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branches (ME, CE  
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# Basics of Energy & Environment

## Ecology, Ecosystem & Biodiversity

# ABOUT ME : VIKAS BHADORIYA

- 5+ Years' Teaching Experience
- M.Tech (Thermal Engineering), Thapar University
- Mentored 10000+ Aspirants for GATE, ESE, SSC JE etc.
- Area of Expertise: Fluid Mechanics, Thermal & Applied, Heat Transfer



## ECOLOGY

Ecology is defined as a scientific study of the relationship of the living organisms with each other and with their environment.

The term 'Ecology' was coined by the German zoologist Ernst Haeckel.

→ study of habitation

The word ecology is derived from Greek word Oikos means habitation and logos means study.

Therefore study of relationship between organism and environment is called ecology.

## ENVIRONMENT

It is the surroundings or conditions in which a person, animal, or plant lives or operates.

It comprises both living (biotic) and nonliving (abiotic) components.

The environment is defined as 'the sum total of living, non-living components, surrounding an organism'

Each and everything with which we interact forms our environment

## Components of Environment

(Non-Living Component)

**Abiotic:** Temperature, water, wind, atmospheric gases, gravity, soil, Topography, ~~oil~~, fire, energy, radiation etc.

(Living components)

**Biotic:** Green and non-green plants, decomposers, parasites, animals, humans etc.

## Atmosphere

It is the body of air which surrounds the earth.

It consists of following layers

**Troposphere:** Lower portion of atmosphere which extends upto 12km and forms 90% gases in atmosphere.

**Stratosphere:** It extends upto height of 50km

A thin layer of ozone layer is present in stratosphere at height of 15 to 30km.

**Mesosphere:** It is situated above stratosphere and extends upto altitude of 80km and shows a decrease in temperature with height

**Thermosphere:** It extends upto 700km and lies above mesosphere and below exosphere

**Exosphere:** The layer beyond thermosphere is exosphere.

space



land or  
solid rock on  
earth

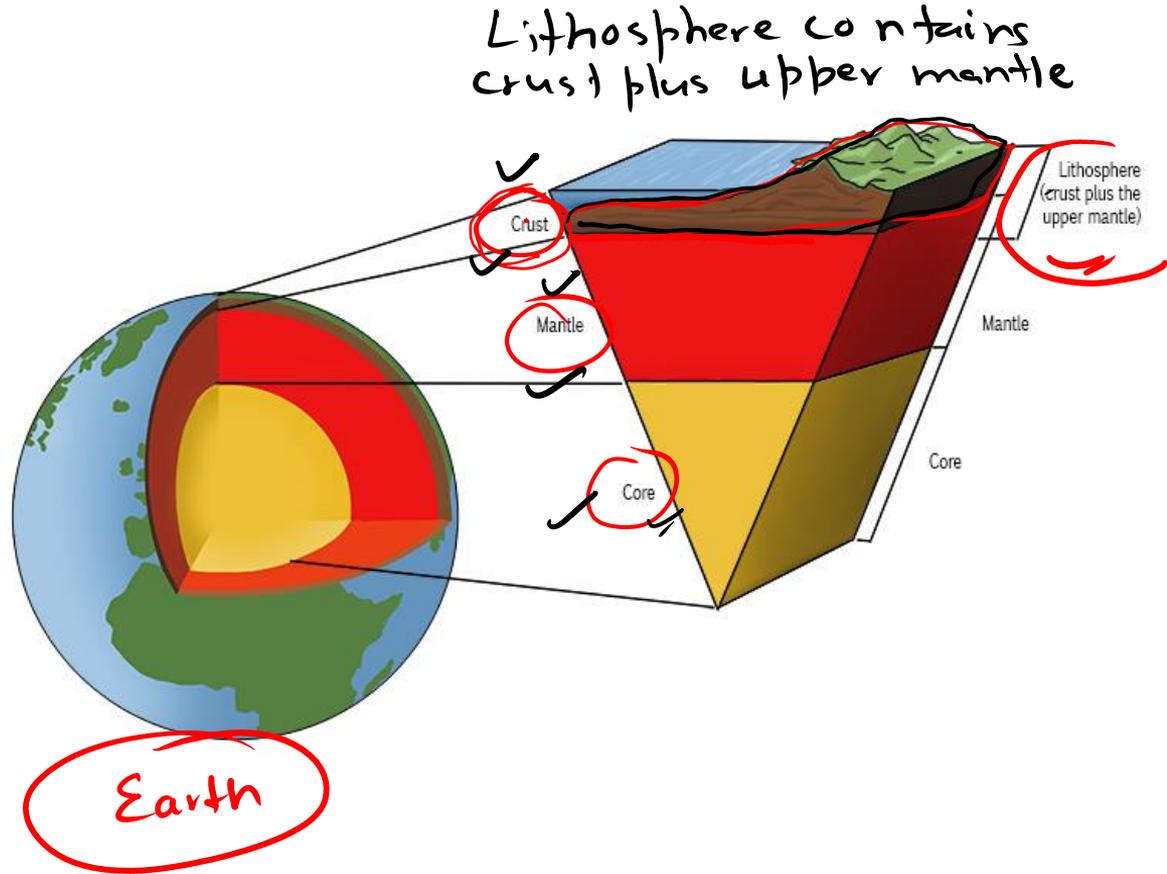
**Lithosphere:** It is the solid rocky crust covering entire earth. The crust is inorganic and consists of minerals.

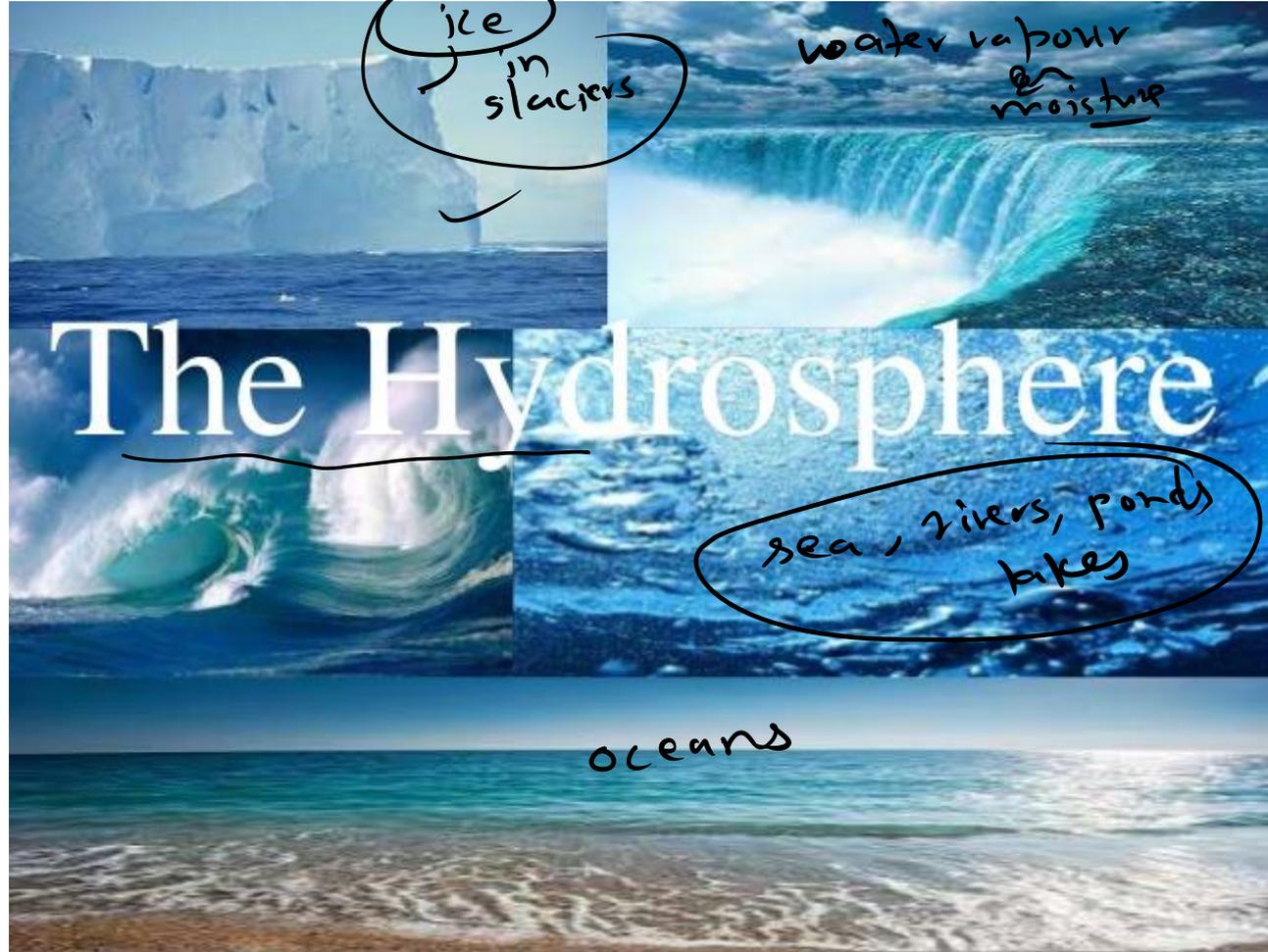
It covers entire surface of earth from top of Mount Everest to the bottom of Mariana Trench.

Mariana Trench → The  
end or last part  
of lithosphere

**Hydrosphere:** It is composed of all water on or near earth surface. It includes oceans, river, lakes, and even moisture in air. , precipitation or rain fall falls on earth.

amount of water on earth





Biotic components

Example: population of human  
population of tigers  
population of lion

## ORGANISATIONS LEVEL IN ECOLOGY

1. **Organism**: Individual living being that has the ability to act or function independently. E.g. plant, animal, bacterium etc.

2. **Population**: Group of organisms usually of same species

3. **Community**: Group or association of population of two or more different species occupying the same geographical area and in a particular time

Aquatic Ecosystem ✓

Terrestrial Ecosystem ✓

Bio → living or life

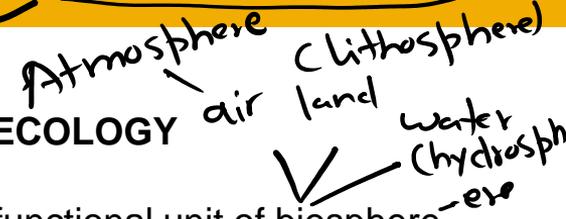
## ORGANISATIONS LEVEL IN ECOLOGY

4. **Ecosystem:** Structural and functional unit of biosphere which consists of community of living beings and the physical environment. It includes plants, trees, animals, birds, fish, micro organisms, water, soil and people.

5. **Biome:** Community of plants and animals that have common characteristics for the environment they exist in.

E.g. Tundra, Taiga, Temperate Deciduous Forest, Tropical rain forest, Desert etc.

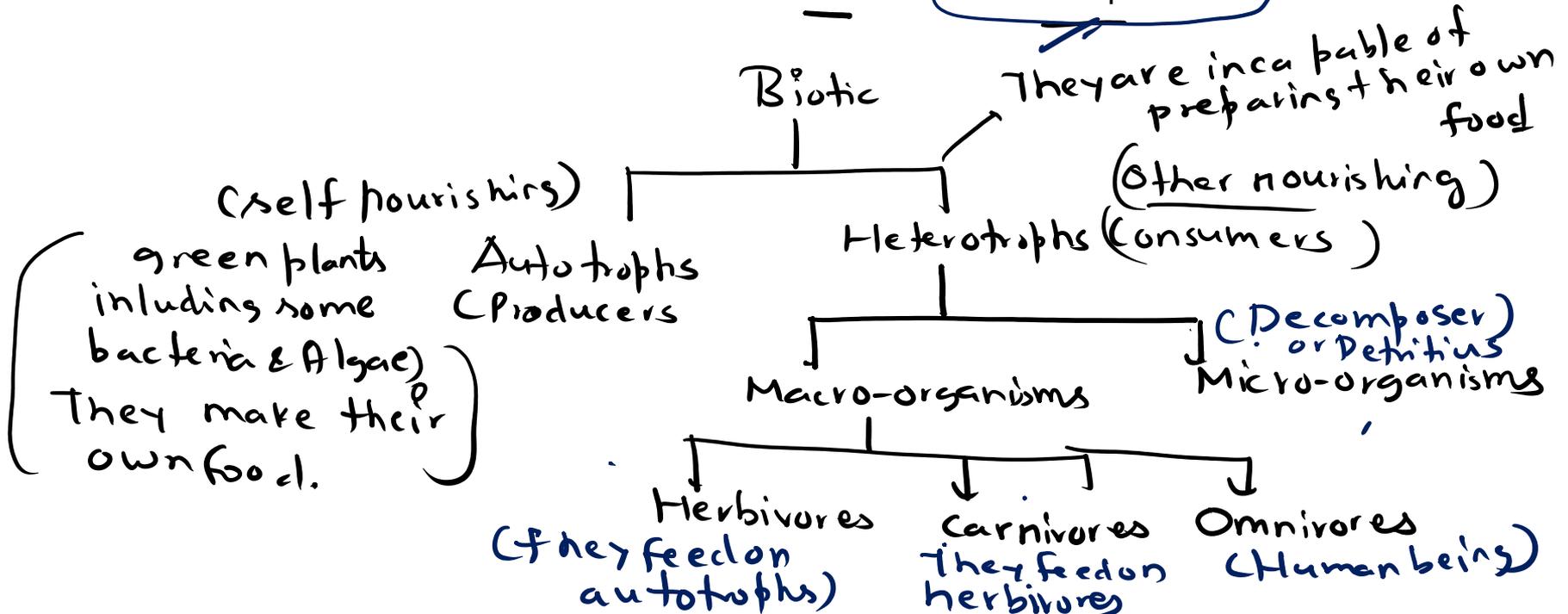
6. **Biosphere:** Part of the earth where life exists. It comprises of atmosphere (air), hydrosphere (water) and lithosphere (land)



## Structure of Ecosystem

It consists of two components:

Biotic and Abiotic components.



Decomposers : They obtain their nutrients by decomposing dead organic substances (detritus) of plants and animal origin ( Bacteria  
earthworm  
fungi,  
Maggots  
termites



Ecological Niche of herbivores is smaller than Carnivores

Ecological Niche of human or omnivores is largest

## Ecological Niche

Every organism in an environment (has a role to play)

It is defined as web of relationship of a member of a flora & fauna (plants) (animals) in a given environment.

It is affected by behaviour dimension (locomotion) & eating) of (travelling) individual members & ecological tolerance of environment





## FUNCTIONS OF AN ECOSYSTEM

It can be studied under the following three headings

- Energy Flow
- Nutrient Cycling
- Ecological Succession

(trophic)  
energy

### ENERGY FLOW

Flow of energy from producer to top consumers is called energy flow.

The study of trophic level interaction in an ecosystem gives an idea about the energy flow through the ecosystem

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The energy always flow from lower to higher trophic level

The trophic level interaction involves following three concepts

- ✓ 1. Food Chain
- ✓ 2. Food Web
- ✓ 3. Ecological Pyramids



## FOOD CHAIN

Predatory (Prey)

It is a sequence of organisms that feed on one another. A food chain starts with producers and ends with top carnivores

Food Chains are broadly classified as:

(Terrestrial)

• **Predatory Food Chain:** Primary source of energy is sunlight. It is generally larger in size.

Grass → Grasshopper → Frog → Snake → Eagle

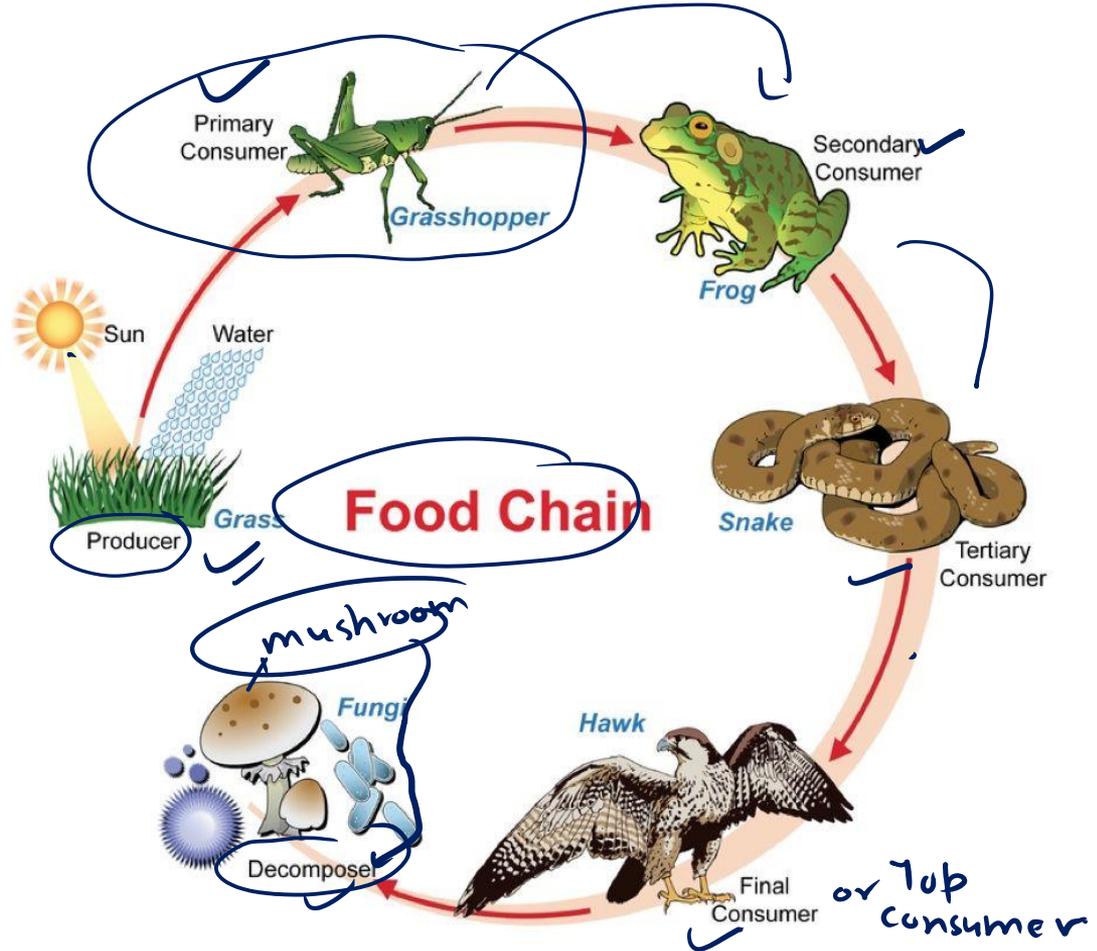
Aquatic: Phytoplanktons → Zooplanktons → Small fishes → Large fishes  
(small plants species in water)

• **Detritus Food Chain:** Primary source of energy is dead matter. It is generally smaller.

Decomposer

(Litter) → Earthworms → Chicken → Hawk

Garbage, filth



## FOOD WEBS

Interconnected food chains are known as food webs.

### **Energy Transfer Law or Trophic Efficiency or Ecological Efficiency**

**Ecological efficiency** means energy transferred from one trophic level to another trophic level

## **ECOLOGICAL PYRAMIDS**

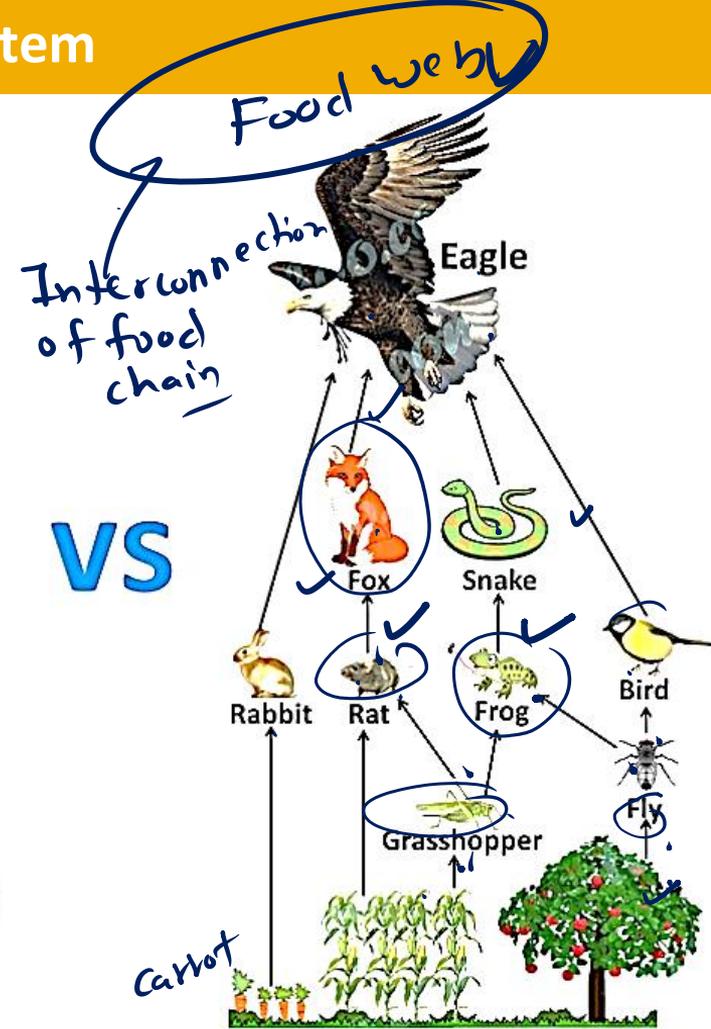
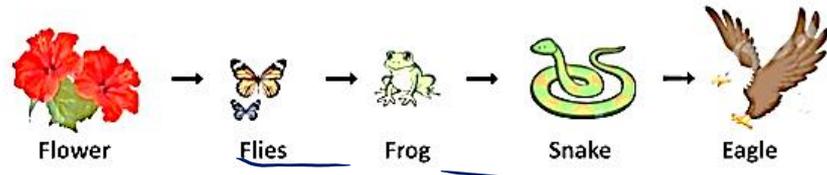
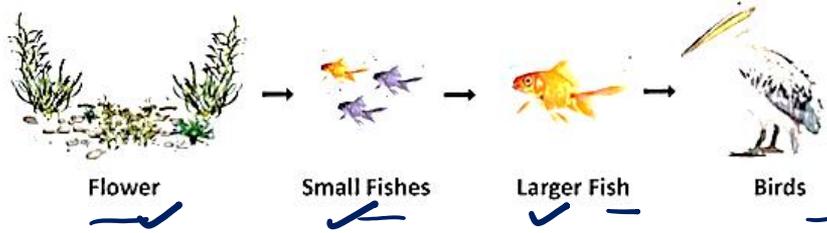
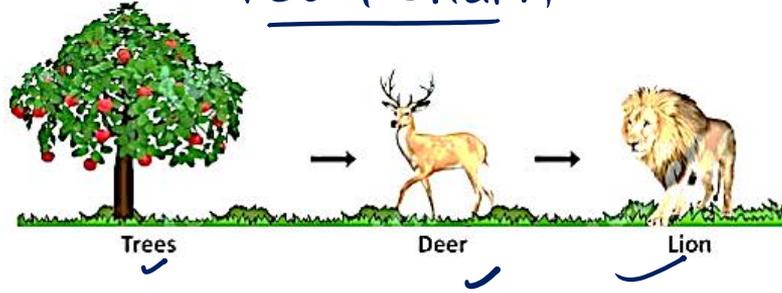
The steps of trophic levels expressed in a diagrammatic way are referred as ecological pyramids. Charles Elton gave the idea of ecological pyramid.

The producer forms the base of the pyramid and the top carnivore forms the tip.

The ecological pyramids are of three categories:

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

## Food Chain

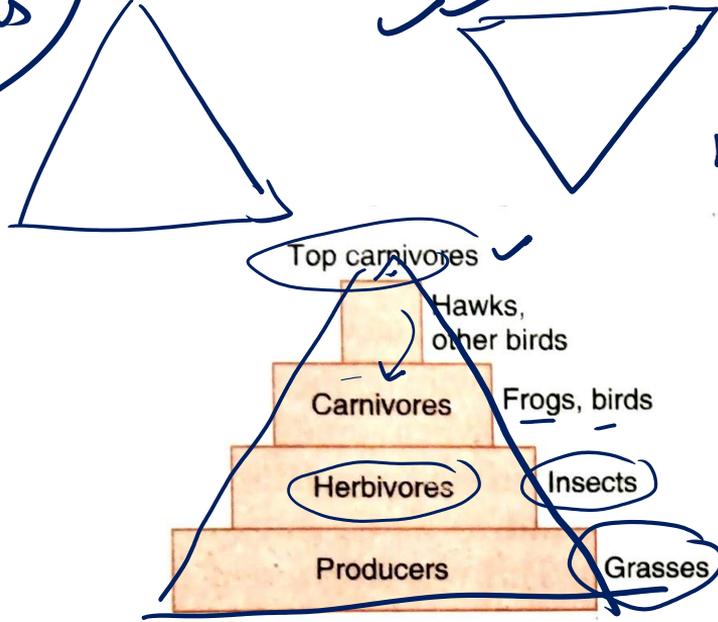


# Ecology & Ecosystem

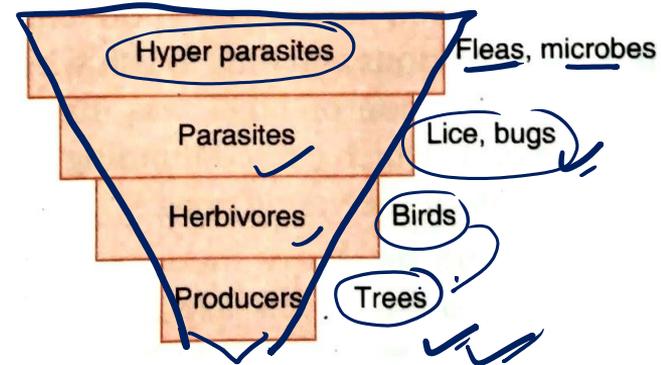
Ecological  
Pyramids

## Pyramid of Numbers [ Inverted or Upright ]

Individuals are placed in pyramid based on their numbers



(a)  
Upright  
Pyramid of Number



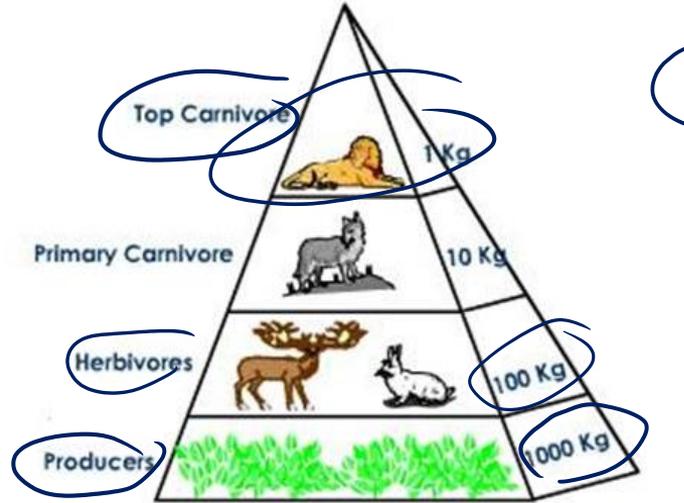
(b)  
Inverted  
Pyramid of Number

## Pyramid of biomass:

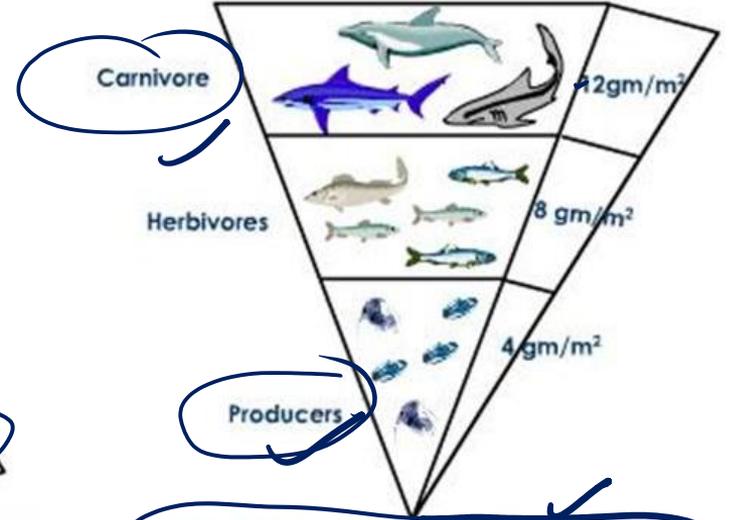
Individuals in each trophic level are weighted instead of being counted.

It can be upright or inverted.

*Inverted Pyramid*



Upright Pyramid of biomass in a Terrestrial Ecosystem



Inverted Pyramid in an Aquatic Ecosystem

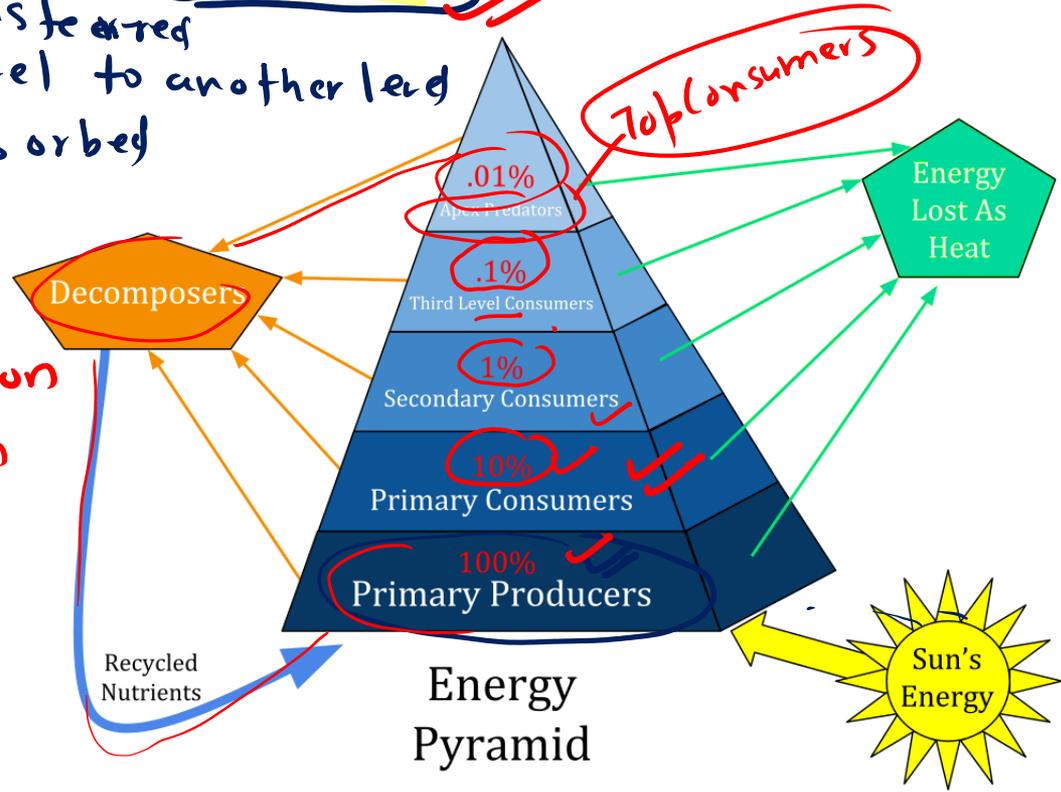
Raymond (10% Law)

According to Lindeman's Law

10% of energy is transferred from one trophic level to another level  
90% of energy is absorbed

for carrying out different metabolic process like respiration digestion & locomotion

Pyramid of energy: It reflects the laws of thermodynamics, with conversion of solar energy to chemical energy and heat energy at each level. It is always upright.



## Ecological Succession

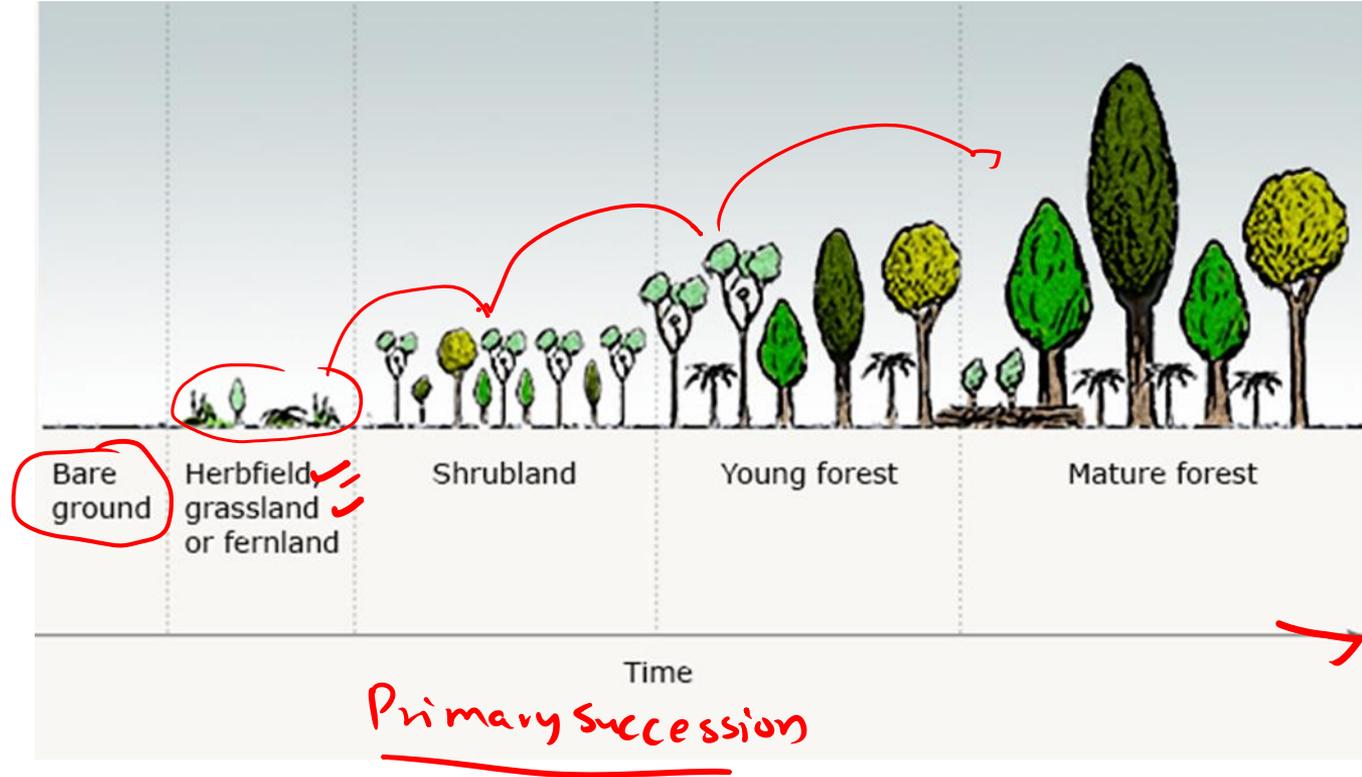
Process through which existing species are replaced by new species

- **Primary Succession:** Succession at a place where life doesn't exist in the past.
- Barren land is transformed from a lifeless environment into an environment which supports life.
- **Secondary Succession:** Succession at a place where life existed in the past
- It is the process where one community is changed into other.
- **Autogenic Succession:** Succession caused by bio-community (living community)
- **Allogenic Succession:** Succession caused by factors external to bio-community.

External factor like  
Cyclone, hurricanes

## ( Ecological Succession Stages )

- ✓ Bare Area(Nudation)
- ✓ Invasion(Migration)
- ✓ Competition
- ✓ Reaction
- ✓ Stabilisation



## Ecological Foot Print

It is a relationship between human consumption demand & the nature's capacity to regenerate the resources

As per some estimates, presently it is around 1.5 to 1.6

It's concept was given by William Rees in 1992.

## Carbon Foot Print

It is defined as total amount of green house gases produced directly or indirectly to support human activities usually expressed in equivalent tons of CO<sub>2</sub>

It is a measure of amount of Green house gases present in our day to day life through fossil fuel for electricity, heating and transportation.

It shows the amount of CO<sub>2</sub> released by human activities.

## Biome

- Biome is a very large ecological area on the earth's surface in which flora and fauna adapt themselves in a particular way in the given environment.
- It is an assemblage or collection of plants, animals and soil where these biotic and abiotic components have common characteristics
- One biome is differentiated by other by its characteristics.

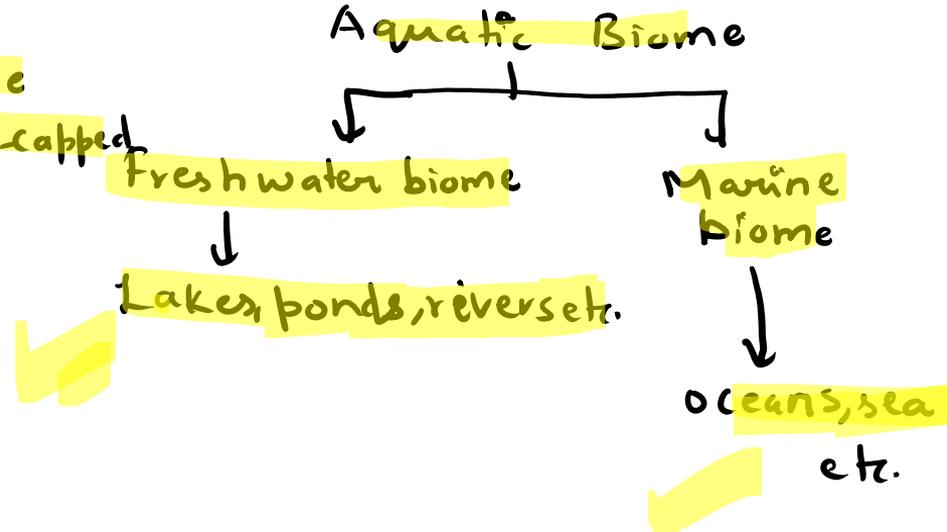
## Terrestrial Biome

1. Tropical rain forest
2. Savanna Grassland
3. Hot desert
4. Monsoon
5. Mediterranean biome
6. Temperate grassland
7. Taiga/Coniferous
8. Tundra
9. Cold desert
10. Montane
11. Polar ice-capped

## Types of Biome

Biome can be classified in two groups

- Terrestrial Biome → biome on land
- Aquatic Biome → biome in water



## Tropical Rain forest Biome



Savanna  
Grassland  
Biome



Mediterranean  
Biome



Temperate  
Grassland  
Biome



Hot  
Desert  
Biome



Cold Desert  
Biome



Tundra  
Biome



Taiaya  
Biome



Montanne  
Biome



Based on abundance of sunlight.

- (1) Photic Biome: It is found in depth of water in lake or ocean that is exposed to intensity of sunlight at which rate of  $\text{CO}_2$  uptake (consumption) or rate of  $\text{O}_2$  production is equal to  $\text{CO}_2$  production or rate of  $\text{O}_2$  consumption.

Aquatic biome is further classified  
(1) Littoral biome: It is biome found in sea, lake or river that is close to shore.

- Based on distance from coast  
(2) Neritic biome: It is found in shallow part of ocean, approx 200m in depth. It refers to that zone of ocean where sunlight reaches ocean floor.

- (3) Pelagic Biome: It is the part of open sea or ocean that is not near the coast or sea floor.

2) Aphotic Biome : It is found in portion of a lake or ocean where there is little or no sunlight.

“Deep ocean” is also known as biological desert of ocean

Maximum biodiversity is found in neritic biome.

## BIODIVERSITY

**Biodiversity** is variety of life and vividness in life, is the term first coined by E.O.Wilson, but it was popularized by media by media during Earth Summit held in Rio de Janeiro in Brazil in 1992.

It refers to variety and variability of all plants, animals and micro-organisms found on earth.

$CO_2$

How  $CO_2$  is produced

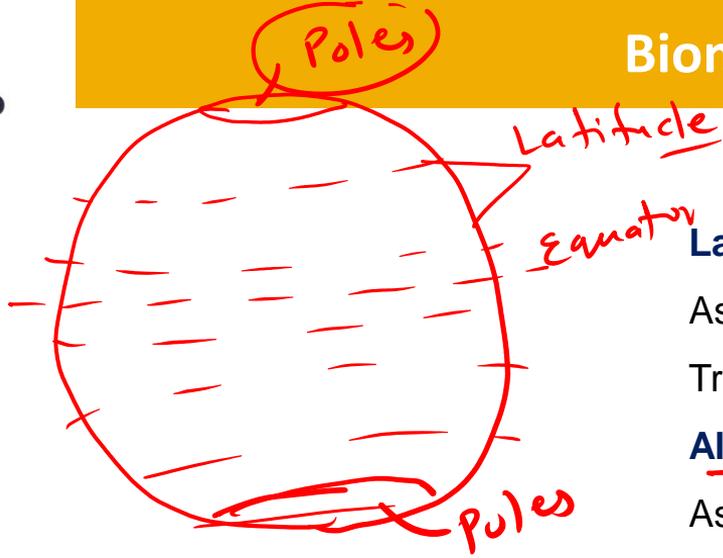


## Types of diversity

- **Genetic diversity:** Intra species diversity (same species)
- **Species diversity:** Inter species diversity (within different species)
- **Ecosystem diversity:** Diversity with the surroundings

Total 17 countries in the world are called Mega-diverse countries. Of them, Brazil is the most mega diverse country due to Amazon forest.

# Biome & Biodiversity



## Latitudinal Diversity Gradient

As latitude increases, Biodiversity decreases; From Poles to Tropics, biodiversity increases

## Altitudinal Diversity Gradient

As altitude increases, biodiversity decreases

Warm and tropical regions are the most biodiverse. Amazon rainforest has high biodiversity on land

Corals (Rainforest of sea) have high biodiversity.

"Coral Triangle" hence known as Amazon of the sea

In depth of sea

Corals



Hot spot

The area which  
require  
a attention

## BIODIVERSITY HOTSPOTS (Term given by Norman Myers in 1998)

Criteria for any location to be declared as biodiversity hotspot

1. Minimum 0.5% of the species of 1500 species of vascular plants are endemic → prone to particular disease
2. Minimum 70% or more of the natural vegetation or the primary vegetation is lost ✓

On the basis of these criteria, there are total 35 biodiversity hotspots in the world.

The forest of East Australia being the latest one

## BIODIVERSITY HOTSPOTS RELATED TO INDIA

There are 5 biodiversity hotspots related to India

1. Western Ghats ✓
2. Eastern Himalaya ✓
3. North-Eastern India ✓
4. Indo Burma border ✓
5. Sunderban ✓

## Western Ghats (Shayadri)

Escarpment → It is a very steep area formed a result of erosion

biodiversity

1. Western Ghats is one of the 8 hottest hotspots in the world
2. It is sometimes called Great Escarpment of India
3. 39 sites from the Western Ghats together declared as World Heritage Sites
4. Western Ghats covers 6 Indian states, viz. Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu
5. For Western Ghats conservation purpose, Western Ghats Experts Ecology Panel headed by **Madhav Gadgil** was appointed in 2010. To have more holistic approach, Kasturirangan Committee headed by Kasturi Rangan was appointed

### NOTE

- 35 Biodiversity Hotspots account around 2.3% of total geographical area but support 50% of endemic plant species
- Around 85% of the original vegetation has been lost in these Biodiversity hotspots

*Previous Year  
Question*

*(Interspecies)*

Q. Besides species diversity and ecosystem diversity, which of the following is included in the term 'bio-diversity'?

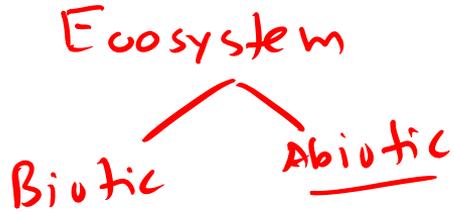
- (a) Genetic diversity *(Intra species diversity)*
- (b) Climatic diversity
- (c) Cultural diversity
- (d) Lingual diversity

Previous  
Year  
Question

Q. Which one of the following regions is characterized by sensitive ecosystems, enhanced occurrences of extreme weather events and natural catastrophes?

- (a) Mountain region
- (b) Evergreen forest region
- (c) Tropical region
- (d) Tundra region

↳ ↳ ↳ landslides



Q. Consider the following statements regarding ecological community:

1. A community is the set of all populations that inhibit a certain area.
2. Ecosystems include both the biological and physical components affecting the community.

Which of the above statements is/are correct?

A 1 only

B 2 only

C. Both 1 & 2

D. Neither 1 & 2

Q. The deepest zone of a lake is known as

A Littoral zone

B Euphotic zone

C Profundal zone

D Limnetic zone

✓ C Profundal zone → It comes under Neritic biome

# ESE 2021 Prelims Paper 1 (GS & EA) Free Crash Course

## Basics of Energy and Environment For ESE



सत्यमेव जयते  
**UPSC**

By Vikas Bhadoria

Mechanical Marvels  
YT channel (Ethics & Values)  
TOP 14

Pdf will be provided in  
GATE Gradeup Telegram  
channel

Conservation of Energy & Environment

5th May

Renewable & Non-Renewable Energy Sources

6th May

Ecology, Ecosystem & Biodiversity

7th May

Conservation of Environment

Imp

8th May

Types of Pollutions & Effect on Environment

9th May

Conventions on Climate Change

10th May

Importance of Environment Impact Assessment

**LIVE**

@ 11:30 AM

