxglove (Digitalis) which is an effective cure for heart disease.
- Vinblastin and vincristine, two anticancer drugs, have been obtained from Periwinkle (Catharanthus) plant, which possesses anticancer alkaloids.

## Fuel:

Our forests have been used since ages for fuel wood. The fossil fuels coal, petroleum and natural gas are also products of fossilized biodiversity.

## PRODUCTIVE VALUES:

These are the commercially usable values where the product is marketed and sold. These may include the animal products like tusks of elephants, musk from musk deer, silk from silk- worm, wool from sheep, fir of many animals etc, all of which are traded in the market. A wild variety of rice from UP Saved millions of hectares of paddy crop from Grossy-Stuntvirus

## SOCIAL VALUES/ETHICAL VALUES:

- These are the values associated with the social life, customs, religion and aspects of the people.
- Many of the plants are considered holy and sacred in our country like Tulsi (holy basil),Peepal, Mango, Lotus, Neem etc.
- The leaves, fruits or flowers of these plants are used in worship or the plant itself is worshipped. The tribal people are very closely linked with the wild life in the forests.

## AESTHETIC VALUE:

- Great aesthetic value is attached to biodiversity. We will not like to visit vast barren lands with no signs of visible life.
- People from far and wide spend a lot of time and money to visit wilderness areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is now known as **ecotourism**.

## ECOLOGICAL VALUE:

It refers to the services provided by ecosystems such as

- prevention of soil erosion,
- prevention of floods,
- maintenance of soil fertility,
- nutrients cycles,
- fixation of nitrogen,
- hydrological cycle,
- acts as carbon sinks,
- pollutant absorption
- Reduction of the threat of global warming

# Hot spots of Bio-Diversity

- There are 25 hot spots at global level. Out of 25, two are present in India, namely the Eastern Himalayas and Western Ghats.

- Nearly 70% of the bird species in this hotspot are endemic. These are the areas of high diversity, endemism and are also threatened by human activities.

- It has been estimated that 50,000 endemic plants, which comprise 20% of global plant life, probably occur in only 18 hotspots in the world.

- Countries which have a relatively large proportion of these biodiversity hotspots are referred to as mega-diversity nations.

# Hotspots in India

## The Eastern Himalayas

- The Eastern Himalayas display an varied topography, a factor that fosters species diversity and endemism. Many deep and semi-isolated valleys are exceptionally rich in endemic plant species.

- In Sikkim, in an area of 7298 km2 , of the 4250 plant species , 2550 (60%) are endemic. there are about 5800 plant species, of which roughly 2000(36%) are endemic.

- Bhutan possesses an estimated 5000 species, of which as many as 750 (15%) are considered to be endemic to the Eastern Himalayas

## Western Ghats:

- Out of India's 49219 plant species , 1600 endemics(40% of the total number of endemics) are found in an 17000 km2 along the sea side of the Western Ghats in Maharasthtra, Karnataka, Tamil Nadu.

- Kerala Forest track up to 500km2 in elevation, comprising one fifth of the entire forest expanse, are mostly evergreen, while those in 500-1500 m range are semi- evergreen. There are two main centers of diversity, the Agasthyamalai Hills and the Silent Valley. The forest cover in western ghats has reduced to 34 %.

# Threats to Bio-Diversity

Extinction, the elimination of a species is a normal process in nature. Species however, human impacts on populations and ecosystems have accelerated that rate of extinction, causing hundreds of species, sub-species and varieties to become extinct every year.

The causes of extinction are:

**Population Risk**

**Environmental Risk**

**Natural calamities**

**Genetic Risk**

**Human Actions**

**Habitat Loss and Degradation**

**Diseases**

# Conservation of Bio-Diversity

- The act or process of conserving. The protection, preservation, management, or restoration of wildlife and of natural resources such as forests, soil, and water.

Conservation of our natural resources has the following three specific objectives:

- (i) to maintain essential ecological processes and life-supporting systems .
- (ii) to preserve the diversity of species or the range of genetic material found in the organisms on the planet .
- (iii) to ensure sustainable utilization of species and ecosystems which support millions of rural communities as well as the major industries all over the world.

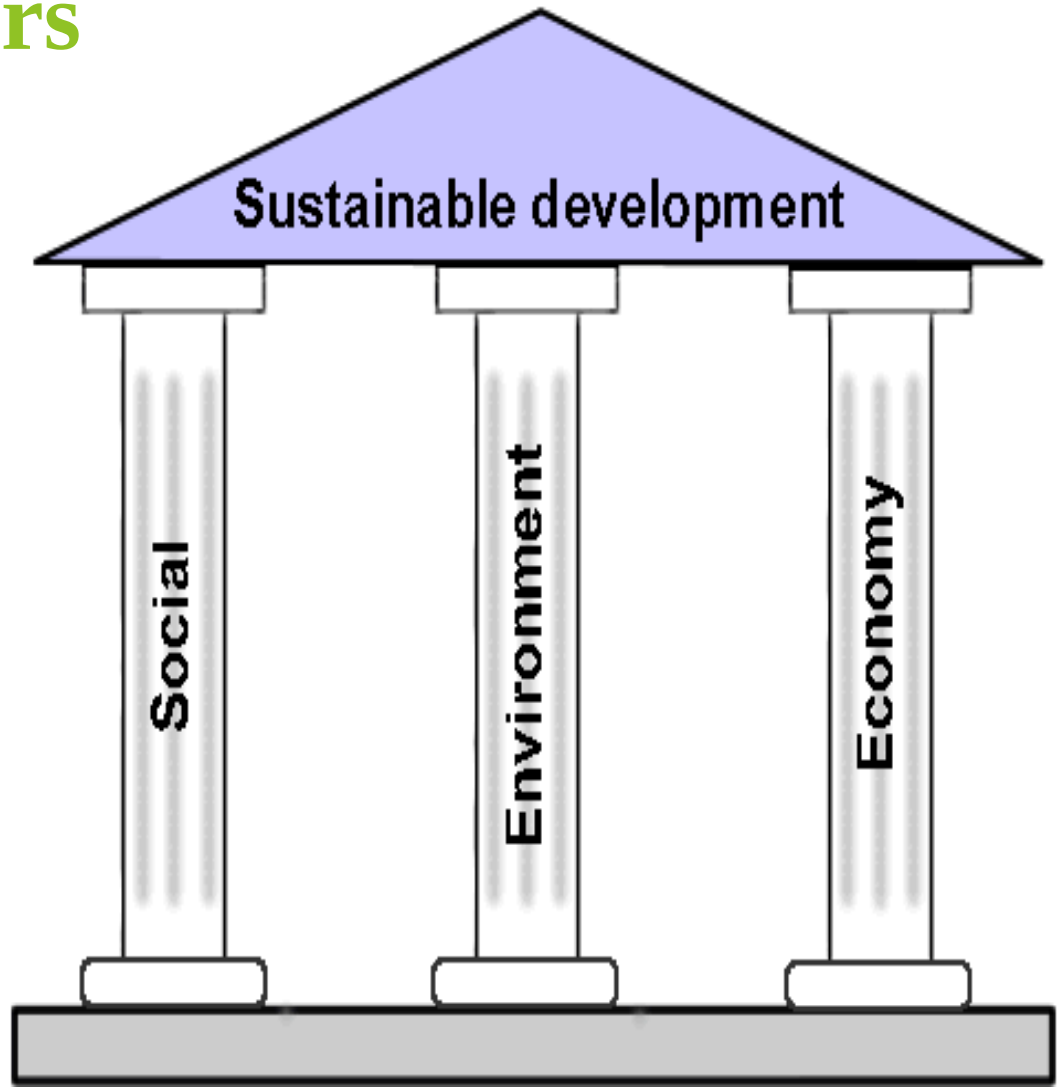
There are two approaches of biodiversity conservation:

- (a) In situ conservation (within habitat): This is achieved by protection of wild flora and fauna in nature itself, e.g. Biosphere Reserves, National Parks, Sanctuaries, Reserve Forests etc.
- (b) Ex situ conservation (outside habitats) This is done by establishment of gene banks, seed banks, zoo, botanical gardens, culture collections etc.

## Definition of Sustainable Development

- According to the World Commission on Environment and Development, the definition of Sustainable Development (SD) is “development that meets the needs of the present without compromising the ability of future generations to meet their own need” (Our Common Future, 1987).

# Sustainability - 3 pillars



# What makes SD

- **Social Goals**
  Sustains institutions , improves justice and encourages participation

- **Economic Goals**
  Ensures basic needs, equity and employment opportunities

- **Environmental Goals**
  Maintains genetic diversity which maximizes productiviy and renewal

# Three core drivers of un-sustainability

- Consumption
  - Use of resources beyond the reasonable limits set by nature
- Production
  - Gross inefficiencies in production.
- Distribution
  - Inequitable distribution e.g. distribution of global income between rich and poor

# Sustainability: Solutions

- Cyclical material use
  - emulate natural cycles; 3 R’s
- Safe reliable energy
  - conservation, renewable energy, substitution, interm measures
- Life-based interests
  - health, creativity, communication, coordination, appreciation, learning, intellectual and spiritual development


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS