Introduction to Environment Studies

Syllabus

Unit 1: Environmental studies: ecosystems, bio-diversity & its conservation

Unit 2: Natural resources: problems & prospects

Unit 3: Environmental pollution control

Unit 4: Disaster Management, Social Issues, Human Population and the Environment.

Books

- E. Barucha, Textbook of Environmental Studies for Undergraduate Courses, Universities Press India Pvt. Ltd.

- S. Chawla, A Textbook of Environmental Studies, McGraw Hill Education Private Limited
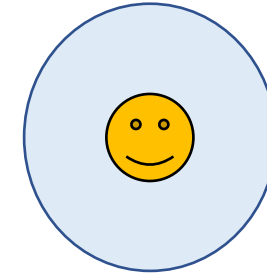
Unit - 1

Environmental studies: Ecosystems, Bio-diversity & its conservation

Unit 1: Environmental studies: ecosystems, bio-diversity & its conservation

Environment ?

Derived from a French word "Environia" means **to surround/ encircle.**
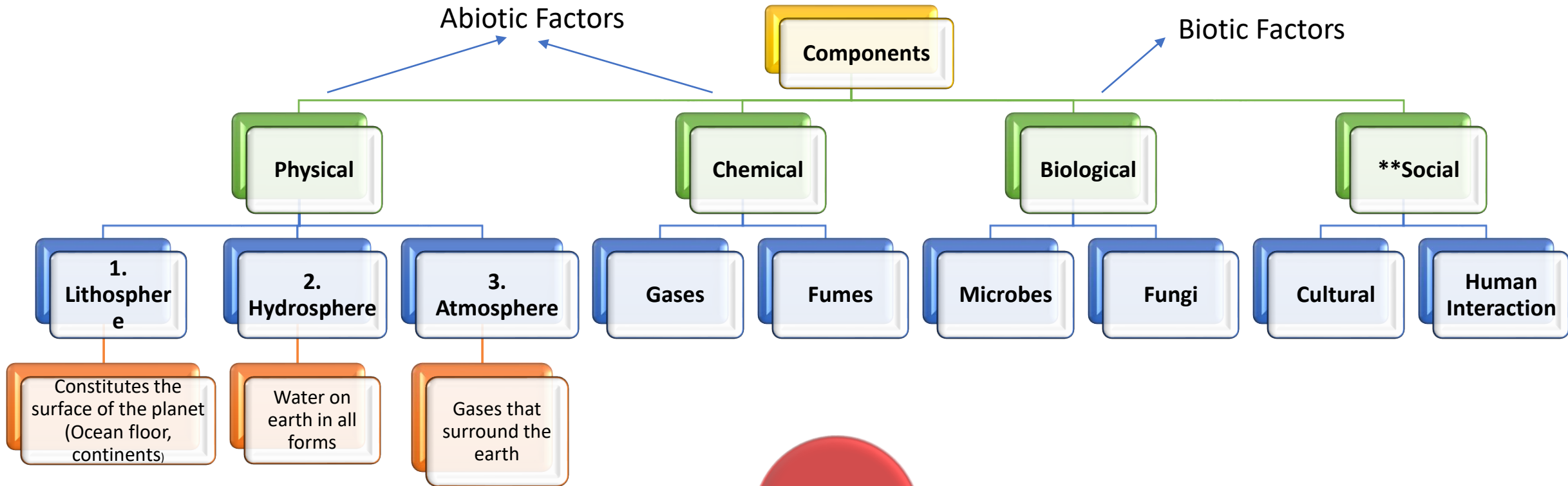
Organism

Environment

Concept of Environment

- **As per the Environment Protection act, 1986-** Environment is the sum total of the water, land, air and the interaction of these components with each other.

- Environment and living organisms are in coexistence and the interaction between both these components form the ecosystem.
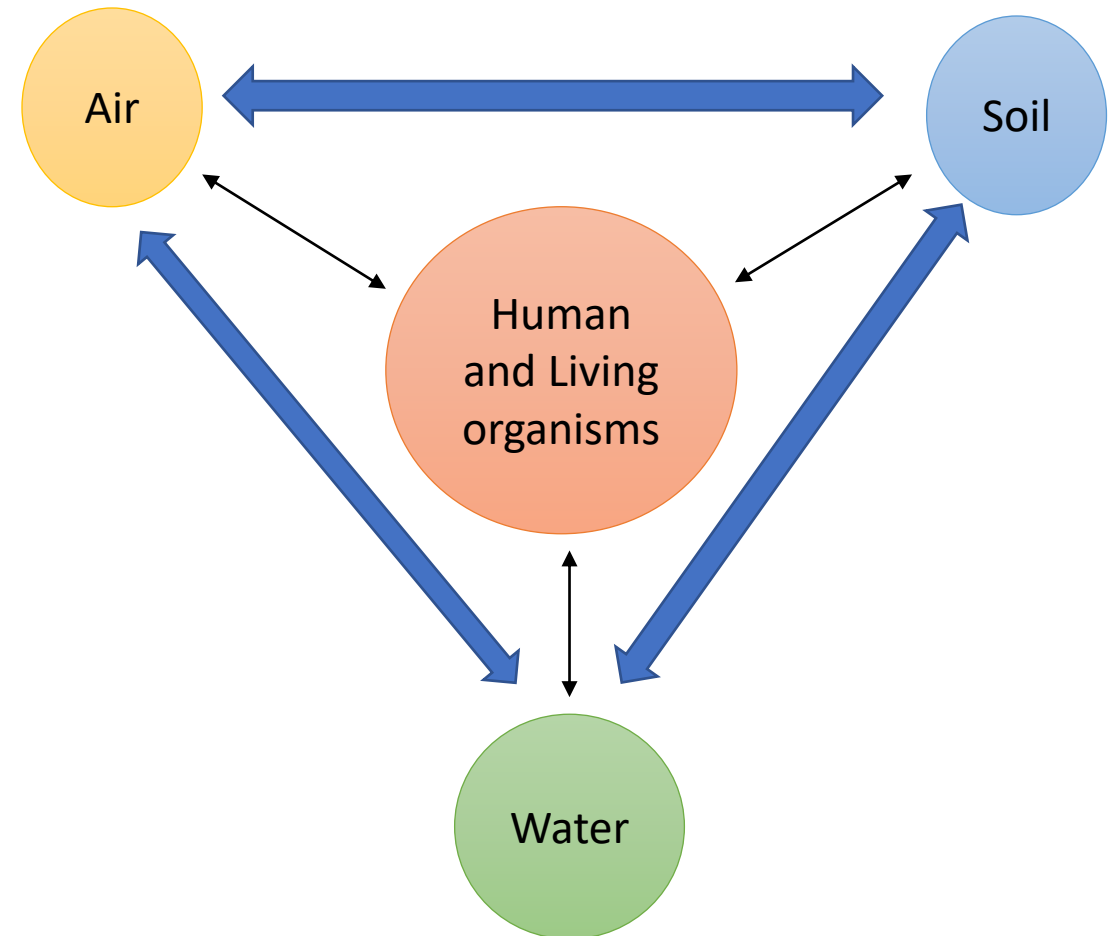
Components of the Environment
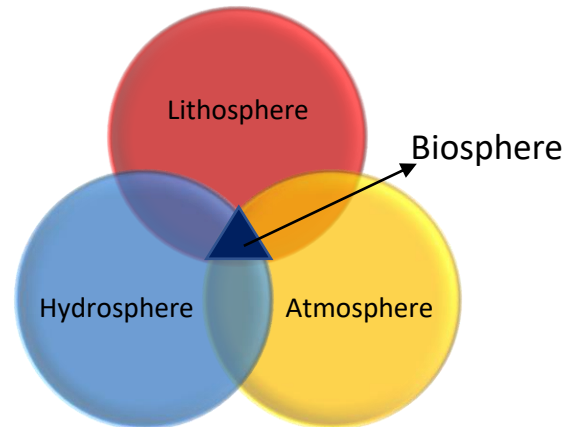
Background

- Environmental studies: A multidisciplinary academic field which systematically studies human interaction with the environment with the aim to deal with issues effecting organisms.

- Late Prime Minister Mrs. Indra Gandhi, introduced the concept of environment protection in India.

- In 1976

- Clause (g) to Article 51A of the Indian constitution states "It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers, and wildlife and have compassion for living creatures."

- Article 48A states "The State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country".

- Article 21 of the Indian Constitution assures the citizens of India the right to a healthy environment

- In 1991, the supreme court of India issued directives to make all the curricula environment oriented.

Multidisciplinary nature of Environment sciences

- The environment is a multidisciplinary science because it comprises various branches of studies like chemistry, physical, medical science, life science, agriculture, public health, sanitary engineering, etc.

- It is the science of physical phenomena in the environment. It studies about the source, reaction, transport effect and fate of physical and biological species in the planet which interacting with air, water, soil and its effect.

- As the environment is complex and actually made up of many different environment like natural, constructed and cultural environment, environment studies is inter disciplinary in nature including the study of biology, geology, politics, policy studies, law, religion, engineering, chemistry and economics to understand the human interaction and effect on the natural world.

Scope of Environment Studies

- The discipline deals with areas like:

- Conservation of natural resources
- Ecological aspects
- Biodiversity conservation
- Pollution control
- Policy making for global environmental issues
- Environment management and planning
- Development of green projects that foster sustainable development

The subject has a wide scope in:

Research

Pollution control boards

NGO

Environment Monitoring labs

Teaching

Importance and need of Public awareness about the environment

There is a Chinese proverb:

If you plan for a year; plant rice, if you plant for 10 years; plant trees and if you plan for 100 years; educate people.

Objective of Public awareness:

- Conservation of nature and natural resources for the betterment of the society.

- Protection of various species for ecological balance.

- Adoption of appropriate means to solve existing environmental problems.

Propagating Public awareness

Public awareness of the environment comes from a result of general knowledge, specialist knowledge of a particular problem and a sense of responsibility for the environment.

- Environmental education: Environmental education must be introduced as a course in schools and colleges.

- Mass media: Newspapers, magazines, television, radio programs can play an important role in educating masses.

- Seminars and conferences: Organizing seminars and conferences that may help to spread the environmental information to generate public awareness.

- Entertainment Folk songs, street plays, documentaries can help propagate environmental awareness.

Ecosystem

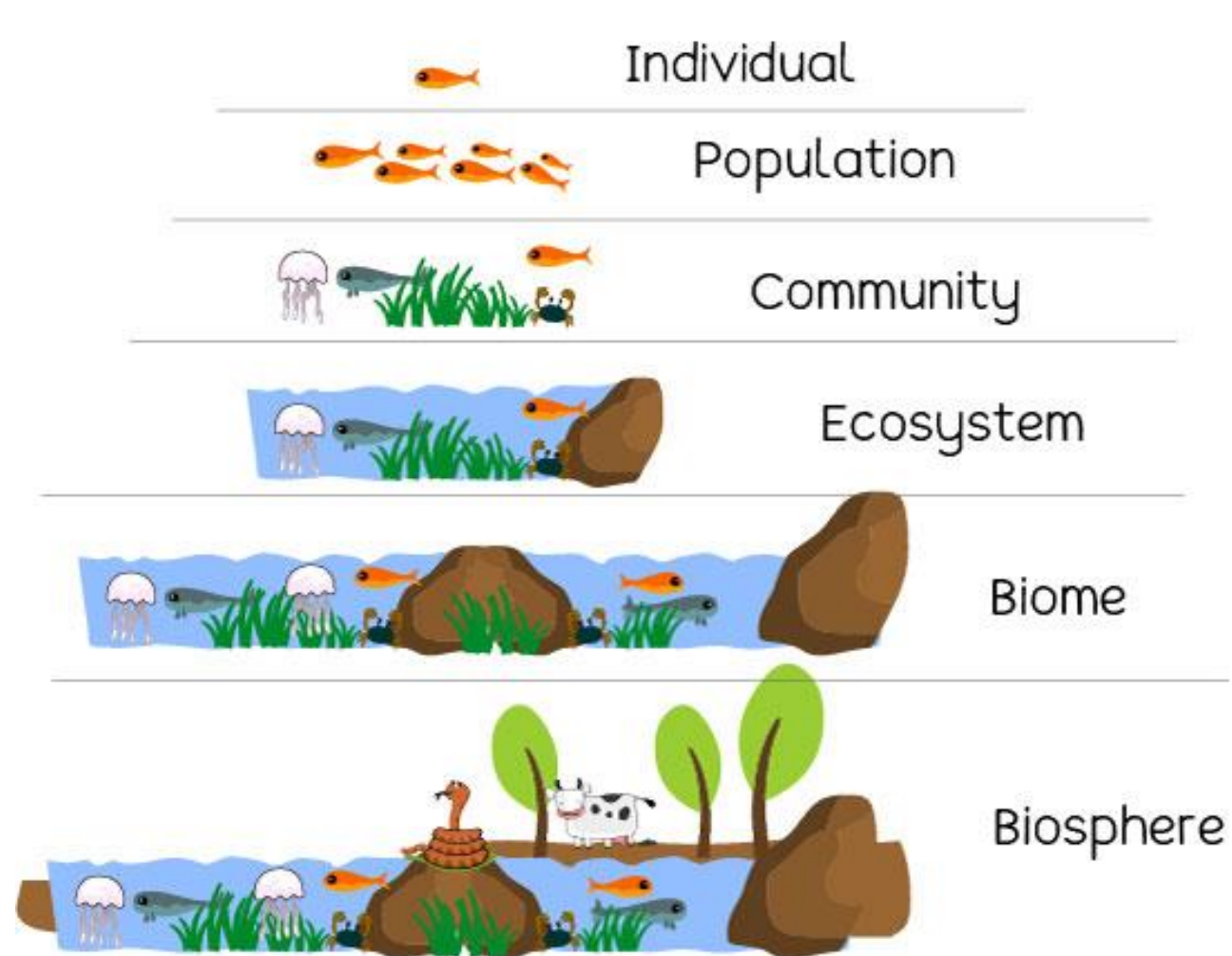- An ecosystem is a geographic area where plants, animals, and other organisms, as well as weather and landscape, work together to form a bubble of life.

- Every factor in an ecosystem depends on every other factor, either directly or indirectly.

- Nutrient cycles and energy flows are the main and distinguishing components of the ecosystem

- **Ecosystems are <u>dynamic</u> entities.**
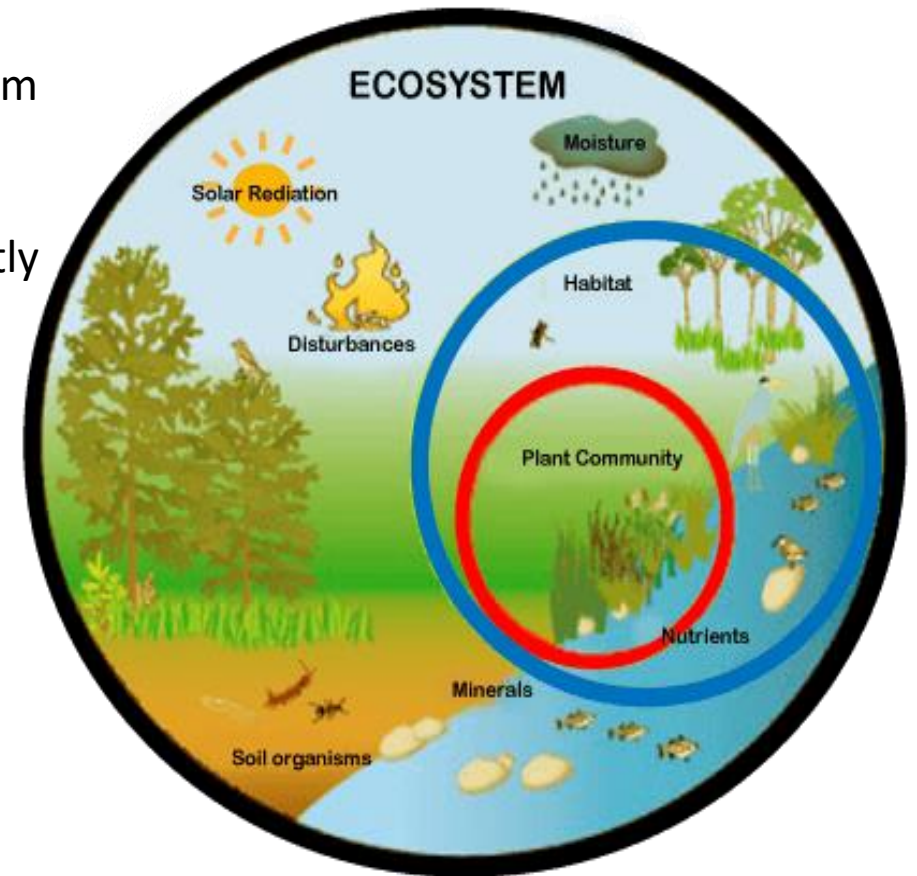
Components

Parameters	Biotic	Abiotic
Definition	Living components - Biotic factors are both organisms and the food the organisms eat.	Non- Living - Factors affecting the growth and survival of living organisms
Examples	Animals, plants, fungi, bacteria – all living things	Forest fires, water, climate, habitat, soil, minerals, human activity
Categories	Main categories 1. Producers 2. Consumers, 3. Decomposers	3 Main categories 1. Climatic Factors (Sunlight, Wind, Precipitation) 2. Edaphic factors (Topography, pH, Soil, Minerals) 3. Social
Main types	Living things	Chemical and physical things

Levels of organisation in an ecosystem

Structure of Ecosystem

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                              Structure of Ecosystem
                                        |
          ┌─────────────────────────────┴─────────────────────────────────┐
    Abiotic Components                                            Biotic Components
          |                                                               |
   ┌──────┴──────────────┐                            ┌─────────────────┼──────────────┐
Climatic              Edaphic                      Producers         Consumers      Decomposers
   |                     |                             or                or              or
┌──┼────┬──────┐   ┌─────┼──────┐                  Autotrophs      Heterotrophs     Saptrotrophs
Rain  Light  Wind Temperature  Soil  pH  Minerals  Topography         |
```

Rain
Light
Wind
Temperature

Soil
pH
Minerals
Topography

Producers or Autotrophs

Consumers or Heterotrophs

Decomposers or Saptrotrophs

| Primary Consumers or Herbivores | Secondary Consumers or Primary Carnivores | Tertiary Consumers or Large Carnivores | Quaternary Consumers or Omnivores |

Functional components & Functions of Ecosystem

Functional components

| Productivity	Decomposition	Nutrient cycling	Energy flow
Productivity It refers to the rate of biomass production	**Decomposition** It is the process of breakdown of dead organic material. The top-soil is the major site for decomposition.	**Nutrient cycling** In an ecosystem nutrients are consumed and recycled back in various forms for the utilisation by various organisms.	**Energy flow –** It is the sequential process through which energy flows from one trophic level to another. The energy captured from the sun flows from producers to consumers and then to decomposers and finally back to the environment.

Functions

1. It regulates the essential ecological processes, supports life systems and renders stability.
2. It is also responsible for the cycling of nutrients between biotic and abiotic components.
3. It maintains a balance among the various trophic levels in the ecosystem.
4. It cycles the minerals through the biosphere.
5. The abiotic components help in the synthesis of organic components that involves the exchange of energy.

Energy Flow in Ecosystem
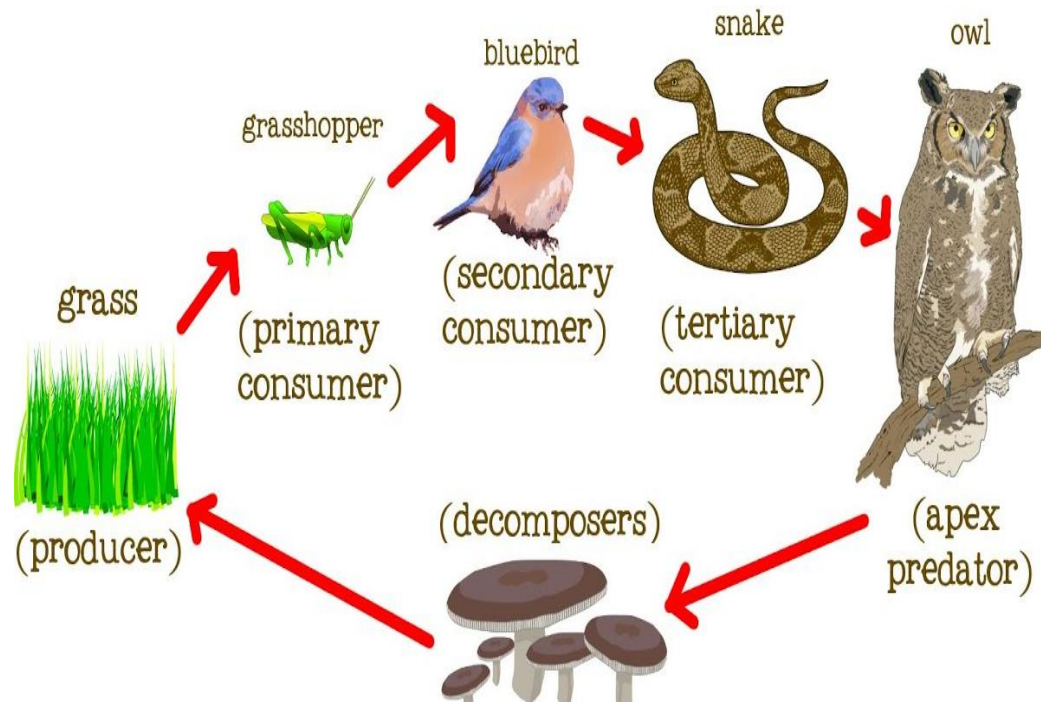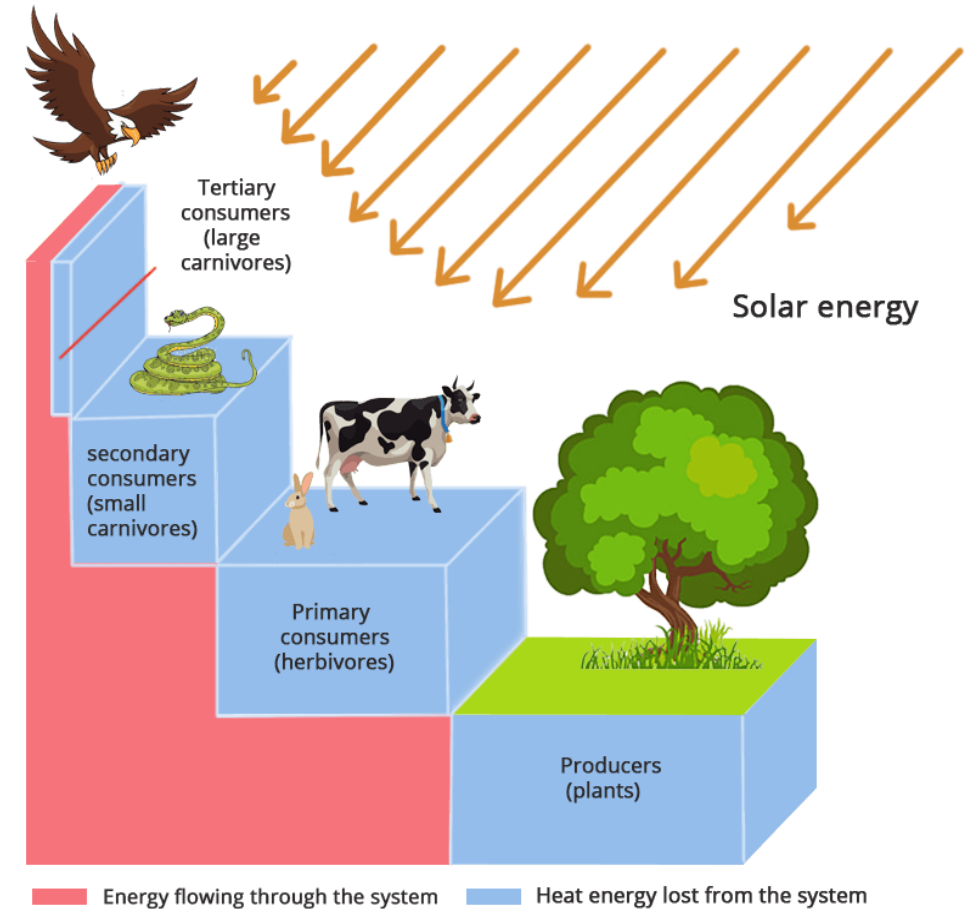

Food Chain
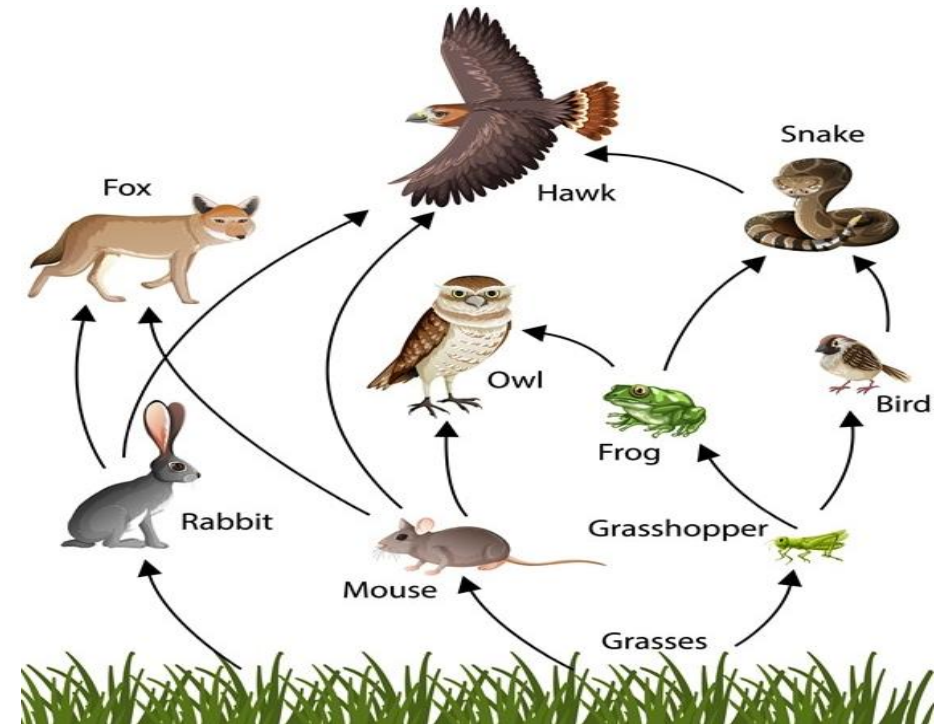
Food Web

Energy Flow in Ecosystem

- The sun is termed as the primary source of energy, as it is primarily required to flow an ecosystem. This energy flows from one organism to another in the form of a food chain.

- Each of the levels within the food chain is a trophic level.

- The arrows in the food chain show that the energy flow is unidirectional, with the head of an arrow indicating the direction of energy flow.

- Energy is lost as heat at each step along the way.

<u>**Ecological Pyramid:**</u>
An ecological pyramid is a graphical representation designed to show the **biomass or bioproductivity** at each trophic level in a given ecosystem.

Tertiary consumers (large carnivores)

Solar energy

secondary consumers (small carnivores)

Primary consumers (herbivores)

Producers (plants)

Energy flowing through the system   Heat energy lost from the system

Pyramid of energy:
Represents the rate at which energy or mass is transferred from one trophic level to the next.
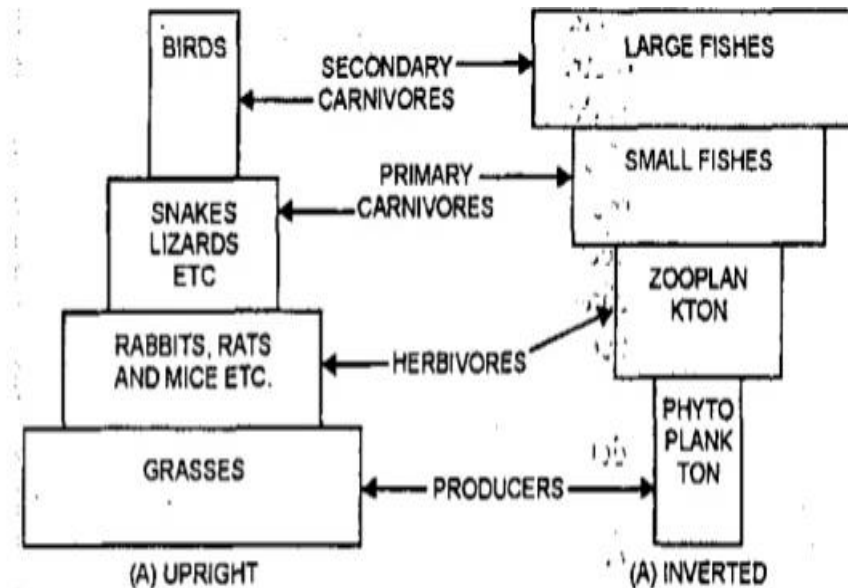
Always Upright
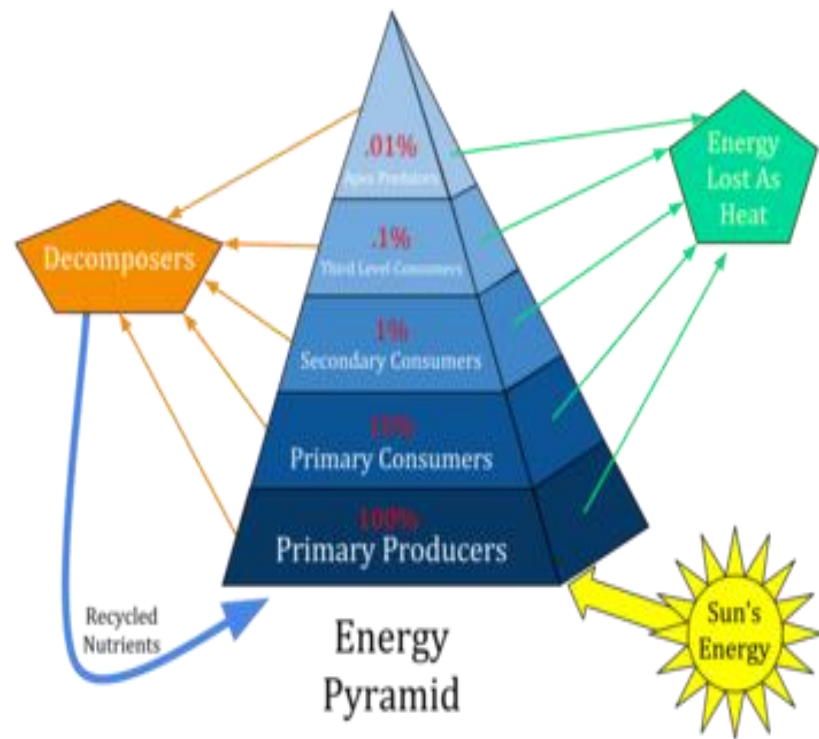
Biomass
It shows different amounts of biomass produced by each trophic level.

Can be upright or inverted.

Pyramid of number
It represents the number of organisms in each trophic level.

Can be upright or inverted

(A) UPRIGHT   (A) INVERTED

ECOSYSTEMS

Natural

Artificial

Aquatic

Terrestrial

Fresh Water

Marine

Grassland

Desert

Forest

Lotic
e.g. rivers,
streams

Wetlands
e.g. marshes,
swamps

Upwelling
Regions

Open
Oceans

Lentic
e.g. ponds, lakes
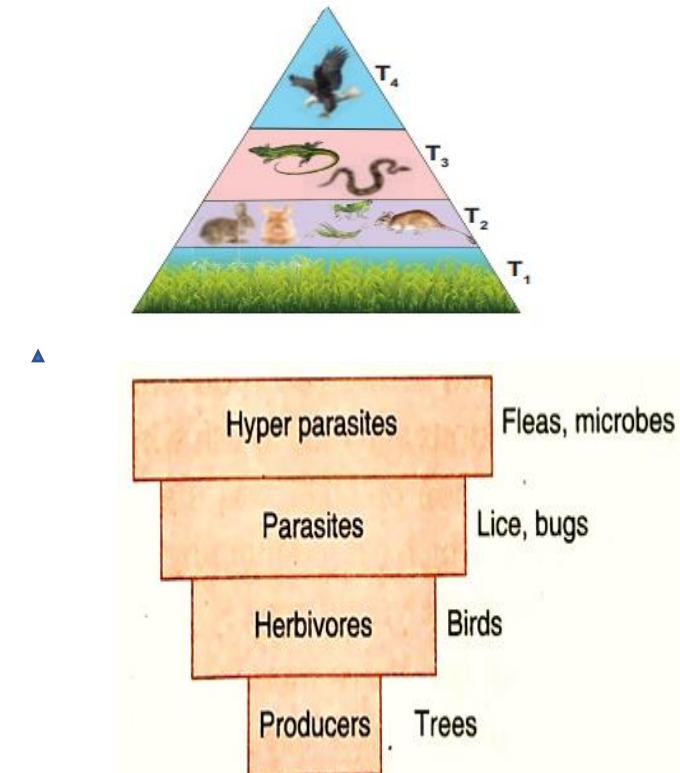
Coastal Areas
e.g. estuaries, coral
reefs, mangroves
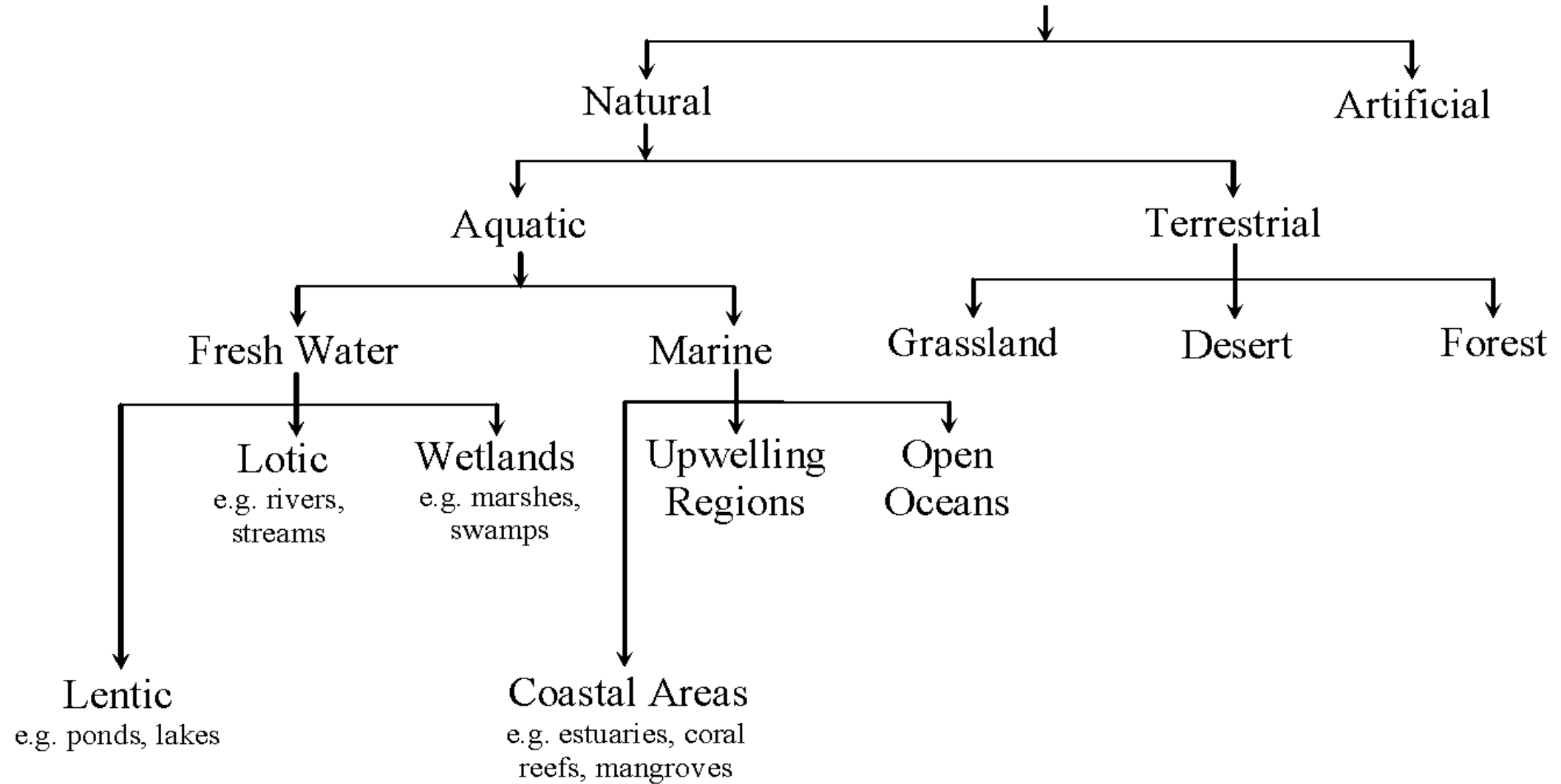
Ecological Succession

- The observed process of steady and gradual change in the species structure of an ecological community over a period of time.

- It is the order of colonization of species in an ecosystem from a barren or destroyed area of land.

Types

Primary
- Starts in lifeless areas such as the regions devoid of soil or the areas where the soil is unable to sustain life.
- Begins in a place without any soil, like: Sides of volcanoes

Secondary
Occurs on a surface where an ecosystem has previously existed. It is the process by which one community replaces another community which has been partially or totally destroyed, might be by natural process such as floods, earthquake etc.

Primary Succession

Climax community

Seral Species

Pioneer species

| Bare rock | Colonised by pioneer species (e.g. moss) | Decomposition creates a layer of topsoil | Grasses grow and displace the pioneer species | More nutrients in soil allows for shrub growth | Increase in soil depth allows for growth of trees |

Secondary Succession

Fire	Annual plants	Grasses and perennials	Grasses, shrubs, pines, young oak and hickory	Mature oak and hickory forest
0 years	1-2 years	3-4 years	5-150 years	150+ years

Pioneer Species → Intermediate Species → Climax Community

Process of Ecological succession

NUDATION: Development of a bare/ barren land due to topographic, climatic or biotic factors.

INVASION: It is the successful establishment of species in an area.
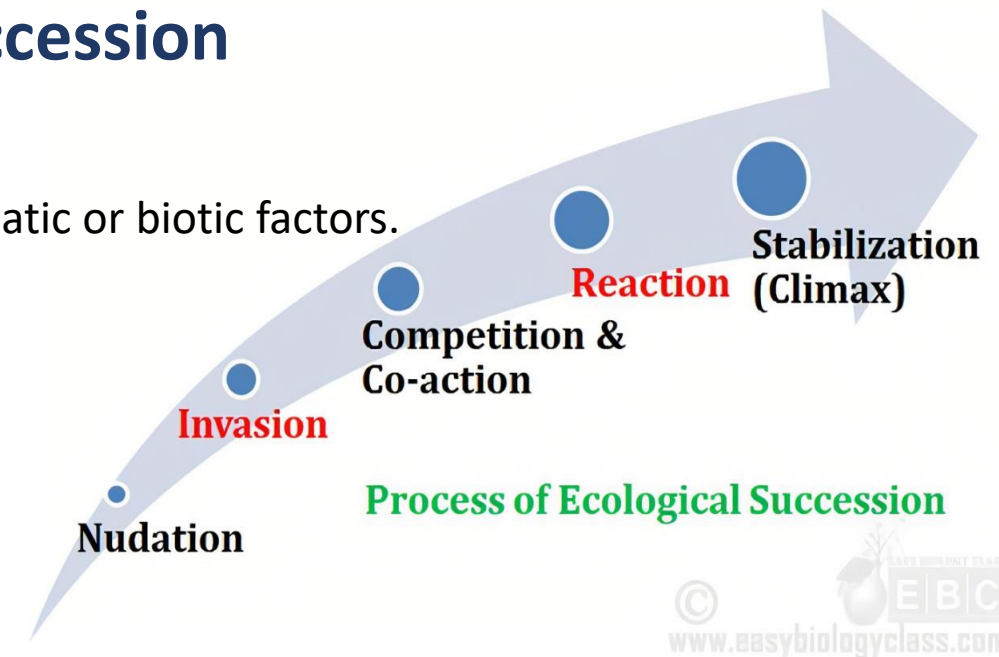The process takes place in 3 stages
- Migration: Introduction of species in the area
- Ecesis: Establishment of species
- Aggregation: multiplication of species in that area.

COMPETITION & CO-ACTION: Increase in the number of species in limited area increases competition. The species effect each other (co-action).

REACTION: It is the most important stage that effects the composition of the ecosystem. It is the modification of the environment due to the interaction of species. This influences the soil properties, microclimate and water quality. Due to these modifications, the existing community becomes unsuitable in the environmental conditions & are replaced by another community. The whole sequence of communities that replaces one another in the given area is called sere.

STABILIZATION: The final community becomes more stabilized with time and is influenced by the climatic factors of the ecosystem. These are known as climax community.

Stabilization (Climax)

Reaction

Competition & Co-action

Invasion

Process of Ecological Succession

Nudation

Biodiversity

Biodiversity

BIODIVERISTY = BIO (Living) + DIVERSITY (Variety)

Biological diversity represent the sum total of various life forms such as unicellular fungi, protozoa, bacteria, and multi cellular organisms such as plants, fishes, and mammals at various biological levels including gens, habitats, and ecosystem.

Types

Genetic diversity	Species diversity	Ecosystem diversity
Total genetic information present in genes of different species	Diversity between species	Variety of habitats, natural communities
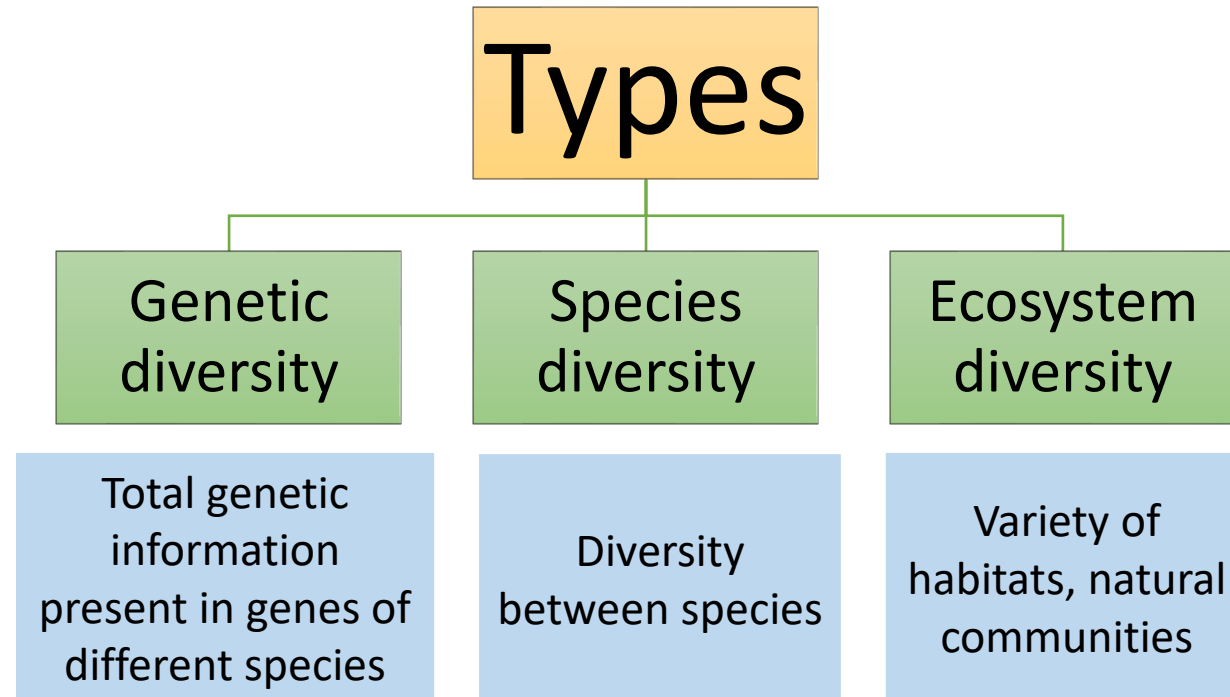
(a) Ecosystem diversity

(b) Species diversity

c. Genetic diversity
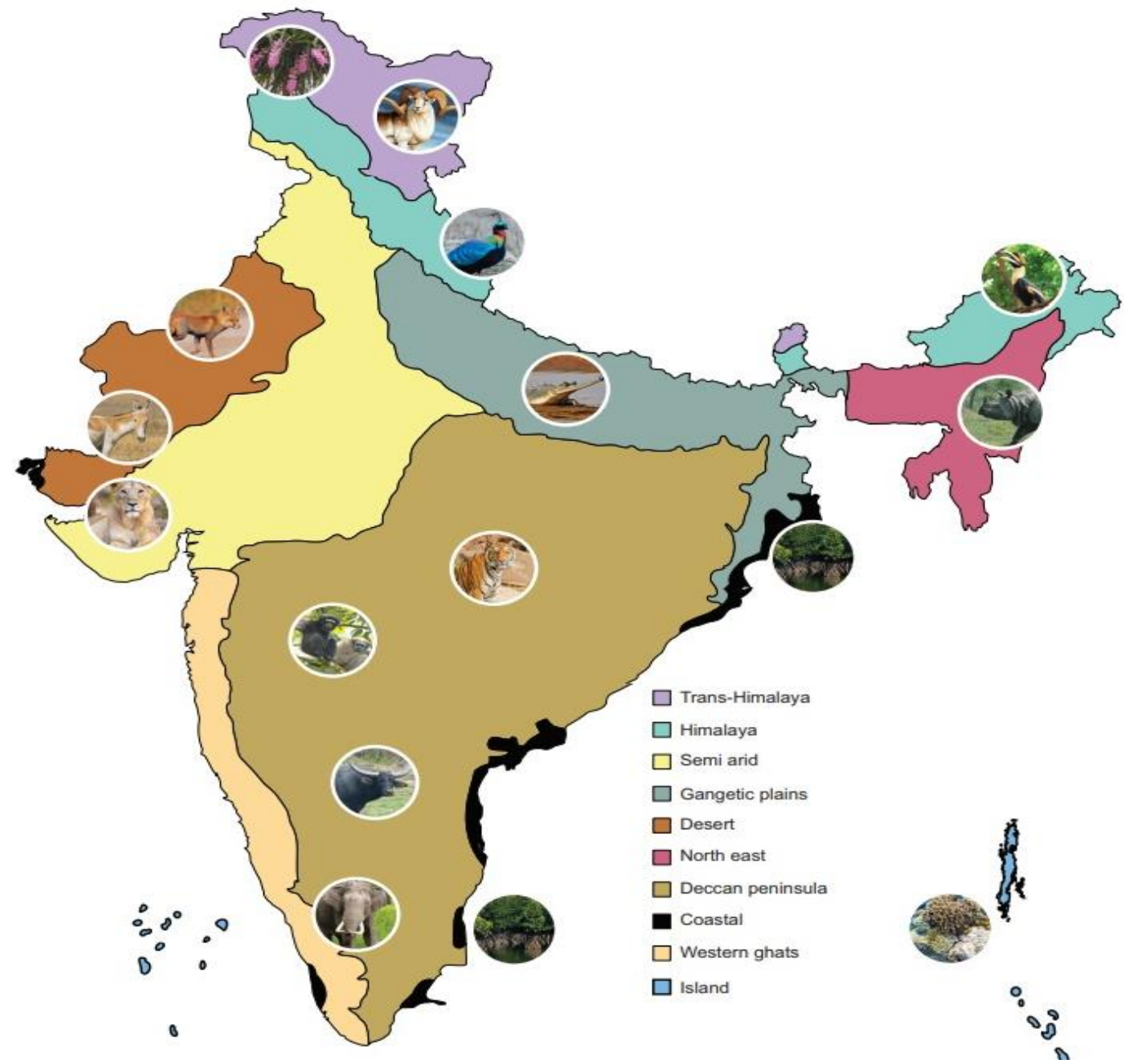
Biogeographic classification of India

- Biogeographic classification of India is the division of India according to biogeographic characteristics.

- Biogeography is the study of the distribution of species (biology), organisms, and ecosystems in geographic space and through geological time.

- **India is divided into ten major regions (by the Forest and Wildlife Dept of Government of India), based on the geography, climate and pattern of vegetation seen and the communities of mammals, birds, reptiles, amphibian, insects and other invertebrates that live in them.**

Biogeographic Region	%*
Andaman & Nicobar Island	0.3
Coastal region	2.5
North East Region	5.2
Gangetic Plains	10.8
Deccan Plateau	42
Western Ghats	4
Semi Arid Region	16.6
Indian Desert Zone	6.6
Himalayan Zone	6.4
Transhimalayan Region	5.6
Total	100

*Of total geographic area

Legend:
- Trans-Himalaya
- Himalaya
- Semi arid
- Gangetic plains
- Desert
- North east
- Deccan peninsula
- Coastal
- Western ghats
- Island

India as a mega diversity nation

- India is one of the 17 mega-diversity countries in the world.

- Indian share of the global biodiversity is about 8.6% of wild plant animal species.

- Over 91,200 species of animals & 45,500 species of plants have been documented in the ten biogeographic regions of the country.

- The country represents 4 of the 34 globally identified biodiversity hotspots (Himalaya ,Indo-Burma , Western Ghats and sundaland)

Biodiversity Hotspots

The idea was developed by Norman Myers in 1988.

Biodiversity hotspots are a method to identify those regions of the world where attention is needed to address biodiversity loss and to guide investments in conservation.

To qualify as a hotspot, a region must meet two criteria:
1. It must contain at least 1,500 species of vascular plants (> 0.5% of the world's total) as endemics
2. It has to have lost ≥ 70% of its original native habitat.

Megadiversity Nations: Countries which have a relatively large proportion of these hot spots of diversity.

Biodiversity Hotspots in India

1. **Himalaya:** Includes the entire Indian Himalayan region (and that falling in Pakistan, Tibet, Nepal, Bhutan, China and Myanmar).

2. **Indo-Burma:** Includes entire North-eastern India, except Assam and Andaman group of Islands (and Myanmar, Thailand, Vietnam, Laos, Cambodia and southern China).

3. **Sundalands:** Includes Nicobar group of Islands (and Indonesia, Malaysia, Singapore, Brunei, Philippines).

4. **Western Ghats and Sri Lanka:** Includes entire Western Ghats (and Sri Lanka).

Biodiversity Hot spots of Inida

300 km
200 mi

LEGEND
- The Himalayas
- Indo-Burma region
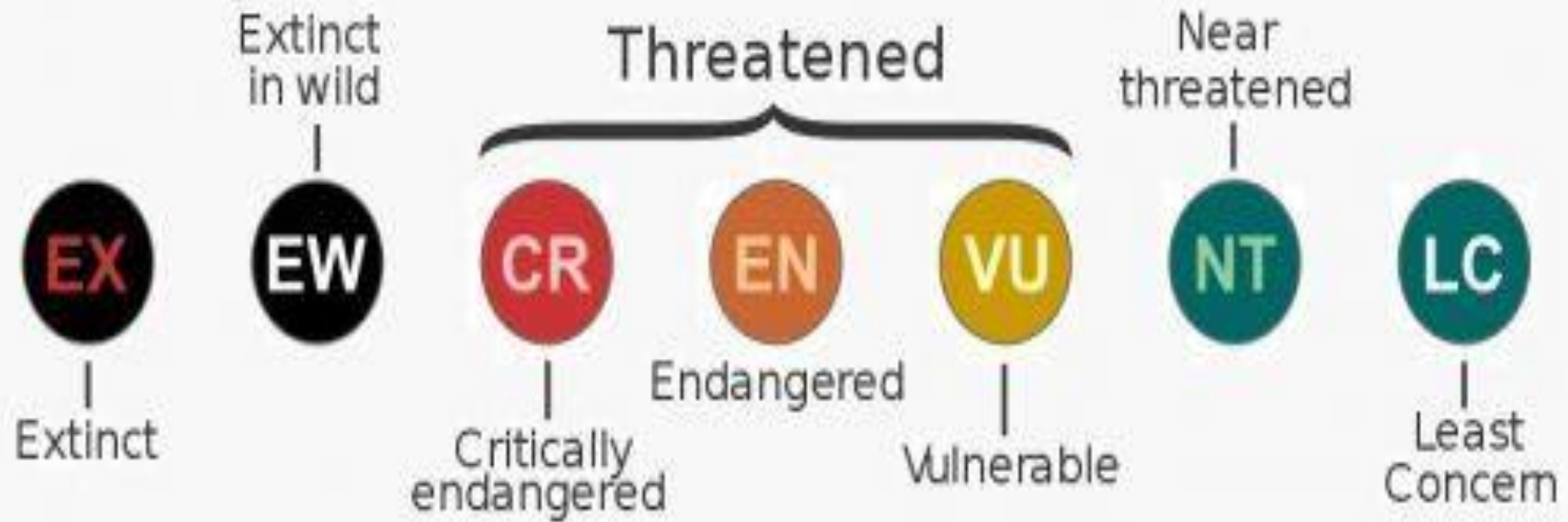- The Western Ghats
- Sundaland
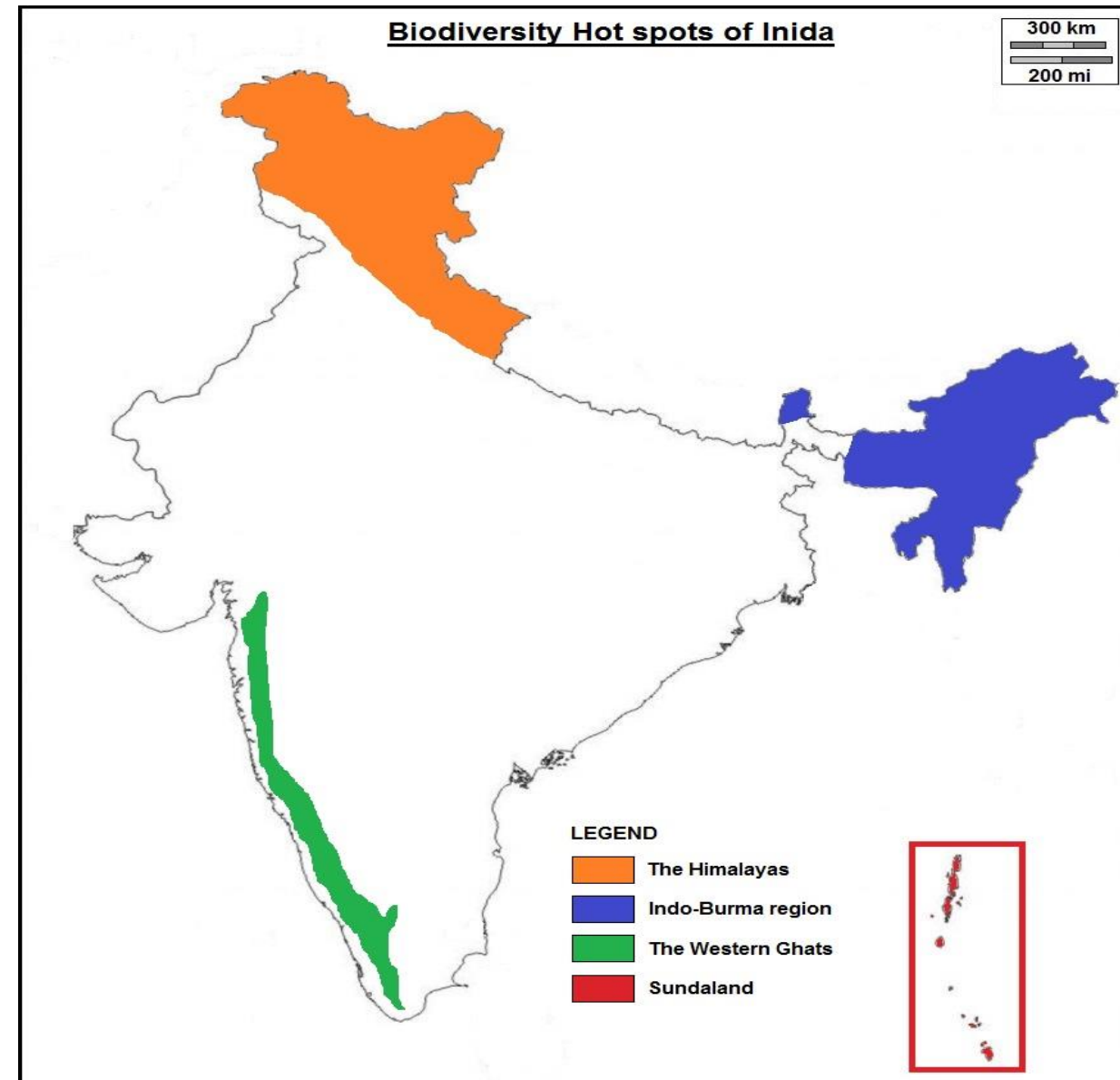
Threats to Biodiversity

The core threat to biodiversity on the planet is the combination of human population growth and the resources used by that population.

Land and Sea use Change

(Including habitat loss and degradation)

Example: Agricultural land use which is responsible for **80%** of the global deforestation

Pollution

Make the environment unsuitable for survival directly and indirectly

Species overexploitation

Example: Overfishing which may decimate global fish populations by 2050

Climate Change

Forcing the animal to shift range or confounding the signals that trigger seasonal events and more

Invasive species and disease

Compete with native species for space, food and other resources; sometimes spread disease that native species have no immunity of

Human animal conflict

When animals pose a direct and recurring threat to the livelihood or safety of people and vice versa

Species classification as per IUCN

RET Species

Rare Species

- A rare species is a group of organisms that are very uncommon, scarce, or infrequently encountered.

- The International Union for Conservation of Nature uses the term "rare" as a designation for species found in isolated geographical locations.

- They are not endangered, but classified as at risk.
- Rare species are generally considered threatened because a small population size is more likely to not recover from ecological disasters.

- Examples of rare species include the Himalayan brown bear, Fennec fox, Wild Asiatic buffalo and Hornbill.

RET Species

Endangered species as classified by the IUCN, are species which have been categorized as very likely to become extinct in their known native ranges in the near future.

Criteria for endangered status:

- Reduction in population size

An observed, estimated, inferred or suspected population size reduction of ≥ 70% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are reversible and understood and ceased.

- Population decline

Population estimated to number fewer than 2,500 mature individuals. An estimated continuing decline of at least 20% within five years or two generations

- Geographical range

Severely fragmented

- Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations.

Examples: One- horned Rhinoceros, Asiatic Lion, Bengal Tiger, Lion tailed macaque, Kashmiri Red Stag, Indian Bison.

Threatened Species

A threatened species are divided into 3 categories: vulnerable, endangered, or critically endangered.

- **Critically Endangered** (Cr) is the highest risk category assigned by the IUCN for wild species. Critically endangered species means a species numbers have decreased, or will decrease by 80% within three generations. It is therefore considered to be facing an extremely high risk of extinction in the wild.
Examples: White rumped vulture, Siberian crane, Ghariyal, Red headed vulture

- **Endangered (EN) species** is a population of organisms which is at risk of becoming extinct because it is either few in numbers, or threatened by changing environmental or predation parameters. Also it could mean that due to deforestation there may be a lack of food and/or water. It is therefore considered to be facing a very high risk of extinction in the wild.
Examples: Bengal Tiger, Lion tailed macaque

- **Vulnerable (VU) species** are the ones which have been categorised by the IUCN as likely to become endangered unless the circumstances threatening its survival and reproduction improve. It is therefore considered to be facing a high risk of extinction in the wild.
 Examples: Black buck, Nilgiri langur, Olive Ridley Turtle

Endemic Species

An **endemic species** is one that is unique to a defined geographic location or habitat, such as an island, nation, other defined zone, etc.

Features of endemic species:
- Due to their isolation, they may acquire unique traits, specific to the climate of that particular region.
- They have a low degree of genetic exchange and variation. Thus, they have saturated genomes and they lack the potential to migrate.
- Due to geographical barriers dispersal of propagules are not able to sustain while they migrate. Thus, their spread is restricted.
- They are highly vulnerable to extinction as they live in specific natural conditions with a low number of individuals. Changes in their living conditions push the endemic species towards extinction.

- Endemic species in India

Being a mega biodiversity country India has Eastern Himalayas, Western Ghats, Western Himalayas as micro centres for endemic plants and animals. Almost 23% of flowering plants found in India are endemic. Almost 60% of all endemic species in India live in eastern Himalayas and the Western Ghats.
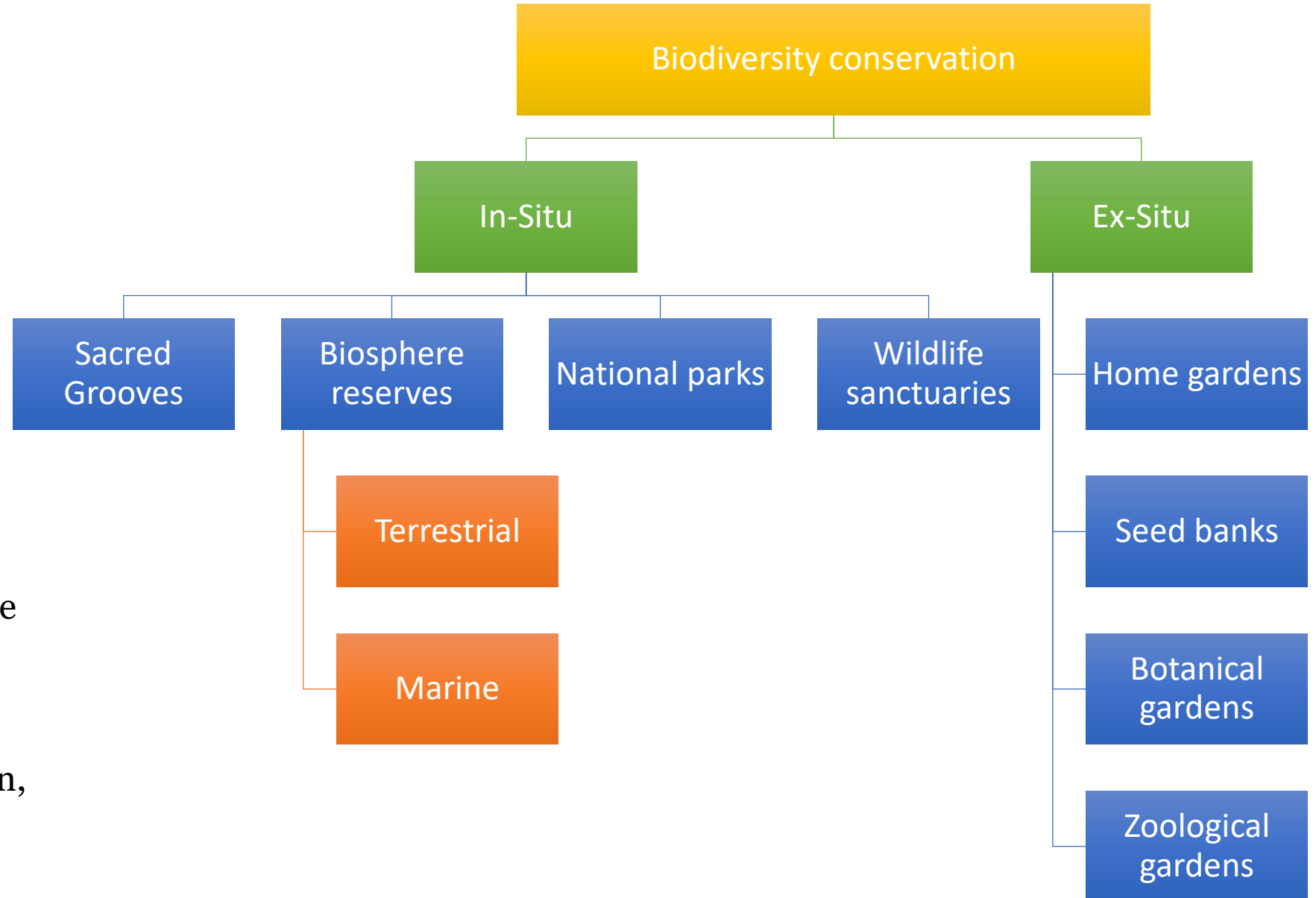
Examples: Asiatic Lion- Endemic to Gir Forest, Gujarat
Lion-tailed Macaque- Endemic Western Ghats
Kashmir Stag endemic to Kashmir Valley

In situ conservation

It is the conservation and protection of genetic resources of plant and animal species in their natural habitats itself.

Ex situ conservation

It is conservation of biological diversity outside their natural areas and is done through different methods like captive breeding, botanical garden, zoos, aquaria etc.

Biodiversity conservation

In-Situ

Ex-Situ

Sacred Grooves

Biosphere reserves

National parks

Wildlife sanctuaries

Home gardens

Terrestrial

Marine

Seed banks

Botanical gardens

Zoological gardens

Biosphere reserve
Biosphere reserves cover very large areas, often more than 5000 km^2. They are used to protect species for a long time.

There are 18 Biosphere Reserves in India

HUMAN SETTTLEMENT

RESEARCH

EDUCATION & TRAINING

TOURISM

Core area

Buffer zones

Transition area