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ZOO 507 Principles of Animal Ecology



HANDOUTS TOPIC NO 1 TO 164

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FOR HARD COPY HANDOUTS

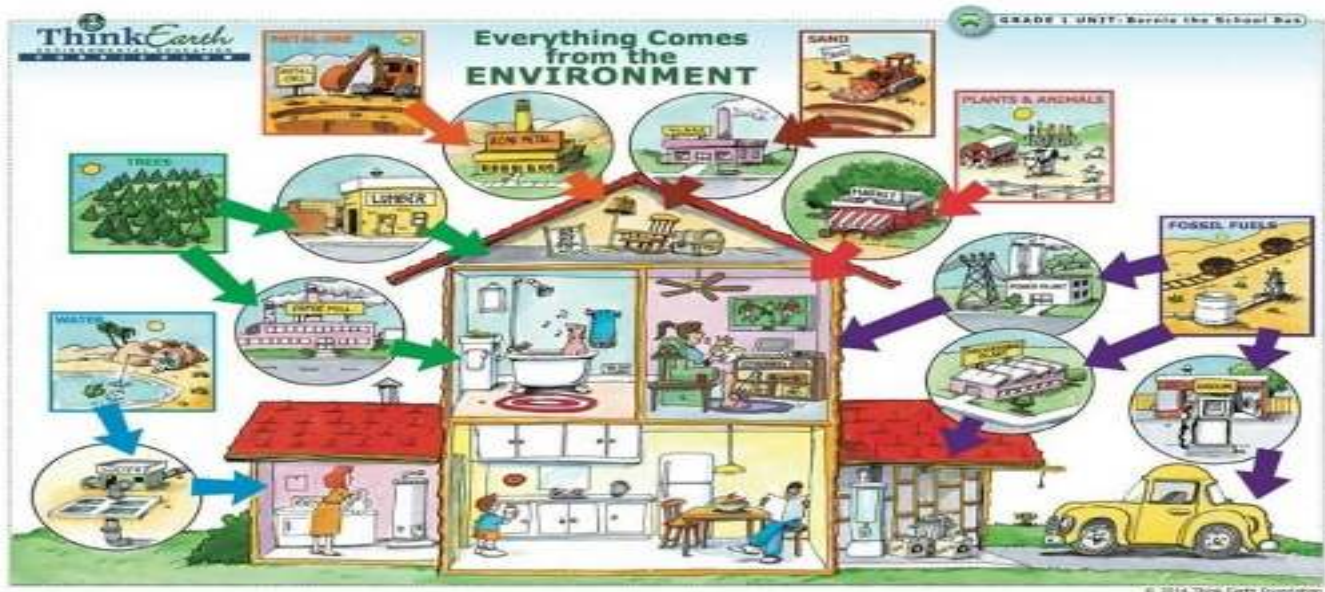
1 Ecology

Agenda

1. Introduction.
2. What is meant by Ecology
3. Importance of Ecology
4. Scope of Ecology
5. Its relevance with man kind

2 Ecology and Environment: Introduction

1. **Ecology** (from Greek word: οἶκος, "house", or "environment" and logos means "study of")
2. **Ecology** is the scientific study of the interactions between organisms and their environment

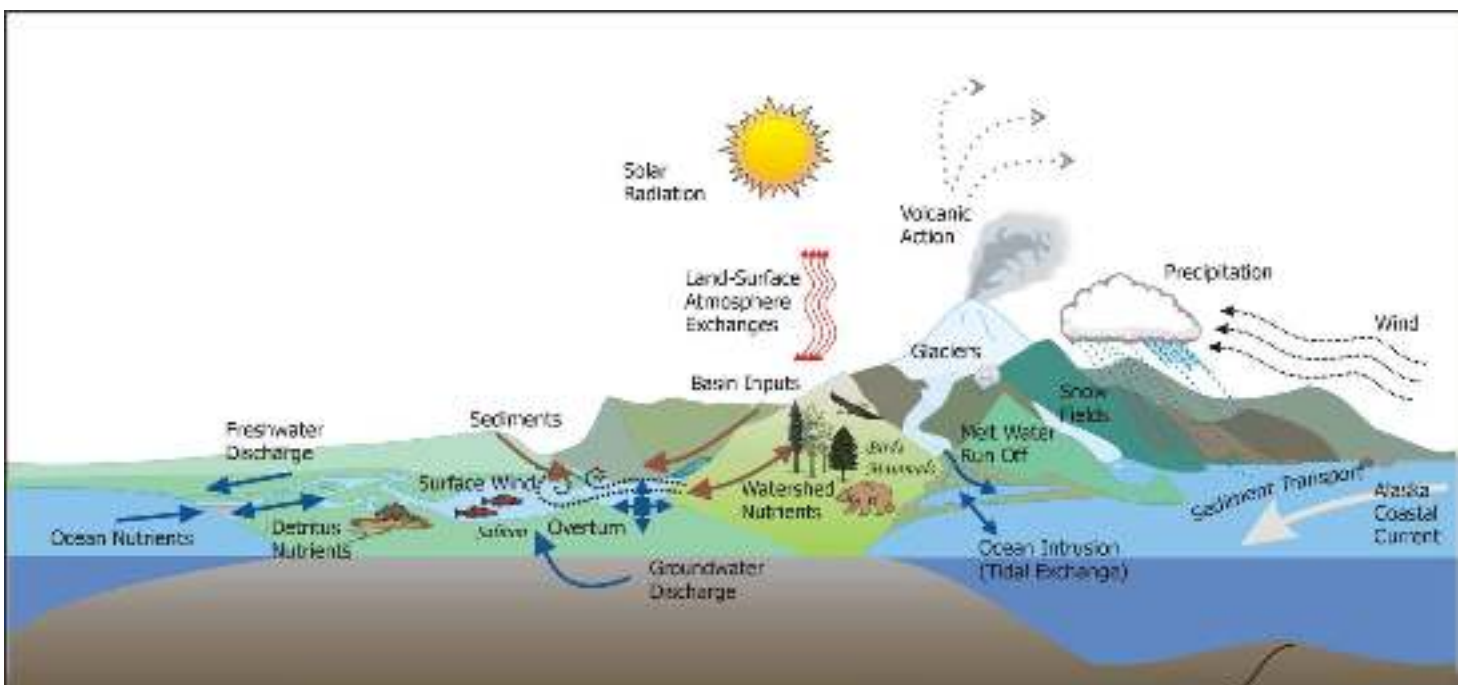


- a) **Autecology**-individual's life history, behavior, adaptation to environment
- b) **Synecology**-group of organisms associated together as a unit

3 Ecology and Environment: Importance

3. Why it is important to study ecology? Or Importance of Ecology

- i. To understand the distribution and abundance of living things in the physical environment.
- ii. It includes the integration of scientific disciplines inside and outside of biology
- iii. Such as biochemistry, physiology, evolution, biodiversity, molecular biology, geology, and climatology.



4 Ecology and Environment: Branches

Branches of Ecology

- i. Applied ecology, (includes agroecology and conservation biology)
- ii. Biogeochemistry
- iii. Biogeography
- iv. Conservation ecology
- v. Ecological succession
- vi. Evolutionary ecology
- vii. Functional ecology,
- viii. Global ecology
- ix. Marine ecology, and fresh water ecology
- x. Microbial ecology
- xi. Paleoecology
- xii. Restoration ecology
- xiii. Soil ecology
- xiv. Urban ecology,

5 Ecology and Environment: Relevance

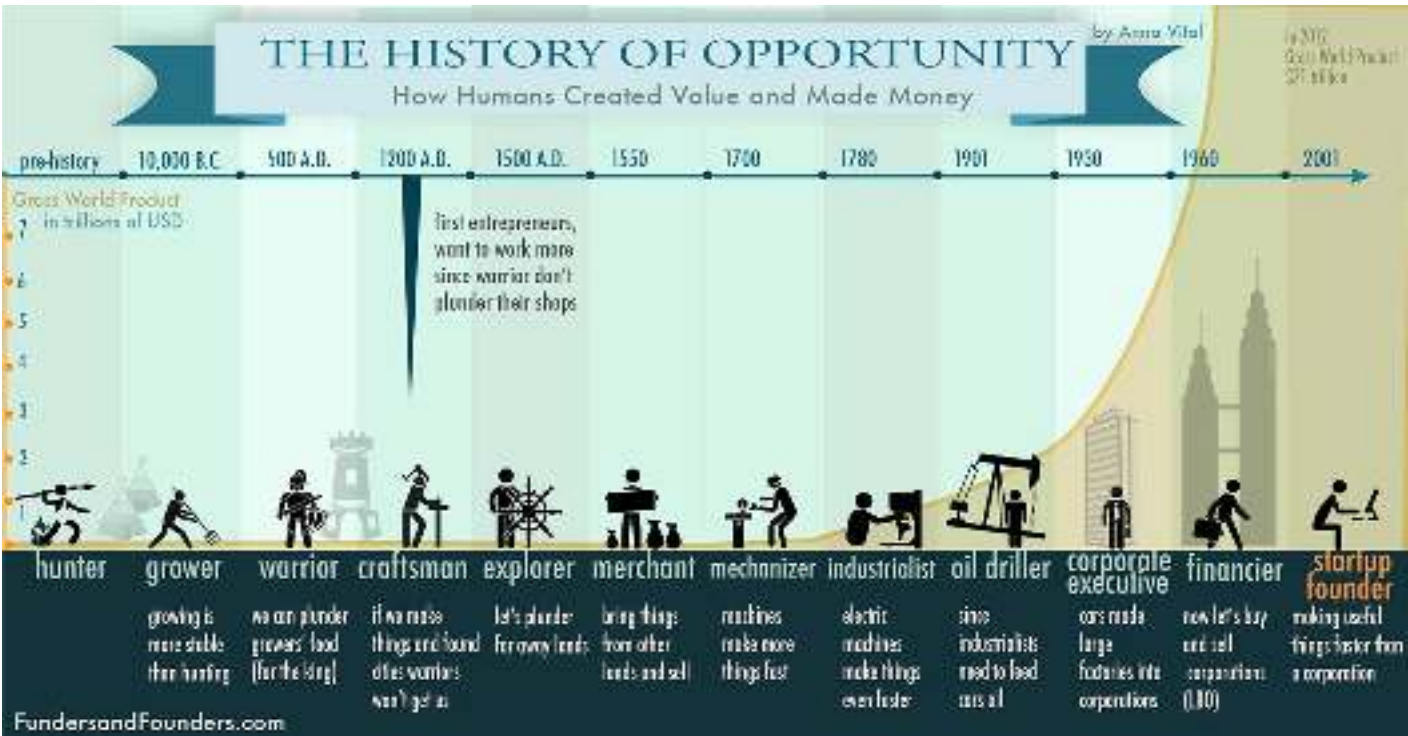
Relevance to man kind

The more you know about the past, the better you prepared for the future

- 1. Start of civilization-Pure Environment- dependency on nature

The more you know about the past, the better you prepared for the future

- 2. Use of fire and other tools to modify surroundings
- 3. Advances in technology-less natural items
- 4. Result-Pollution



6 Ecology and Environment: History

History of Ecology

1. Aristotle and ancient Greece philosophers clearly point out ecological topics
2. German Biologist-Ernst Haeckel -1869-“**Ecology**” first used
3. Early 1700s-Leeuwenhoek- pioneer in study of **food chain**
4. Botanist's- Richard Bradley- **Biological Productivity**
5. Frederick Clements, Victor Shelford, Raymond L, Edward A- establish “**field of Ecology**”
6. **1968-1970**- picture of Earth- Pollution
7. 1970s- “**Decade of Environment**”
8. 22nd April 1970- First “ **Earth Day**”
9. **1980s-1990s**- Environmental issues with political backward

7 Ecology and Environment: Scope

2. Scope of ecology

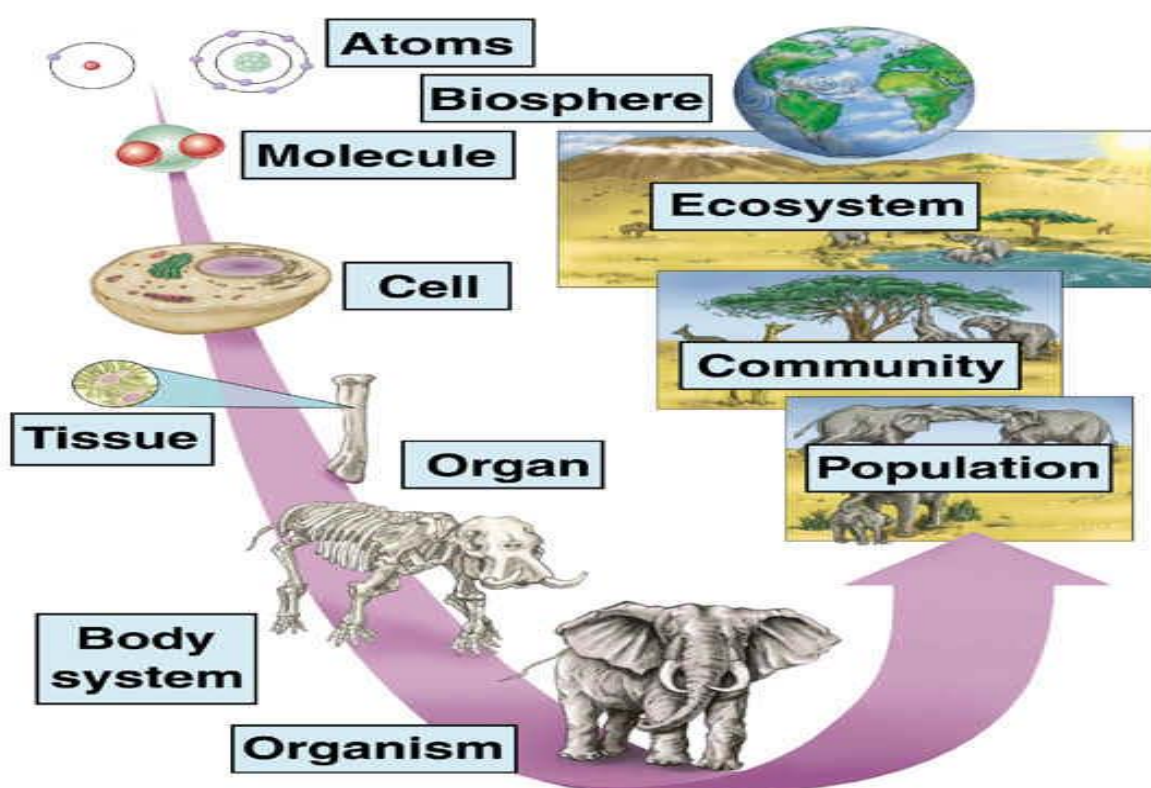
- i) all organisms living on Earth
- ii) all physical and chemical surroundings.
- iii) for this reason,
- iv) the field is usually divided into different levels of study including: organismal ecology, population ecology, community ecology and ecosystem ecology

8 Level of organization

Four levels of biological organization—

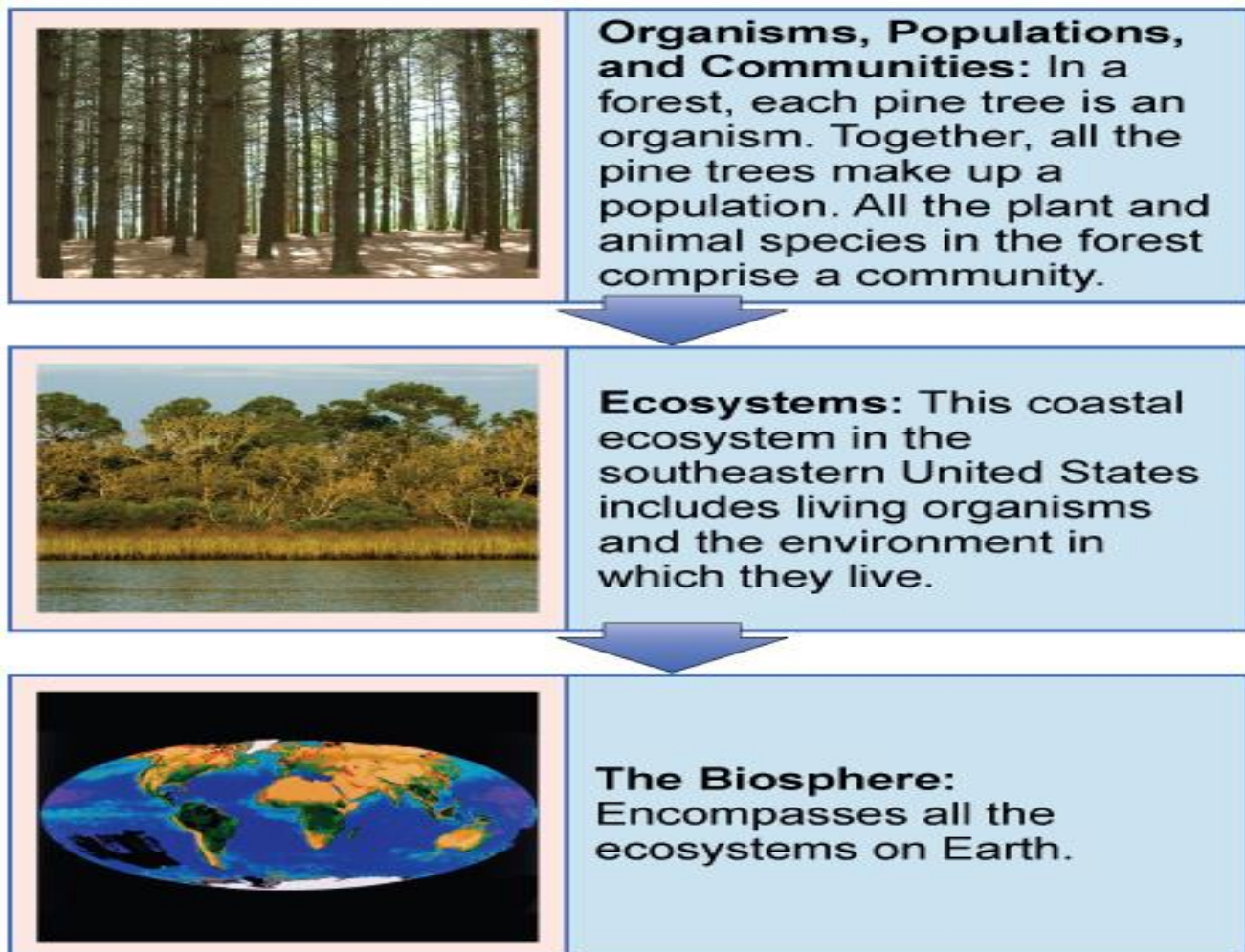
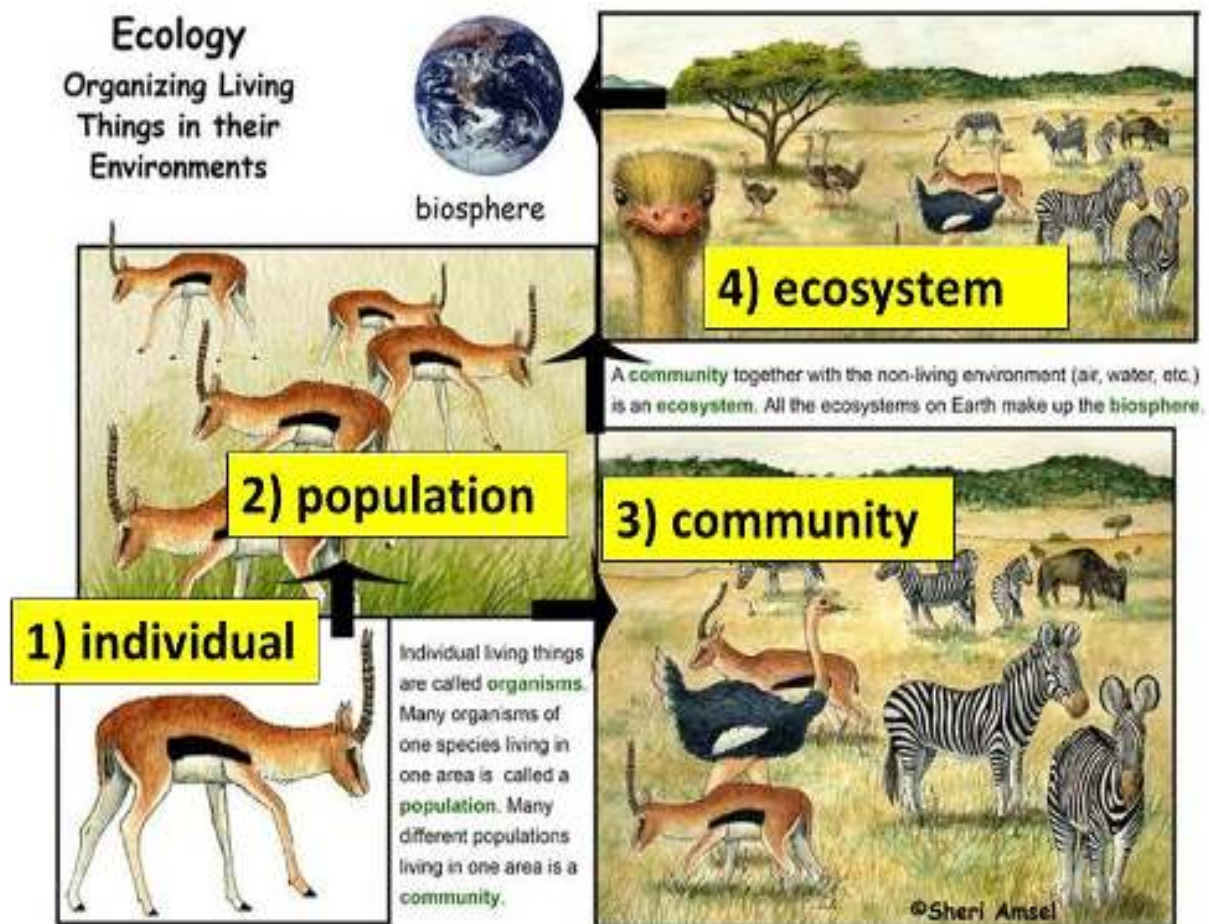
- a) **organismal**, organisms interactions with their environments
- b) **Population**, how populations changes over time
- c) **Community**, different populations interactions in a community
- d) **Ecosystem**, examine the living species (the biotic components) of the ecosystem and the nonliving portions (abiotic components), such as air, water, and soil, of the environment.

Raven/Berg, Environment, 3/e
Figure 4.1



Harcourt, Inc.

4 levels of organization



9 Homeostasis

Level of organization: Homeostasis

Definition: “tendency of system, especially the physiological system of higher animals, to maintain internal stability owing to the coordinated response of its parts to any situation or stimulus that would tend to disturb its normal condition or function”

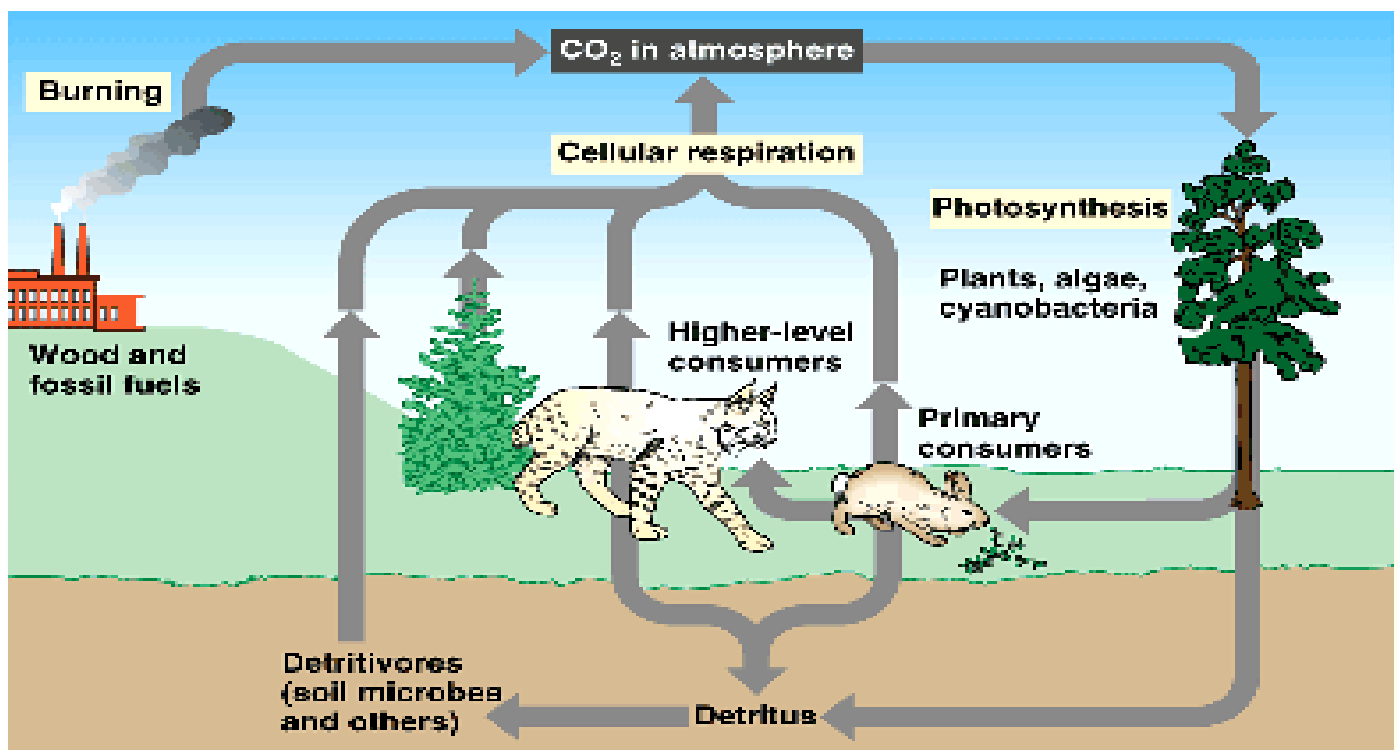
Level of organization: Characteristics of Ecosystem

Ecosystem- living (biotic) and non-living (abiotic) environments

- inseparable
 - interrelated
 - interact with each other
- e.g. small as puddle, Large as ocean or forest or desert

Ecosystem- living (biotic) and non-living (abiotic) environments

- inseparable
 - interrelated
 - interact with each other
 - flow of energy (inputs) and cycling of materials (outputs) between living and non-living components
 - functional unit/system of Ecology
 - flow of energy follow-nevery used again
- thermodynamics laws
- materials can be reused



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Level of organization: Biosphere

Ecosphere- largest and nearly self sufficient biological system

Including all living organisms of earth interacting with the physical environment

(Lithosphere-the Soil

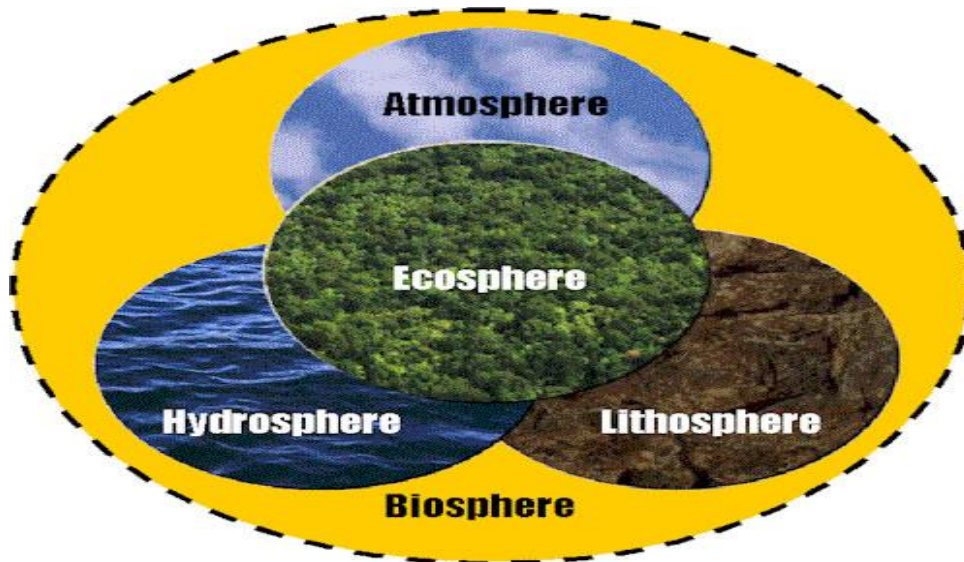
Hydrosphere-water

Atmosphere-air

whereas

Biosphere- life zone of the earth

Ecosphere = Biosphere + Lithosphere + Hydrosphere + Atmosphere)



11 Types of Ecosystem

Types of Ecosystem

Natural

i) Terrestrial

e.g. Grassland (Savana), Forest, Desert ecosystems

ii) Aquatic

a.Lentic (Stagnant water) like lake, ponds etc.

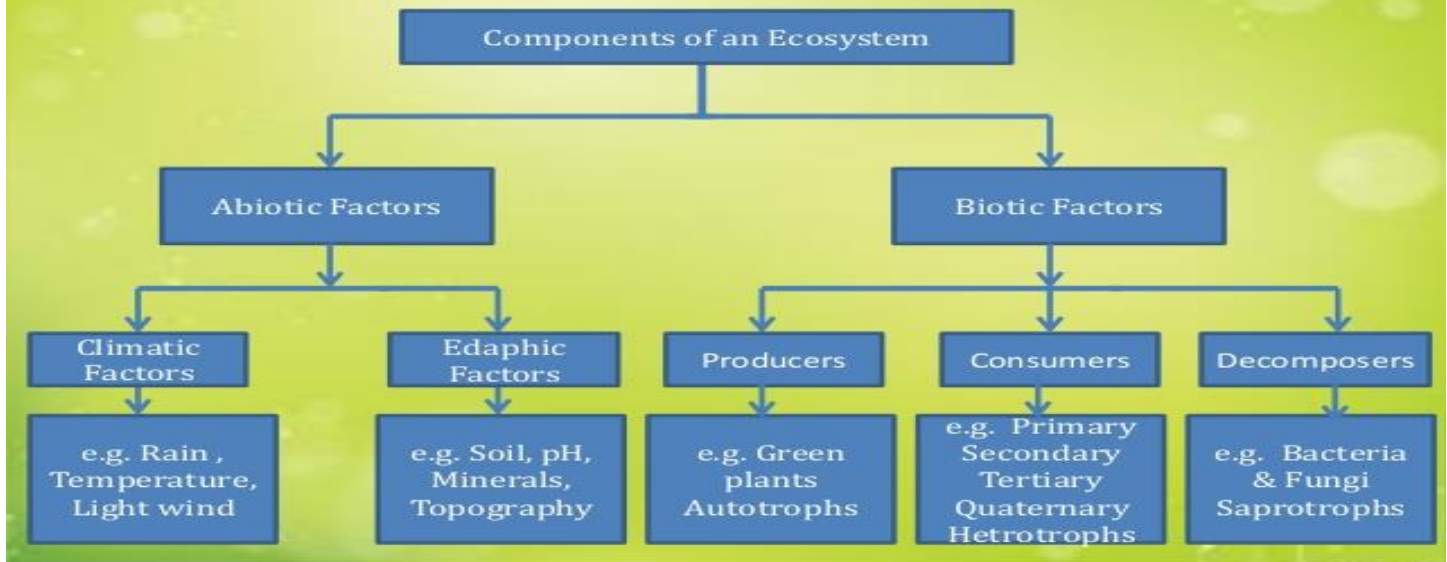
b.Lotic (Flowing water) like river, ocean, sea, etc.

Artificial

A crop land, garden, aquarium, park, kitchen garden.

12 Components of Ecosystem

Components of an Ecosystem



Components of Ecosystem-Abiotic

Tolerance range-tolerance level for temperature range

e.g. a human being would die if he stood out in minus 50°C for any length of time

Optimum range- certain range within tolerance range

e.g. human body works at 37°C

Limiting factor-abiotic factor out of animal tolerance range

Abiotic Components

Non-living components of Ecosystem-

-can not be generated by living organisms by themselves

- **three basic categories:**
- Climatic (humidity, sunlight, Air & temperature)
- Edaphic (Soil and geography of land)
- Social (use of land and water)
- **Abiotic Components- act as**
- **-Resources**
- Soil
- Water
- Atmosphere/Air
- **-Regulatory abiotic factors**
- Light
- Temperature
- Pressure
- Humidity etc

13 Components of Ecosystem-Abiotic

Light

- i) Sun light-ultimate source
- ii) Photosynthesis-glucose-light energy converts into chemical energy
- iii) Light intensity and duration depends on degree of latitude

14 Components of Ecosystem-Abiotic (Light)

Light

- iii) Light intensity and duration depends on degree of latitude
- iv) Equator-direct sunlight-warm
- v) Tropics-less light than equator-diverse life forms
- vi) Temperate cold zones
- vii) Ice covered poles

15 Components of Ecosystem-Abiotic (Atmosphere/Air)

Atmosphere/Air

- i. **Mixture of gases**
- ii. **Layers of atmosphere**
- iii. **Air pressure**
- iv. **Role of atmosphere(air) for life on earth**

16 Components of Ecosystem-Abiotic (Temperature)

Temperature

- i) Temperature is the function of light
- ii) temp-affect body's metabolic rate
 - a) **Torpor**
 - b) **Hibernation**
 - c) **Winter sleep**
 - d) **Aestivation**

17 Components of Ecosystem-Abiotic (Soil)

Soil

- i) Basic medium for land based ecosystems
- ii) Natural reservoir of inorganic mineral elements
- iii) Contain humus- material formed by decomposition of dead plants and animals
- iv) More humus-diverse life forms

Soil Types

- a) **Sandy soil**-do not hold- desert
- b) Silt Soil
- c) **Clay soil**- hold water – grasslands and forests
- d) **Loamy soil**-fertile-agricultural land

18 Components of Ecosystem-Abiotic (Water)

Water

- 1. Life originator

Source

- 2. Ice, glaciers, rainfall

3. Living bodies are almost made of water
4. **70%** of earth
5. Helps in the process of photosynthesis and other cycles in nature
6. Water bodies-heat sink-regulate temperature
7. Water need varies among different animals

Water

To categories ecosystems

1. Aquatic Ecosystems

- a) Ocean ecosystem
- b) Freshwater ecosystem

2. Terrestrial Ecosystem

- a) Tropical rain Forests
- b) Desert Ecosystem

Water as limiting factor

1. In terrestrial environment
2. In water environments in which amount is subjected to great fluctuation (temporary ponds)
3. High salinity raises water loss from organisms by osmosis

19 Components of Ecosystem-Abiotic (Humidity and ...

Humidity and Temperature

1. Invisible vapour (humidity)
2. Absolute humidity
3. Ounce/cubic yard
4. Relative humidity
5. Temperature governs humidity
6. Effect on intensity of solar rays
7. Effect on transpiration vs evaporation
8. Source of soil moisture

20 Components of Ecosystem-Abiotic (Flood and Fire)

Flood and Fire

Flood

“Excess of water flows Seasonal”

- a) Caused sever damaged to soil
- b) Removal of fertile top soil layer
- c) Increase moisture in soil
- d) Unfit for crop cultivation

Fire

- a) Itself neither abiotic nor biotic
- b) Caused by burning of biotic and abiotic chemicals

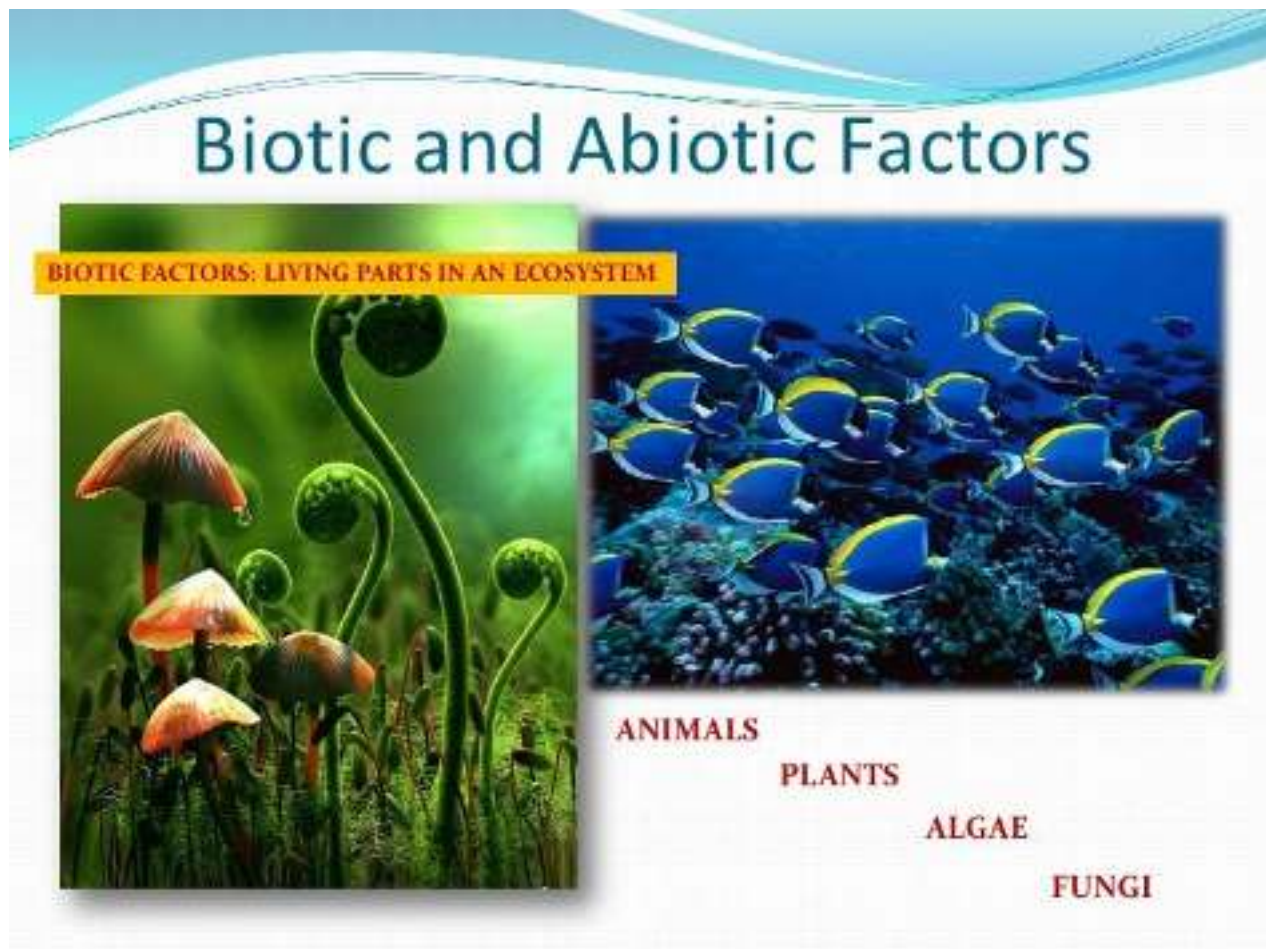
c) product abiotic compounds, including charcoal that may continue as part of carbon cycling, and carbon dioxide that enters the atmosphere and is used by plants.

21 Components of Ecosystem-Biotic

All living organisms found in the environment including plants, animals and microorganisms

Biotic or Living components- Categories of biotic component

1. Producers or Autotrophs-Plants
2. Consumers or Heterotrophs-Animals
3. Decomposers-Microorganisms



22 Components of Ecosystem-Biotic (Producers)

Producers or Autotrophs-

Green plants (Land environment)

Producers or Autotrophs- Green plants (Land environment)

1. They synthesize food for all the organisms of ecosystem
2. Convert sunlight or solar energy to chemical energy
3. converts inorganic substrate into organic food by the process of photosynthesis

Producers or Autotrophs-

(Aquatic environment)

Two Types

Floating plants : called **phytoplankton** ("phyto"- plants, "plankton" - floating.) for example, *Spirogyra*, *Ulothrix*, diatoms and *Volvox*.

Floating plants



Water lily



Pistia sp



Water hyacinth



Producers or Autotrophs-

(Aquatic environment)

Two Types

(b) **Rooted plants** : These plants occur in concentric layers from periphery to the deeper zones.

examples of rooted plants are *Typha bulrushes*, *Sagittaria*, *Hydrilla*, *Rupia*, *Chara*.

4. 1st trophic level
5. rate at which the radiation energy is stored by photosynthesis in green plant is called gross primary productivity (GPP).

23 Biotic components-Consumers

Consumers:

They are heterotrophs which obtain energy from producers directly or indirectly.

They can be further divided as

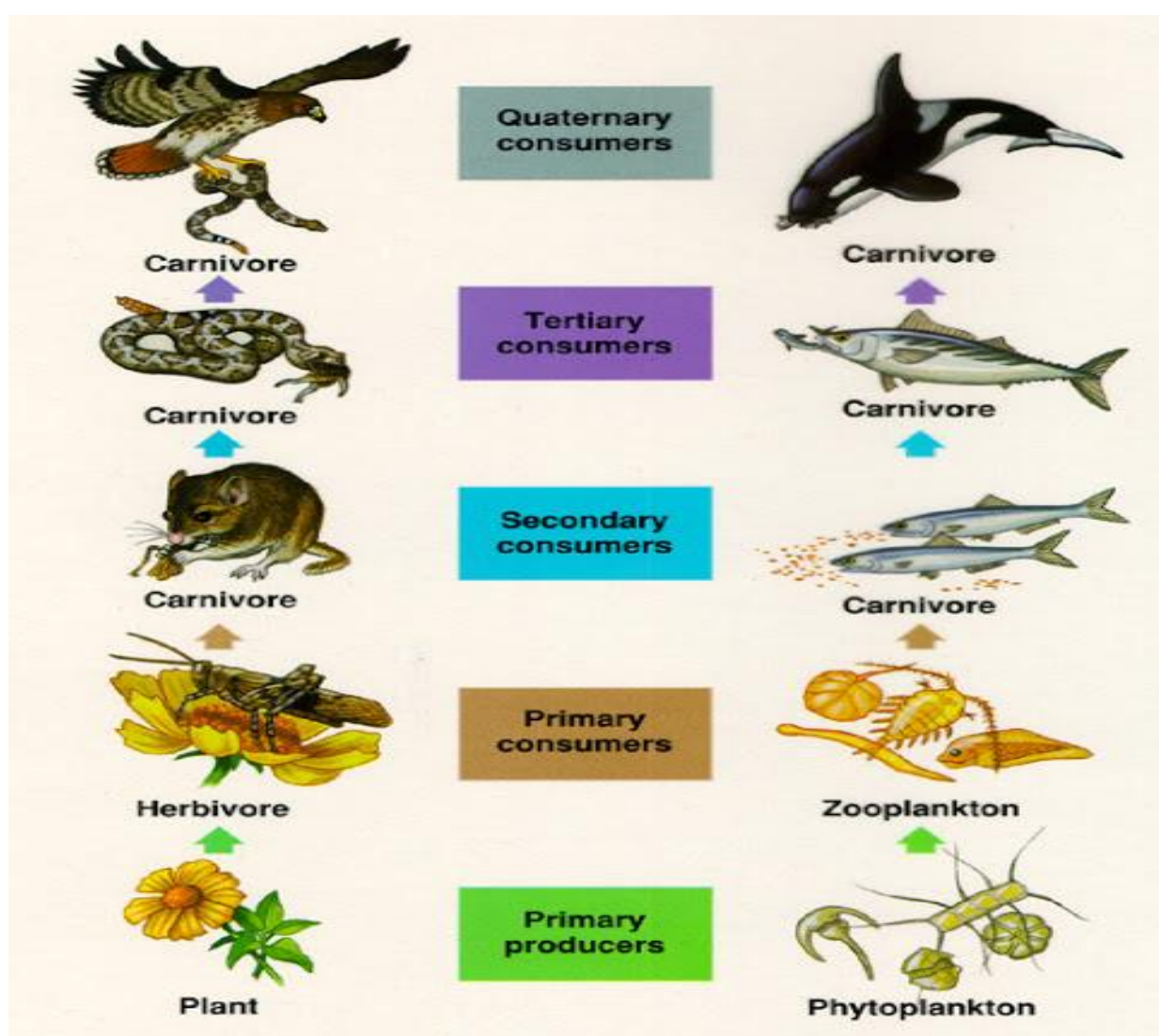
- i. **Primary consumers**
- ii. **Secondary consumers**
- iii. **Tertiary consumers**

Consumers:

- i. **Primary consumers- (herbivores) in land ecosystem**-animals which feeds directly on plants.

At 1st level consumers, called as primary consumers,

examples: herbivores animals such as deer, goat, cow etc.



Consumers:

i. Secondary consumers

animals that feeds on other animals.

They are omnivores and carnivores animals.

e.g: Bear, wolf, jackel, and snake etc.

iii. Tertiary consumers:

These animals get their food from all consumers.

They are top carnivores.

e.g: lion, tiger, and eagle etc.

Special feeding groups (Consumers)

Scavengers : These are the animals that feed on the dead plants and animals.

e.g. termites and beetles feed on the decaying wood

Marine invertebrates, Vultures and hyena are other examples of scavengers

Special feeding groups (Consumers)

Omnivores : Omnivores consume both plants and animals as source of their food

e.g. human beings.

the red fox feeds on berries, small rodents as well as on dead animals.

Thus it is a herbivore, carnivore and also a scavenger.

Special feeding groups (Consumers)

Parasites : They live and feed on/in other living organisms called *host*.

Parasites not only feed on their host but they also cause lethal or nonlethal disease in it.

e.g: human head lice, bacteria

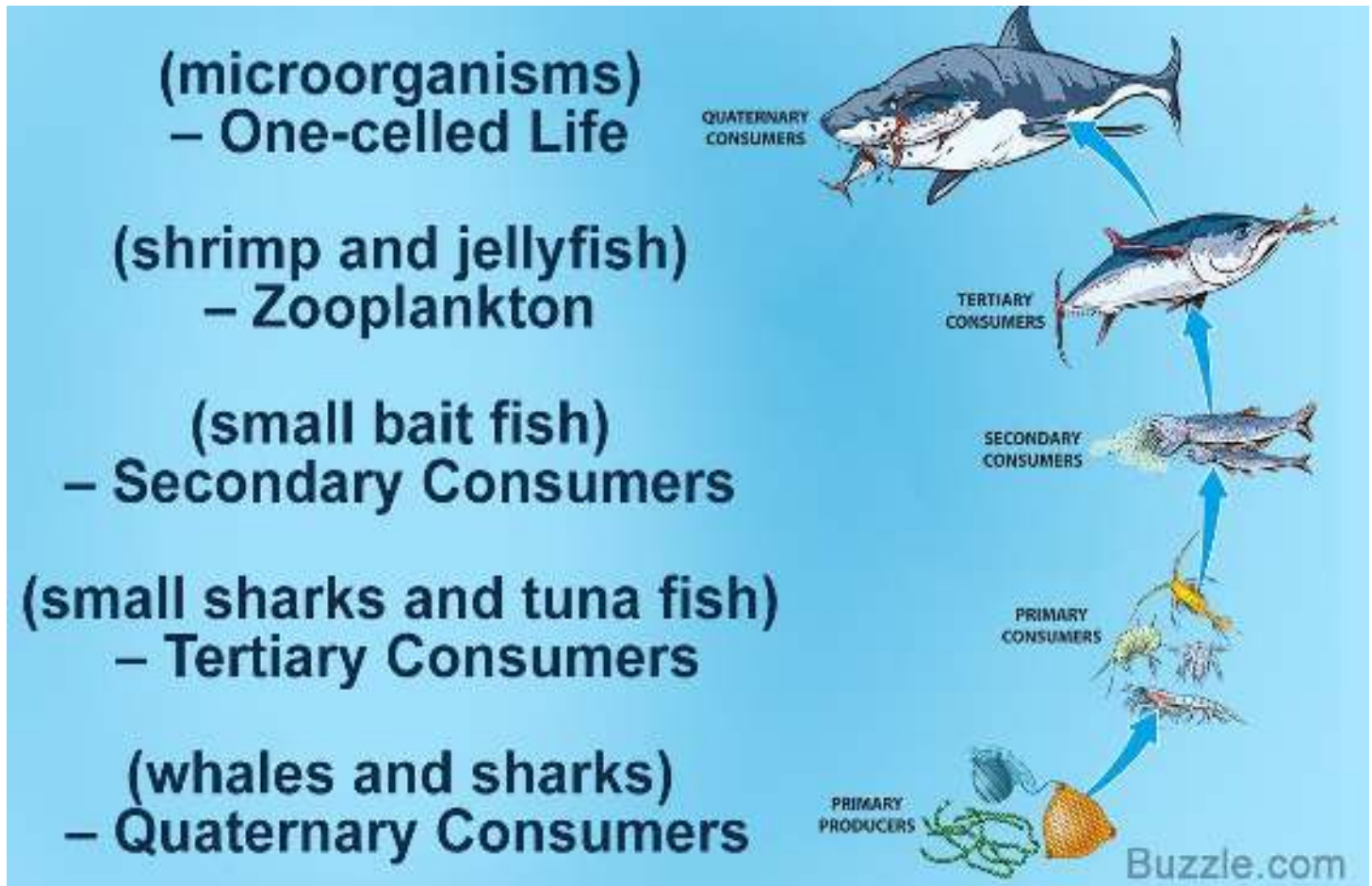
Consumers in aquatic ecosystem

i. Primary consumers

as microconsumers,
zooplanktons and benthos

ii. Secondary consumers:

aquatic predaceous insects, game fish etc



24 Biotic components-Decomposers

Decomposers

1. Feed on dead and decayed plants or animals.
2. Make up the final tropic level in food chain.
3. They decompose the dead and decay matter and helps in recycling the nutrients.

They are classified into two class

1. **Micro-Decomposers:** bacteria' fungi' protozoa
2. **Macro-Decomposers:** earth worm' nematodes' molluscs

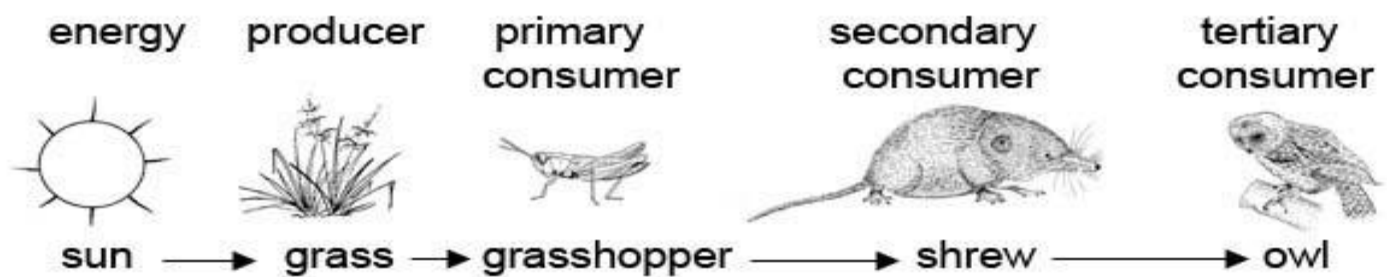
25 Food Chains

Food chain

“Transfer of food from the plants (producers) through a series of organisms with repeated eating and being eaten is called a food chain”

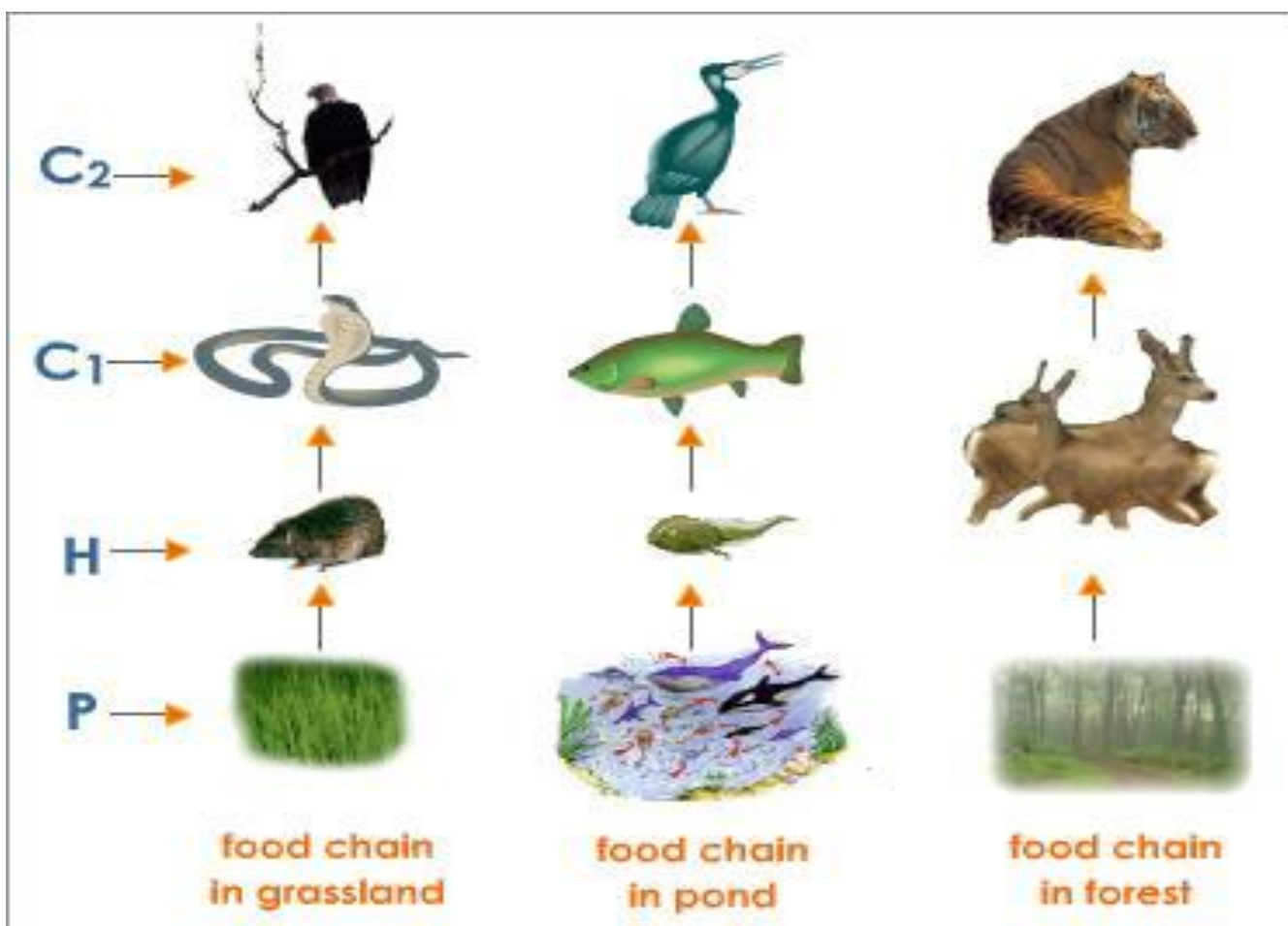
e.g.

Grasses → Grasshopper → Frogs → Snakes → Hawk/Eagle



Food chain and trophic level

1. Each step in the food chain is called trophic level.
2. In this fig grasses are first and eagle, crane and lion represents the fourth and third trophic level.
3. **P=Producers**
4. **H=Herbivores**
5. **C=Consumers**



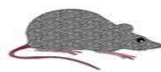
Three important features in these **food chains** are :

1. Weaker organisms are attacked by the stronger organisms
2. Number of organisms is reduced at each higher level but the size of organisms is increases.
3. The number of steps in a food chain is limited to 4-5.

Food Chains



Corn



Rat



Owl

A three linked food chain



Carrots



Rabbit



Fox



Lion

A four linked food chain



Grass



Grasshopper



Frog



Python



Eagle

A five linked food chain

26 Food Chains and trophic levels

Food chain and trophic level

FC consists of trophic levels:

1. (Producers) Autotrophs
2. first trophic level

Food chain and trophic level

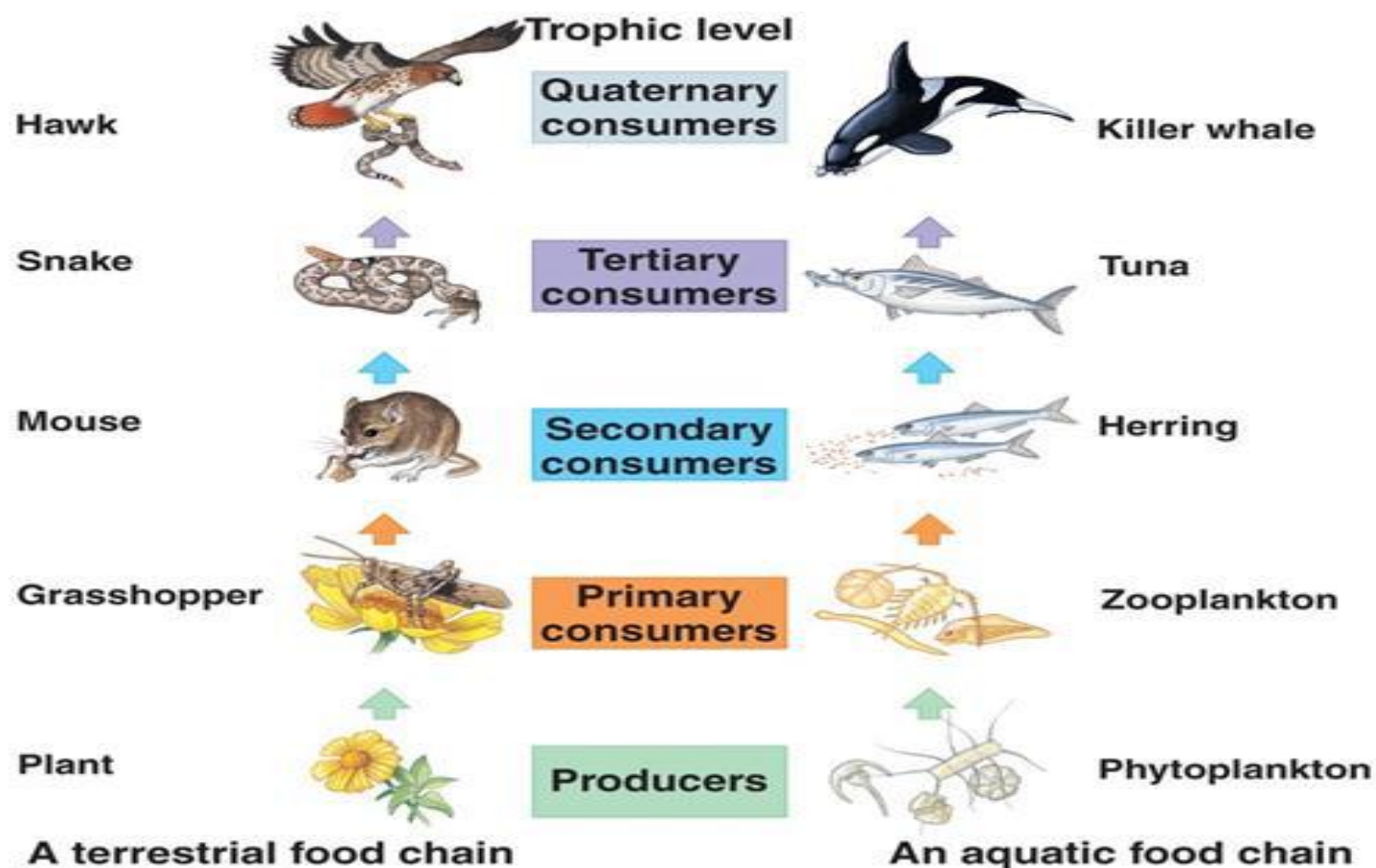
FC consists of trophic levels:

1. (Producers) Autotrophs
2. first trophic level

Gross Primary Productivity (GPP)

Net Primary Productivity (NPP)

$$GPP = NPP + R \text{ or } GPP - R = NPP$$



Food chain and trophic level

2. Primary consumers Herbivores

- a) are at the 2nd trophic level in food chain
- b) capable of converting energy stored in the plant tissue into animal tissue
- c) They can digest high cellulose diet.

2. Secondary consumer (Carnivores)

- a) are at the 3rd and 4th trophic level in food chain
- b) size of the carnivore/ increases at each trophic level

3. Decomposers :

- a) They make up the final trophic level in a food chain.
- b) feed on dead organic matter called detritus of all the trophic levels

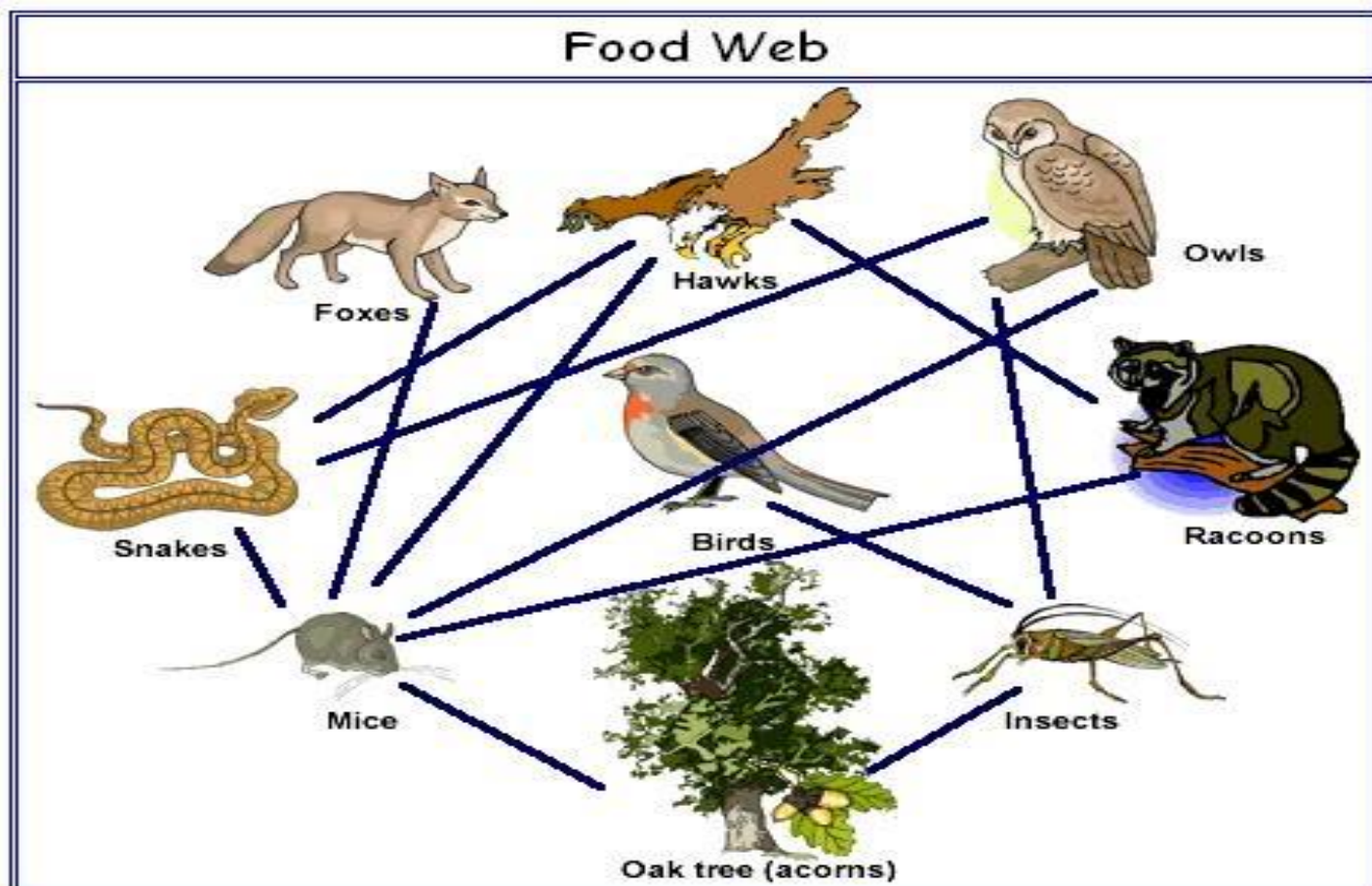
3. Decomposers :

- c) help in recycling the nutrients.
- d) **Examples:** bacteria, fungi, mites, millipedes, earthworm, nematodes, slugs, crabs and mollusks

27 Food Webs

Food web

1. In a food web one trophic level may be connected to more than one food chain
2. Food web is the geographical description of feeding relationship among species in an ecological community



Food web

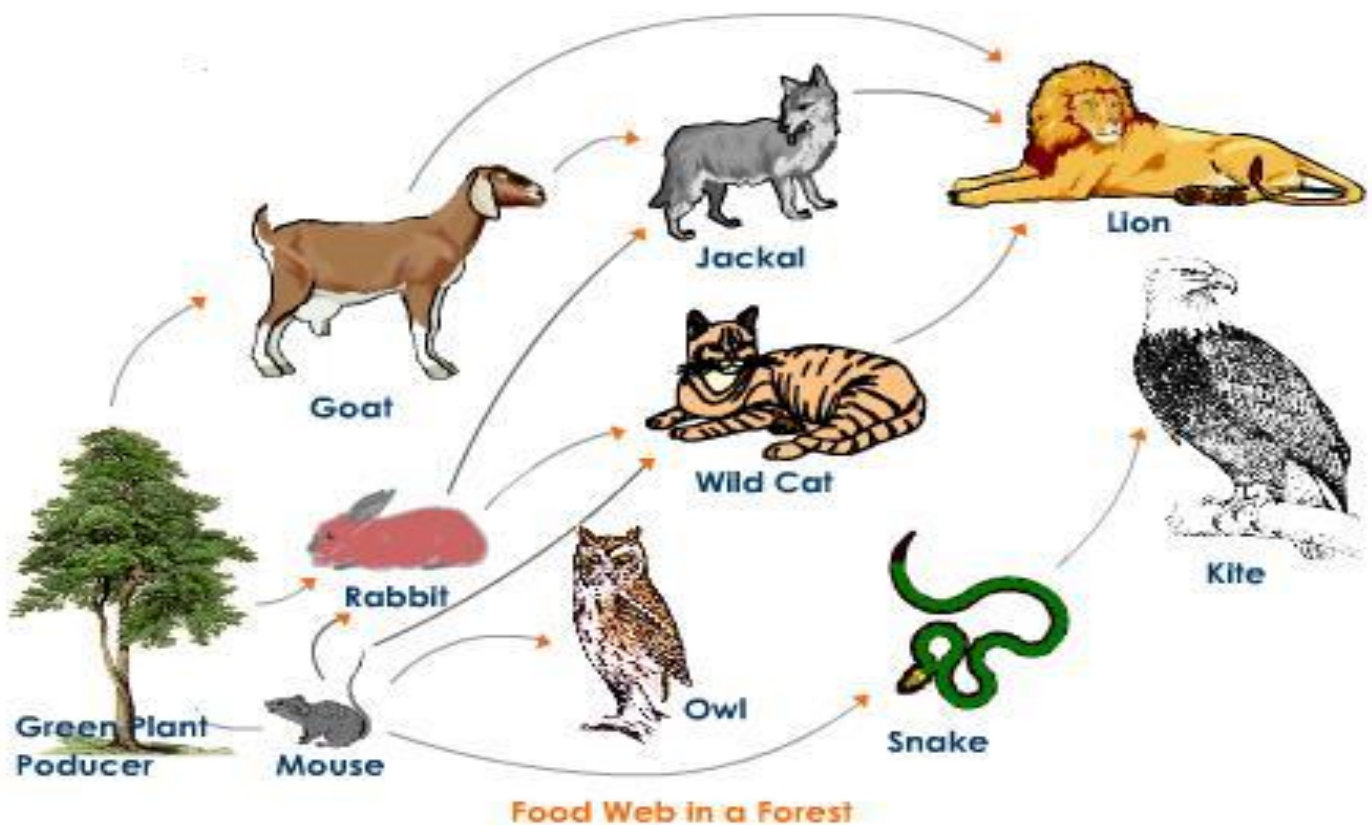
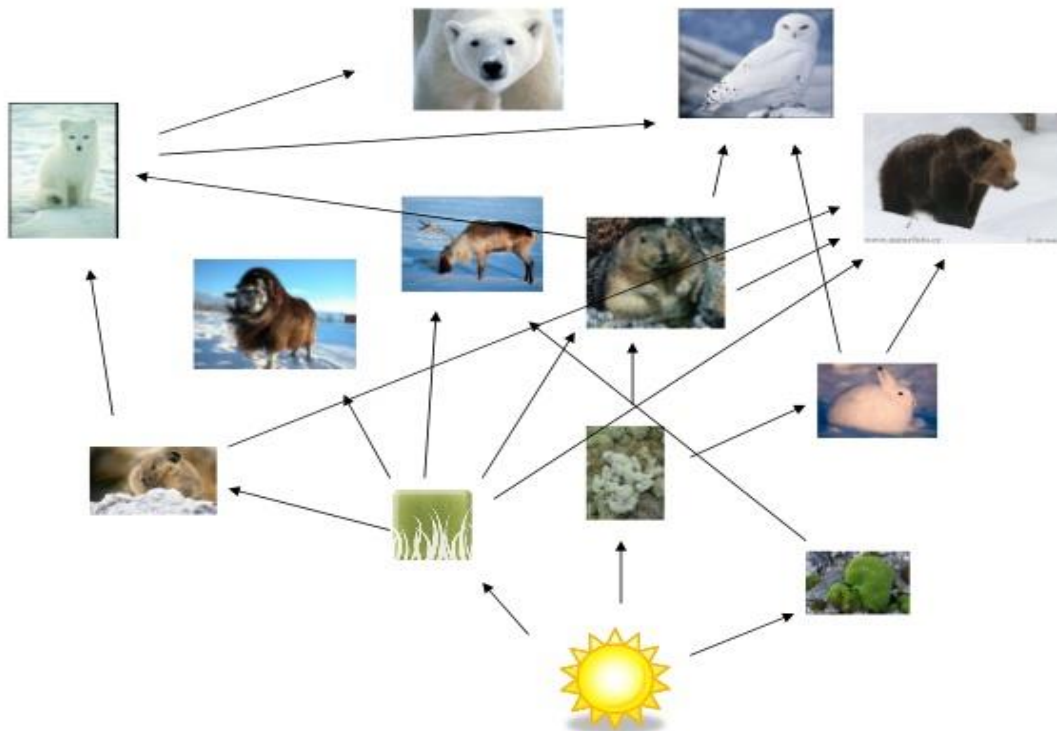
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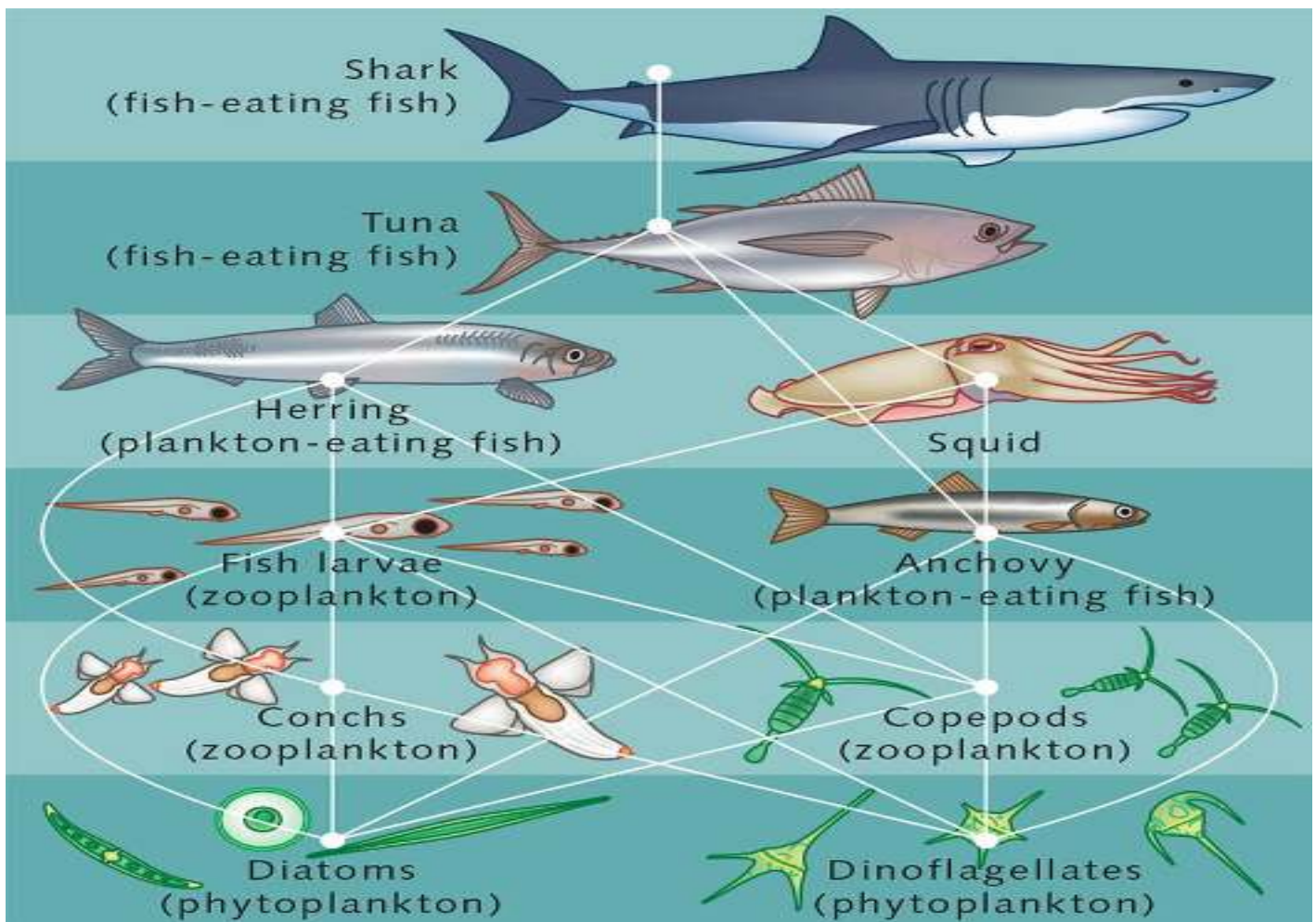
Food web

1. It even specify the energy relation and transfer of energy amongst them
2. Food web is the geographical description of feeding relationship among species in an ecological community
3. **e.g** Grass land food web
4. Tundra Food Web

Tundra Food Web

Everything is Decomposed after they die.





28 Energy in ecological system

Thermodynamics

Definition:

“it’s the branch of physics which studies energy, its transfer from one place to another and its transformation from one form to another form.”

Thermodynamics

The laws of thermodynamics describe the relationships between thermal energy, or heat, and other forms of energy, and how energy affects matter

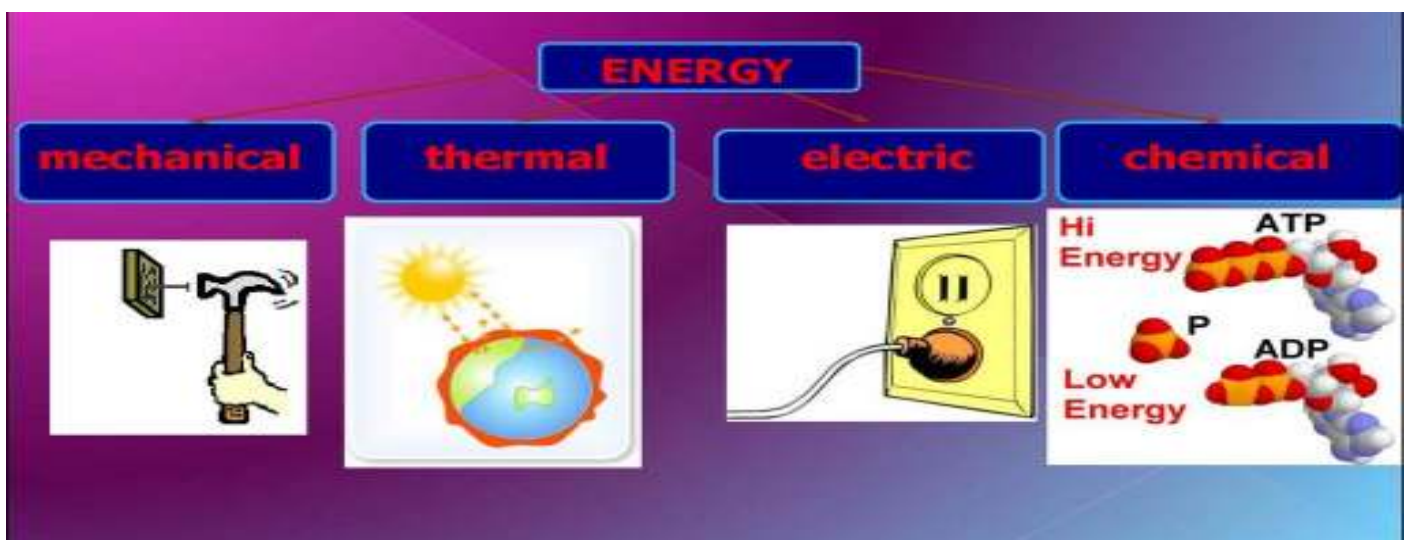
Energy is the ability to do work.

different forms of energy

1st law of Thermodynamics Or

Conservation of Energy

Energy can be transformed from one form to another but can neither be created nor destroyed the total *quantity* of energy in the universe stays the same



2nd law of Thermodynamics Or

Law of Entropy

Its about the *quality* of energy

It states that as energy is transferred or transformed, more and more of it is wasted

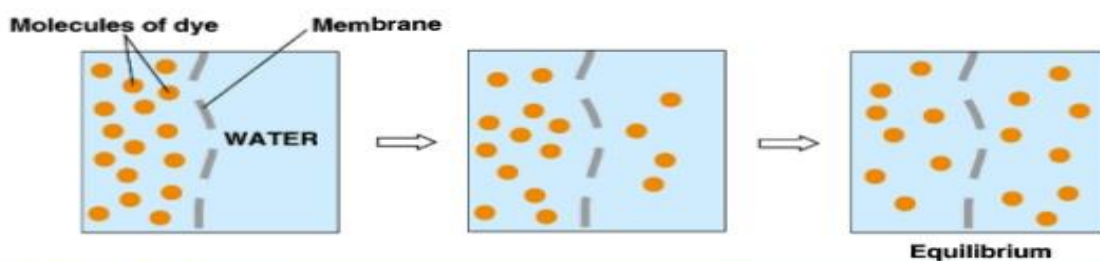
It is concerned with the direction of natural processes.

It asserts that a natural process runs only in one sense, and is not reversible

For example, heat always flows spontaneously from hotter to colder bodies, and never the reverse, unless external work is performed on the system

Diffusion

- **2nd Law of Thermodynamics governs biological systems**
 - ◆ universe tends towards disorder (entropy)



- **Diffusion**
 - ◆ movement from **high** → **low** concentration

Biological perspective of thermodynamics principles

In living cell, thermodynamics changes are essential for biological functions such as growth, reproduction photosynthesis and respiration

Biological perspective of thermodynamics principles

- In living cells, thermodynamic changes are essential for biological functions such as growth, reproduction photosynthesis and respiration.
 - Light → Chemical : photosynthesis.
 - Chemical → Chemical : cellular respiration.
 - Chemical → Electrical : Nervous system.
 - Chemical → Mechanical : Muscles.

Biological perspective of thermodynamics principles

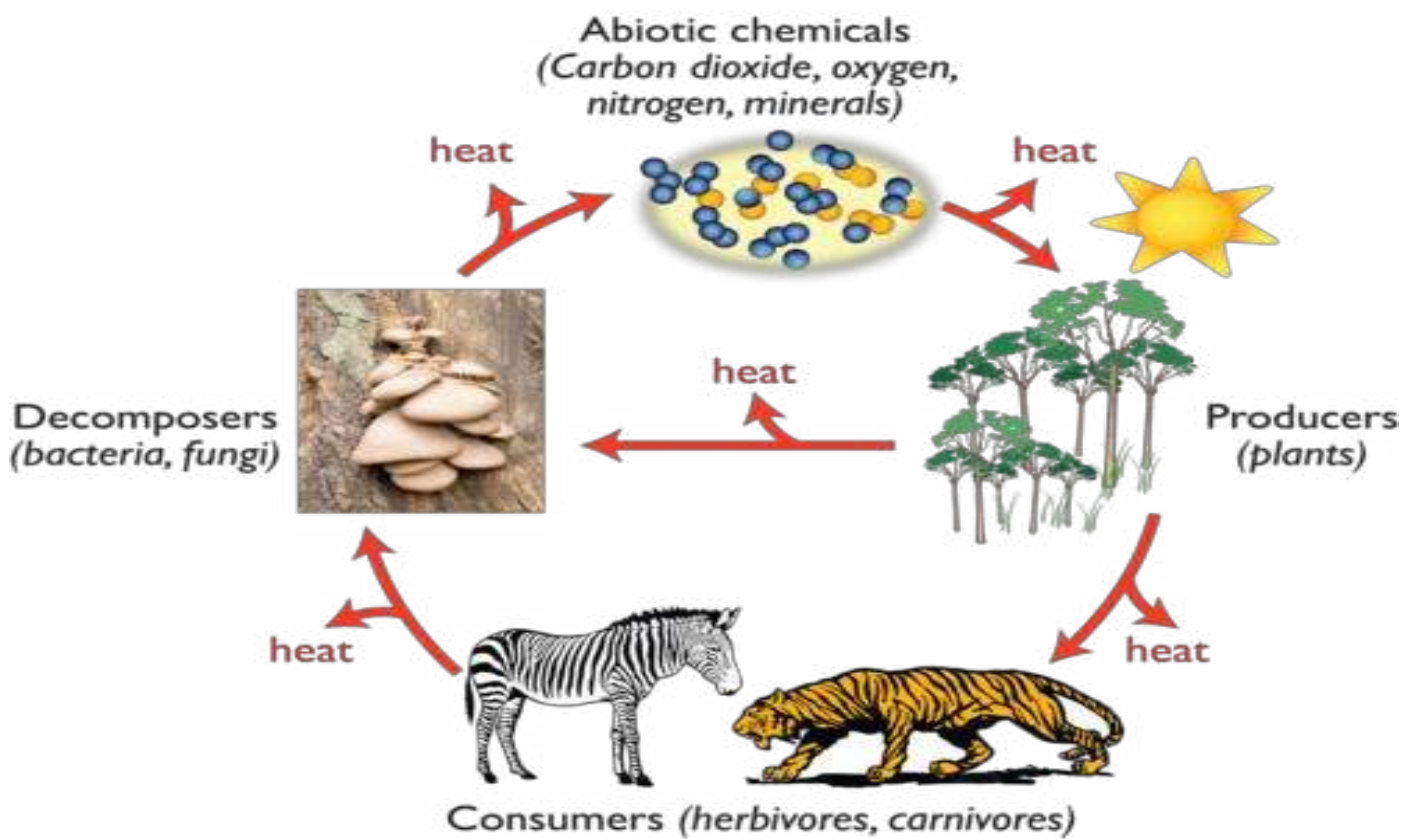
Light-chemical: Photosynthesis

Chemical-chemical: cellular respiration

Chemical-Electrical: Nervous system

Chemical- Mechanical: Muscles

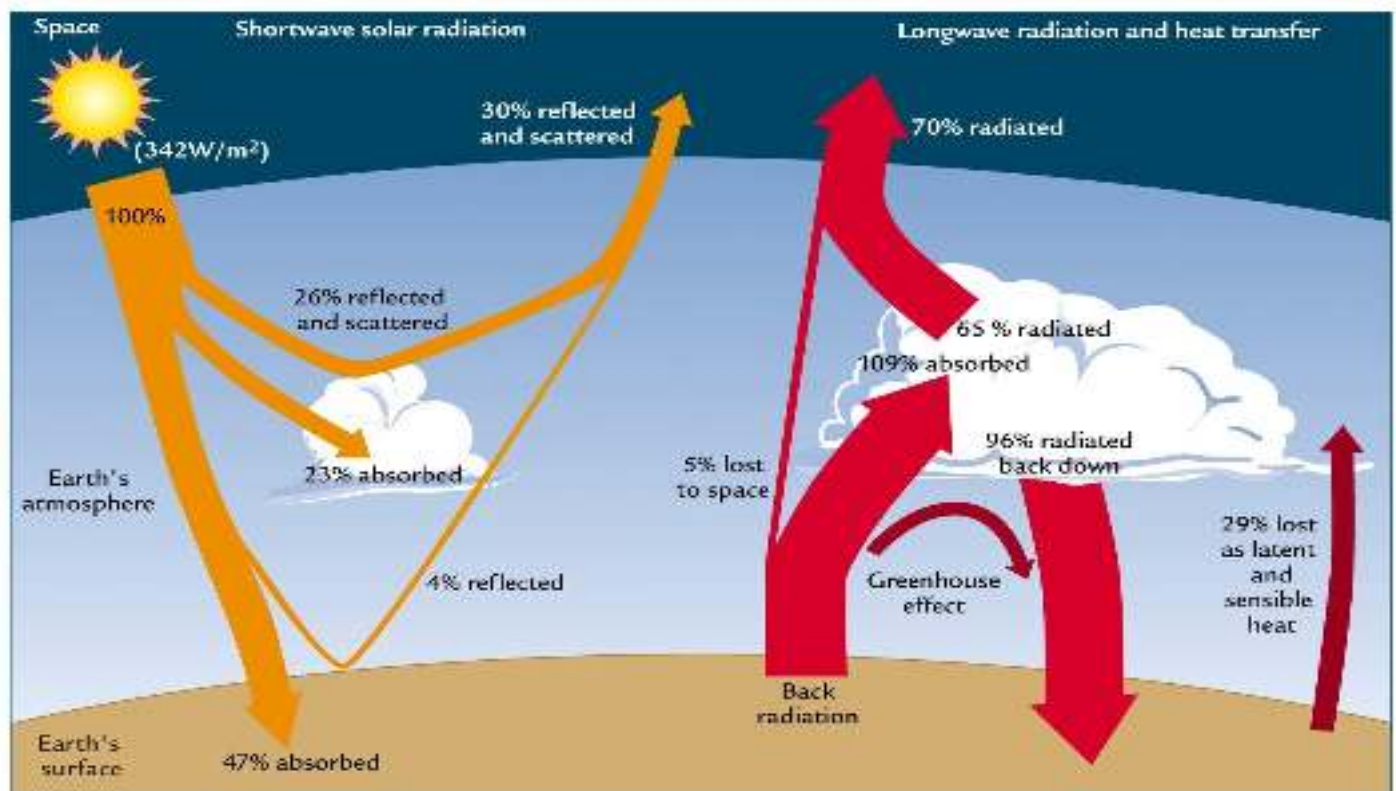
Matter and Energy in an Ecosystem



Solar radiation as energy source sun is a sustainable source of energy

Solar radiation reached on surface of earth on clear day

1. Ultraviolet radiation- 10% - short wavelength-absorbed by Ozone layer



Solar radiation as energy source

2. Visible light-medium wavelength-45%- least attenuated by clouds, water

3. infrared rays-45%- longer wavelength-absorbed and reradiated as heat in a complex manner by atmosphere, clouds, and various natural and man – made objects and surfaces

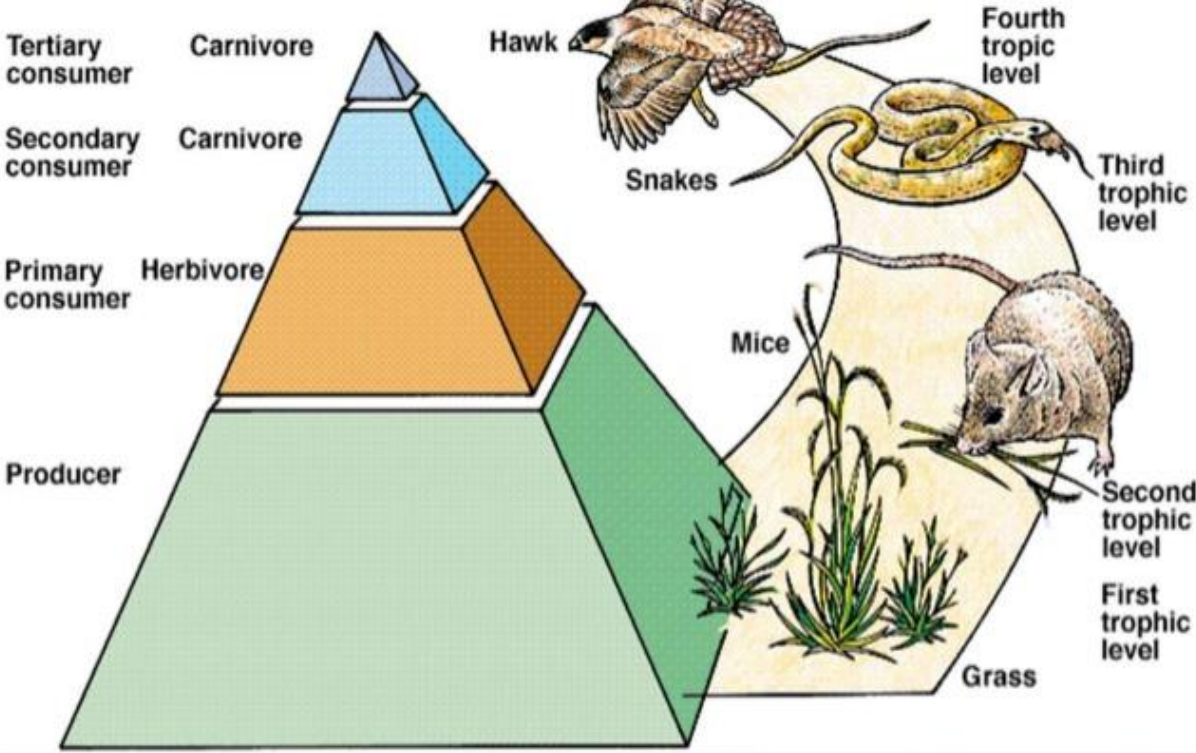
Flow of energy in Ecosystem

Important factor as describe

Types and number of organism would live in ecosystem

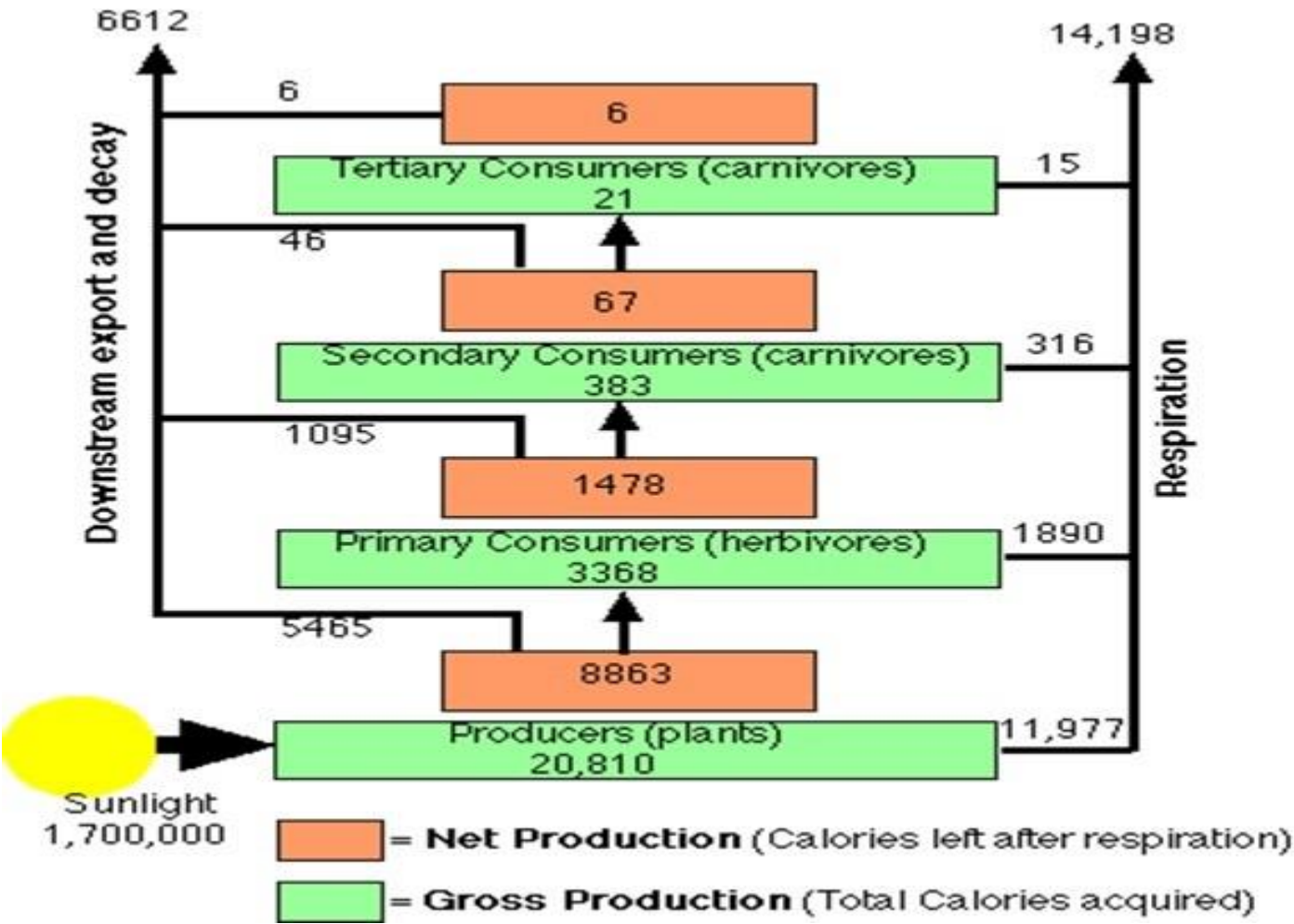
Ecological Pyramids- relative amount of energy, biomass, number of organisms at each level in ecosystem

Energy Flow Through an Ecosystem

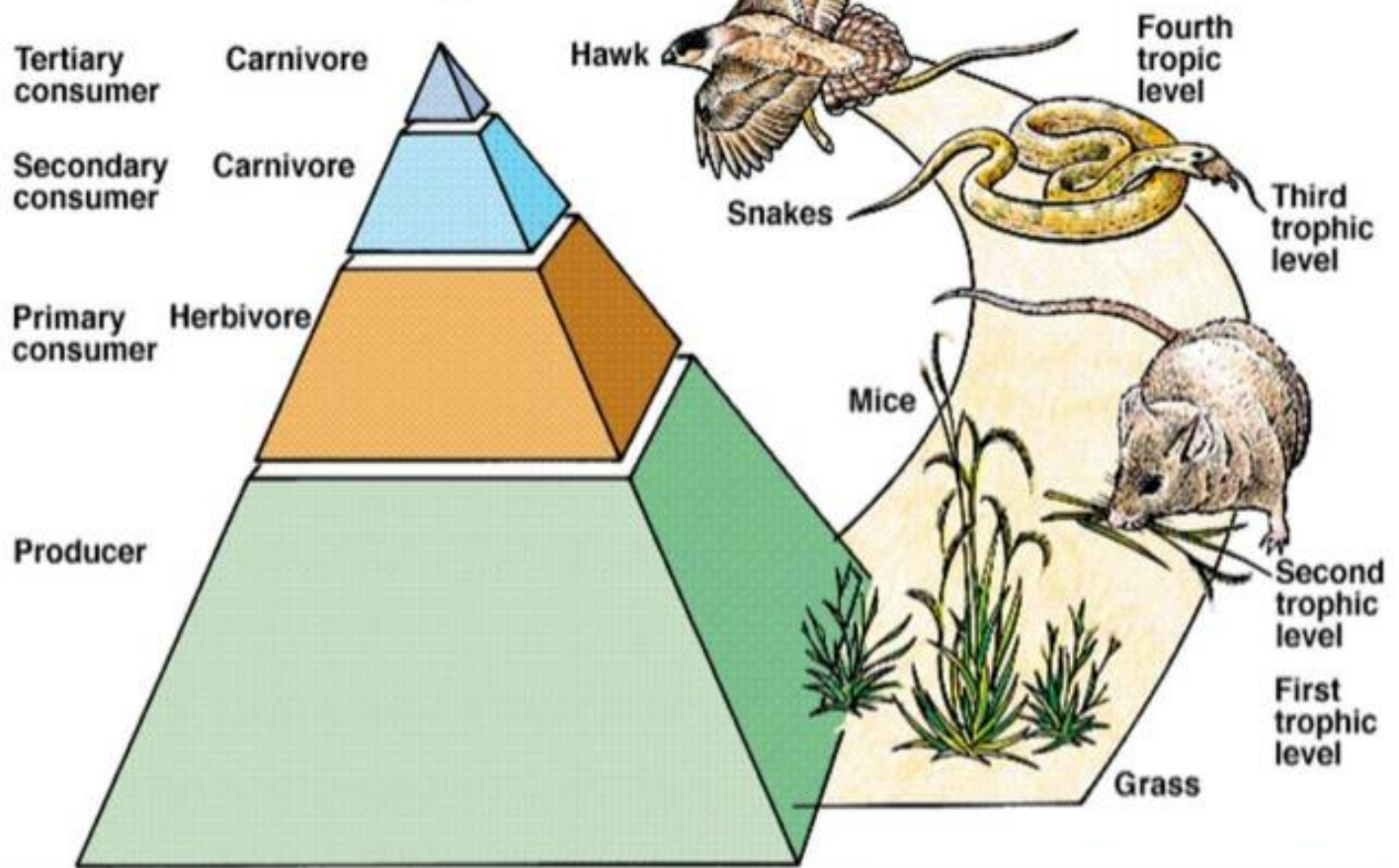


Flow of energy in Ecosystem

Ecosystem- energy flows through different trophic levels by food chain following law of thermodynamics



Energy Flow Through an Ecosystem



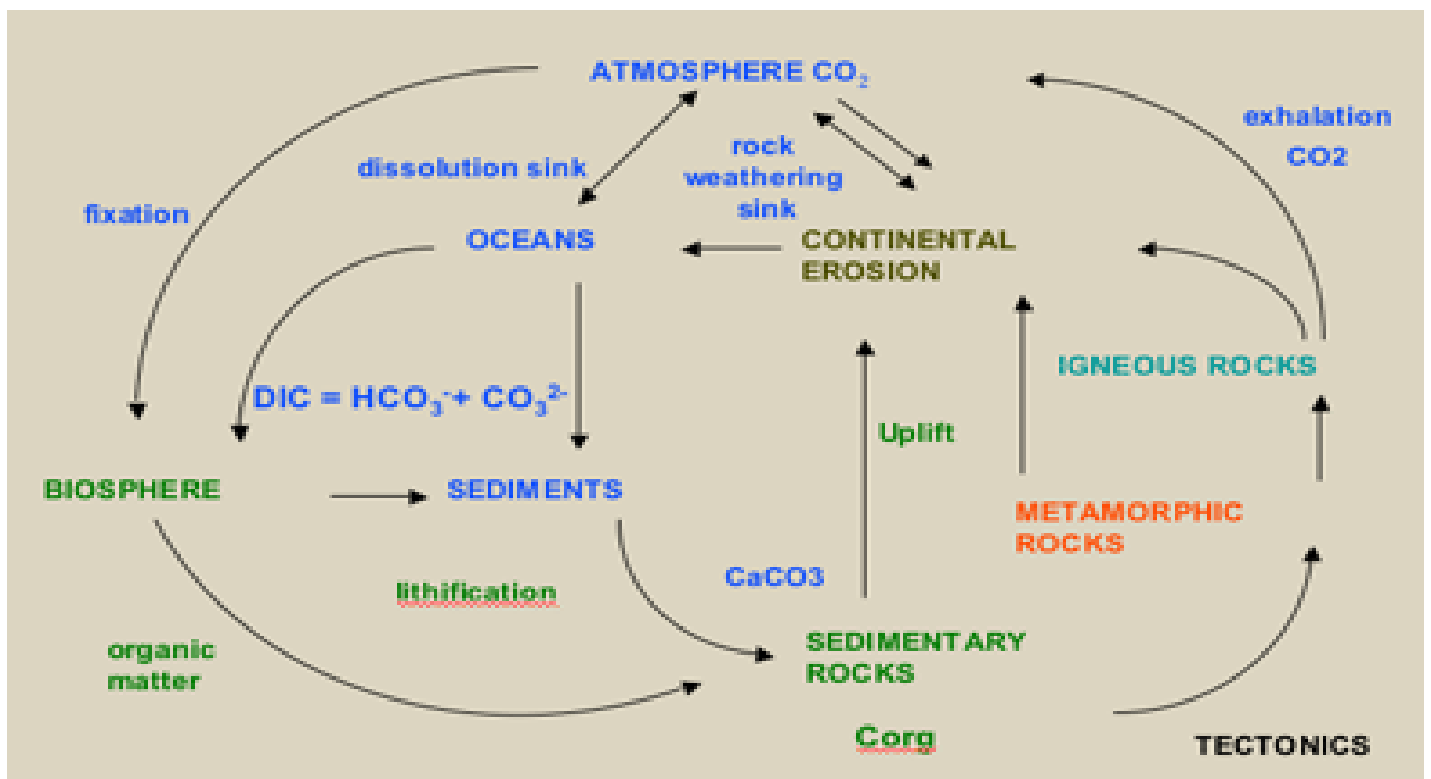
30 Biogeochemical Cycle

Biogeochemical cycles

“the chemical elements, including all essential elements of protoplasm, tend to circulate in the biosphere in characteristics pathways from environment to organisms and back to environment” these more or less circular pathways are called biogeochemical cycles”

Biogeochemical cycles

1. Interaction between Biotic and Abiotic environments
2. Photosynthesis-Transpiration-Respiration-Decomposition
3. Recycling of material to be used over and over again
4. Elements move through 4 components of earth system
5. **Atmosphere (Air)**
6. **Hydrosphere (water)**
7. **Lithosphere (Soil)**
8. **Biosphere (Living things)**
9. **Examples:** Nitrogen, Carbon, Water, Phosphorus, Sulphur cycles



Biogeochemical cycles

1. **Nutrient cycles**- movement of elements and minerals
2. Two pools or compartments for nutrient cycle
 - a) **Reservoir Pool**
 - b) **Labile or Cycling pool**

Biogeochemical cycles

- a) **Reservoir Pool**
Large, slow moving, abiotic
- a) **Labile or Cycling pool**
Smaller, active and usually biotic

31 Types of biogeochemical cycles

Types of Biogeochemical cycles

- a) **Gaseous type**-in which reservoir is in atmosphere or the hydrosphere (Ocean)

examples.

Nitrogen Cycle
Carbon Cycle
Water Cycle

- b) **Sedimentary type**-in which reservoir is in the earth Crust

examples.

Phosphorus Cycle
Sulphur Cycle

32 Nitrogen Cycle

Importance of Nitrogen

Building structure of protein, DNA and RNA- (nitrogenous bases-nucleotides-genetic material and chlorophyll)

a) Atmosphere

as reservoir -78%-

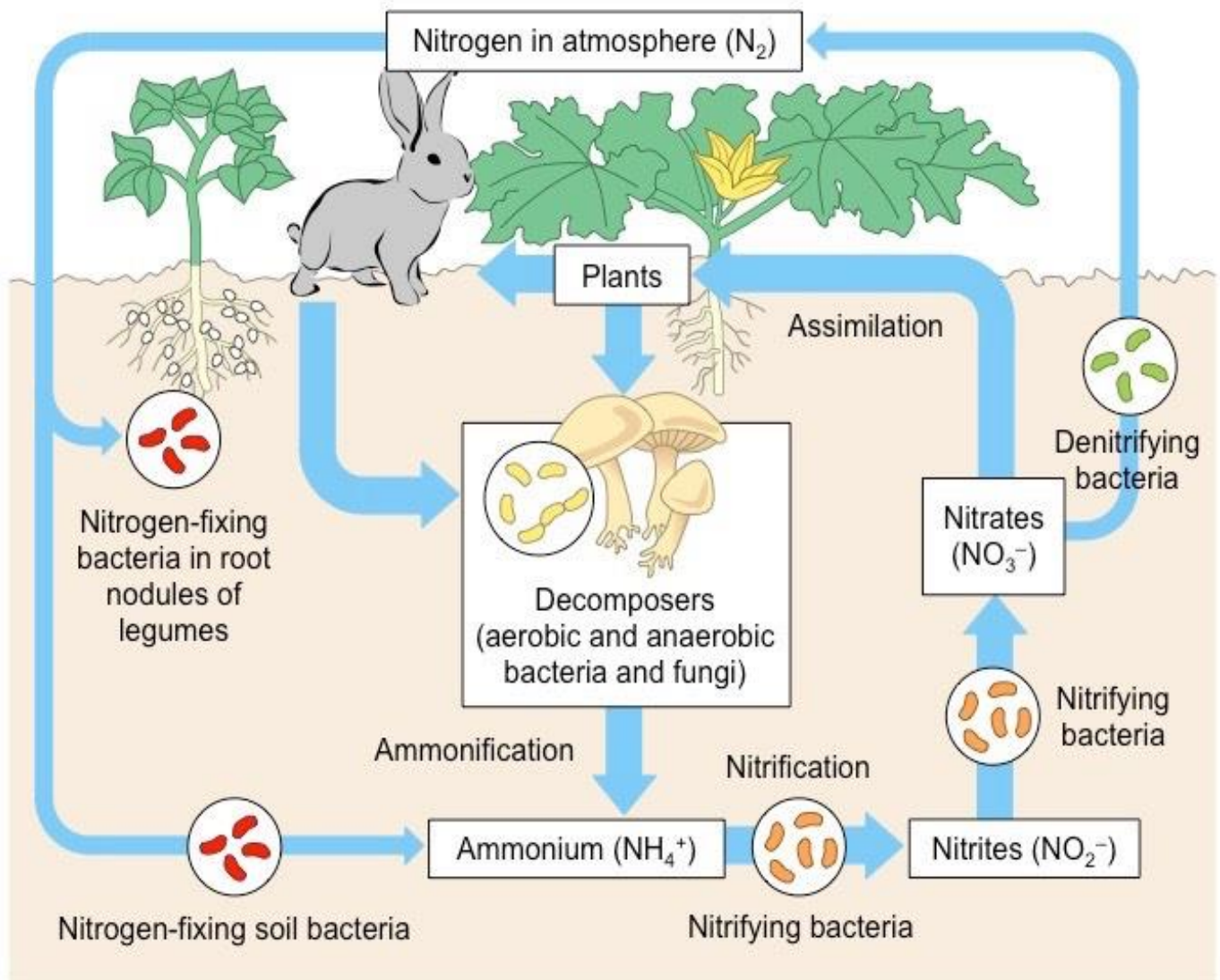
safety valve

N₂ Cycle Steps

Nitrogen fixation- conversion of Inert atmospheric nitrogen (N₂) into the usable form –ammonia (NH₃) or ammonium ion or nitrates.

None-Biological Fixation

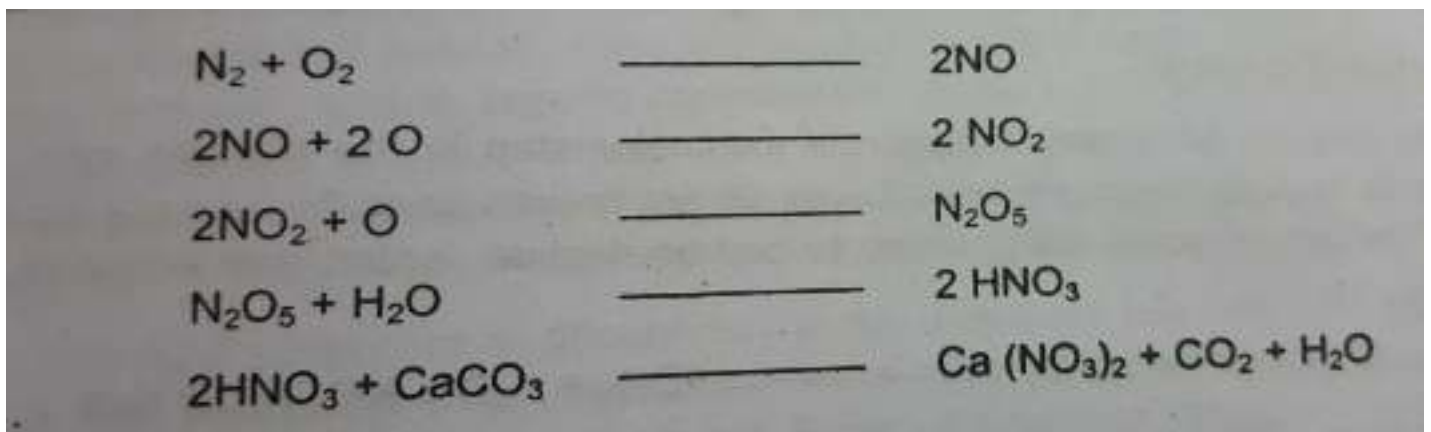
Biological Fixation



33 Nitrogen Cycle -Non Biological Nitrogen Fixation

Non Biological Nitrogen Fixation

1. Atmospheric fixation: A natural phenomenon where the energy of lightning splitting up of the gaseous nitrogen, combining with oxygen (ozone layer) into nitrogen oxides and is then used by plants as nitrates.



2. Industrial nitrogen fixation: Is a man-made alternative that aids in nitrogen fixation by the use of ammonia.

Ammonia is produced by the direct combination of nitrogen and hydrogen and later, it is converted into various fertilizers such as urea.

34 Nitrogen Cycle -Biological Nitrogen Fixation

Biological Nitrogen Fixation

Steps

- 90% fixed nitrogen to earth (100-200 kg/ha)
- ammonia (NH_3) or ammonium ion or nitrites or nitrates basic useable form by plants
- Legume nodules plants-10g glucose-fix 1g
- Free living microbes fixers-100g glucose- 1g

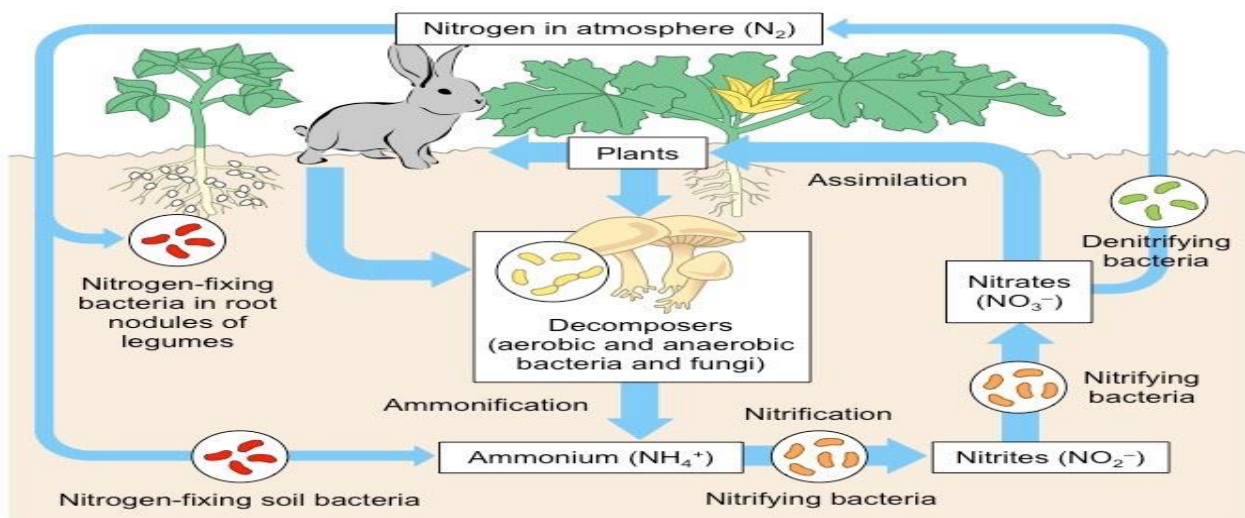
Biological Nitrogen Fixation

Steps

- Ammonification
- Nitrification
- Assimilation
- Denitrification

3. Biological fixation:

- Mutualistic bacteria-beneficial association with
- Leguminous (agricultural system)
- Root nodules in none-leguminous plants
- Free living nitrogen fixing bacteria-Soil
- Cyanobacteria- Ocean ecosystem

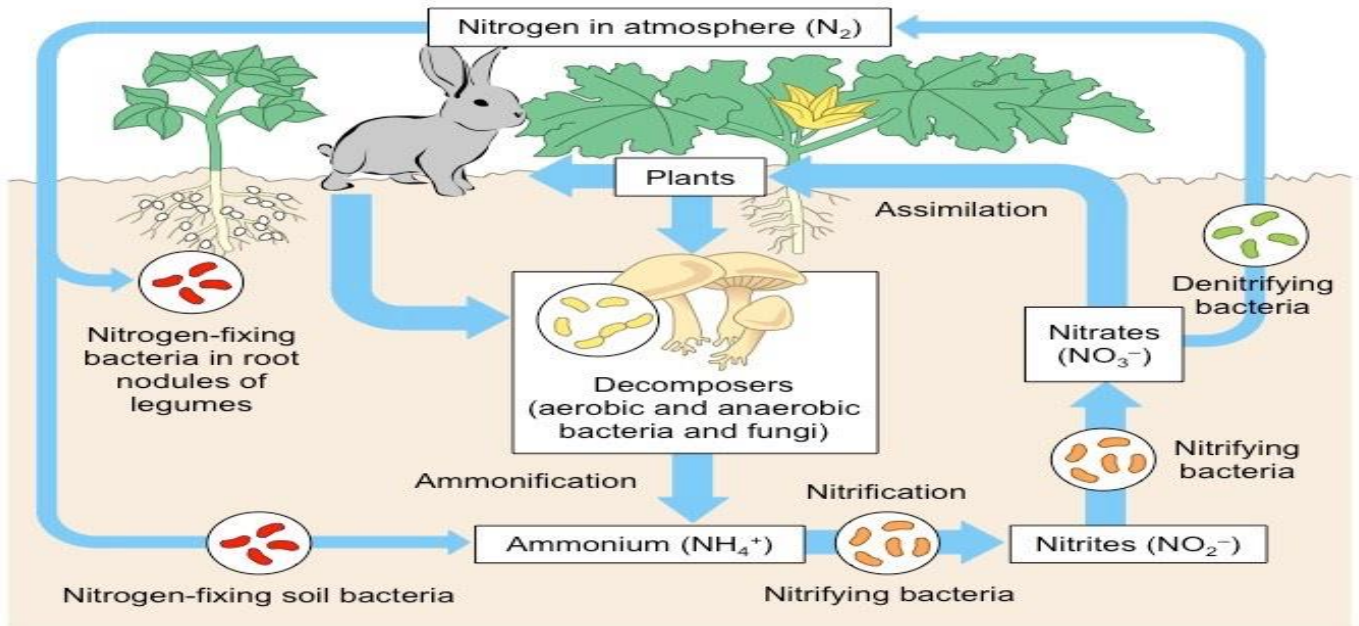


35 Nitrogen Cycle -Biological fixation

3. Biological fixation:

Nodulated legumes and none leguminous plants

mutualistic relationship with aerobic rod shaped soil bacteria of genus *Rhizobium*-surrounding of plant roots called Rhizospheres- damaged epidermal cells of root hairs- plant response is nodule formation- enzyme is nitrogenase



3. Biological fixation:

Many none leguminous plants-alder, Ginkgo, Russian Olive- grow in wildland-filamentous bacteria-actinomycetes in root nodules- so can fix nitrogen

160 spp-8 genera-5 families- of dicotyledons-actinomycetes induced nodules

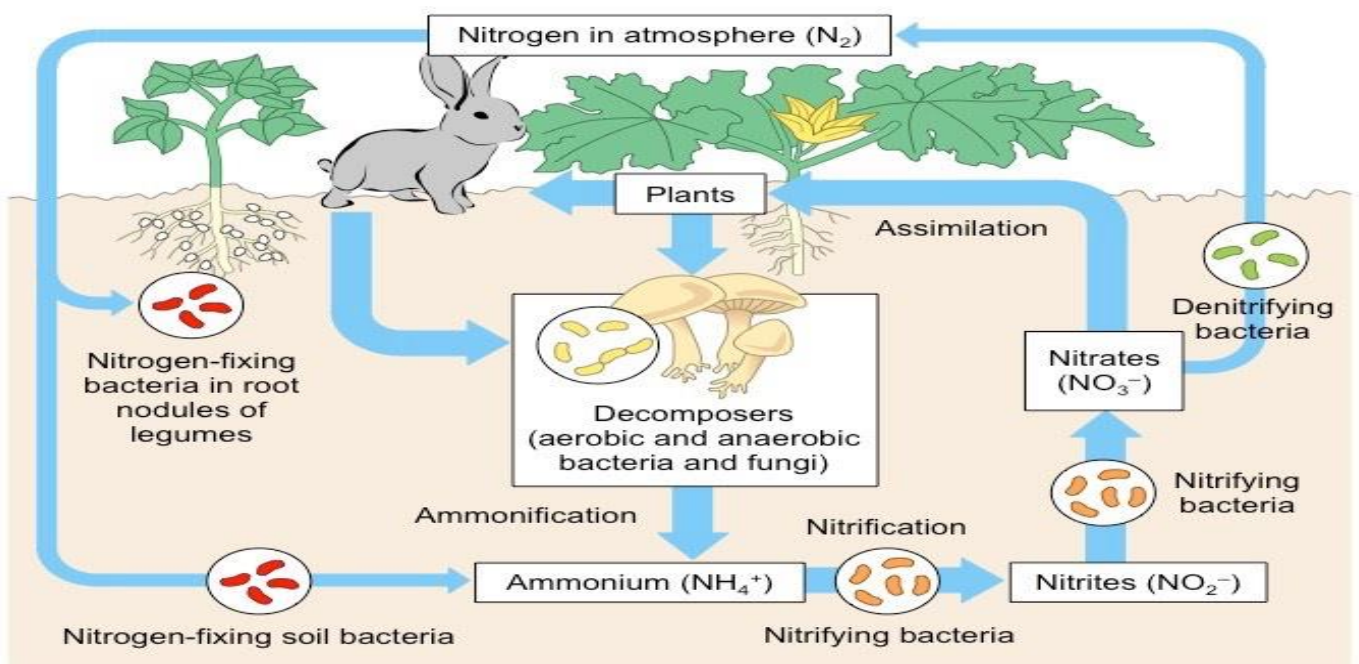
36 Nitrogen Cycle -Biological fixation II

3. Biological fixation:

Free living bacteria- 15 known genera fix gaseous nitrogen-*Azobacter* (aerobic), *Clostridium* (anaerobic) found nearly all types of soil, pH of soil 6-7, ammonia is first stable and final product

Cyanobacteria- (*Anabaena*, *Nostoc*, blue green algae) fix nitrogen in soil and aquatic habitat.

Fix nitrogen in rice paddies in Asia



37 Nitrogen Cycle-Ammonification & Nitrification

Ammonification

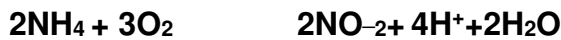
When plants or animal die, the nitrogen present in the organic matter is released back into the [soil](#).

Ammonification

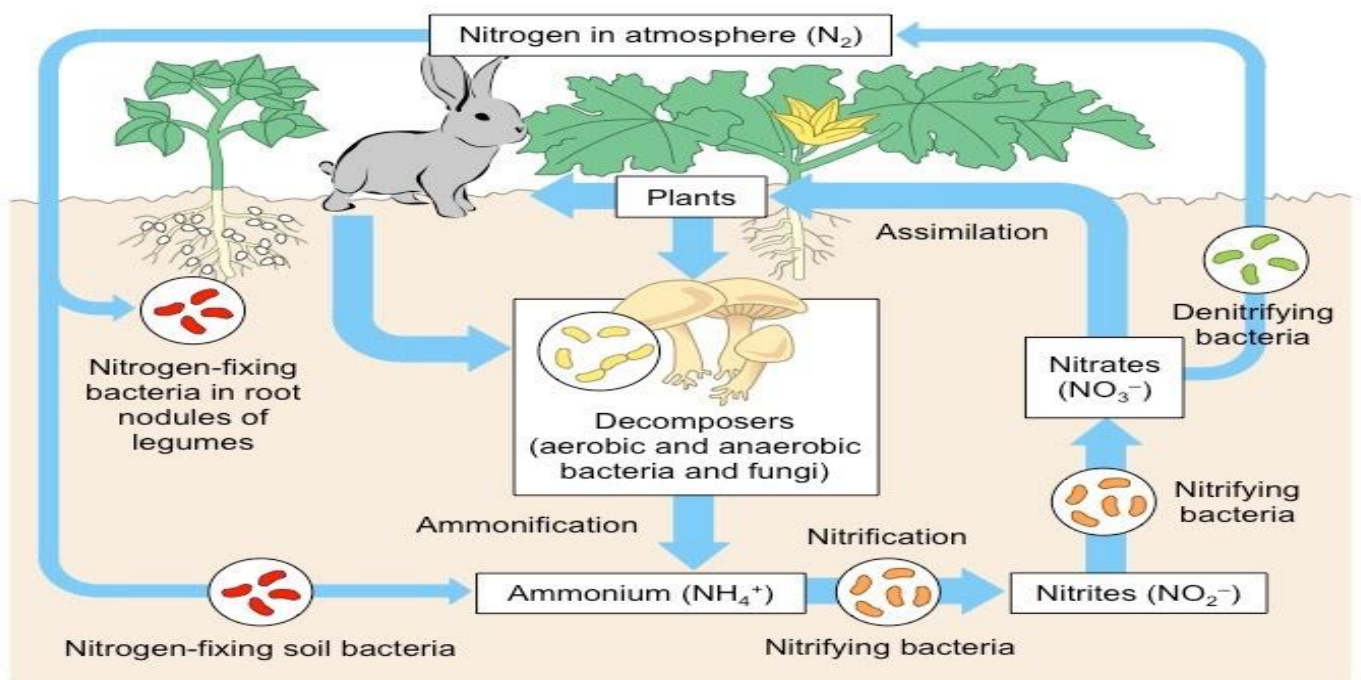
The decomposers, namely bacteria or fungi present in the soil convert the organic matter back into ammonium. This process of decomposition produces ammonia which is further used for other biological processes.

Nitrification-ammonia is oxidized into nitrate

Nitrosomonas bacterium in soil



nitrites are converted into nitrates by *Nitrobacter*



38 Nitrogen Cycle-Assimilation & Denitrification

Assimilation

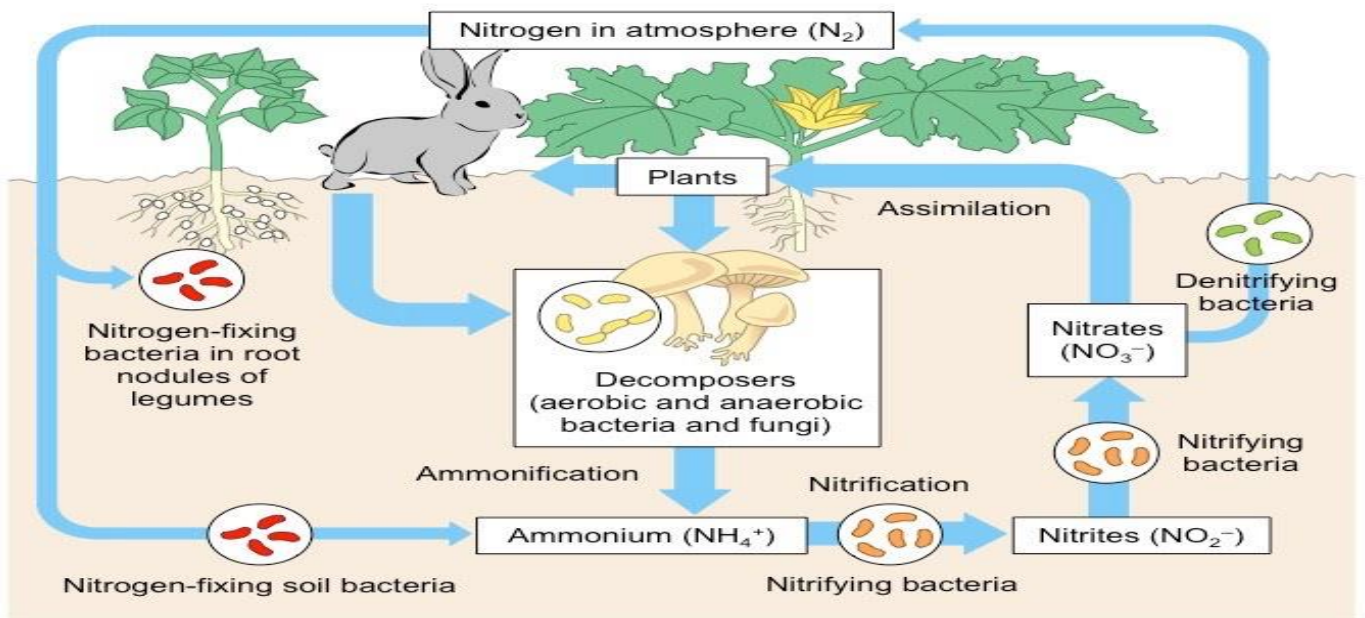
Primary producers- nitrite ions, nitrate ions or ammonium ions- through roots- plant protein

Nitrogen enters in Food chain

When Primary consumers eat plants

Denitrification

Denitrification is the process in which the nitrogen compounds makes its way back into the atmosphere by converting nitrate (NO_3) into gaseous nitrogen (N).-anaerobic microbes denitrifying bacterial species- *Clostridium* and *Pseudomonas*



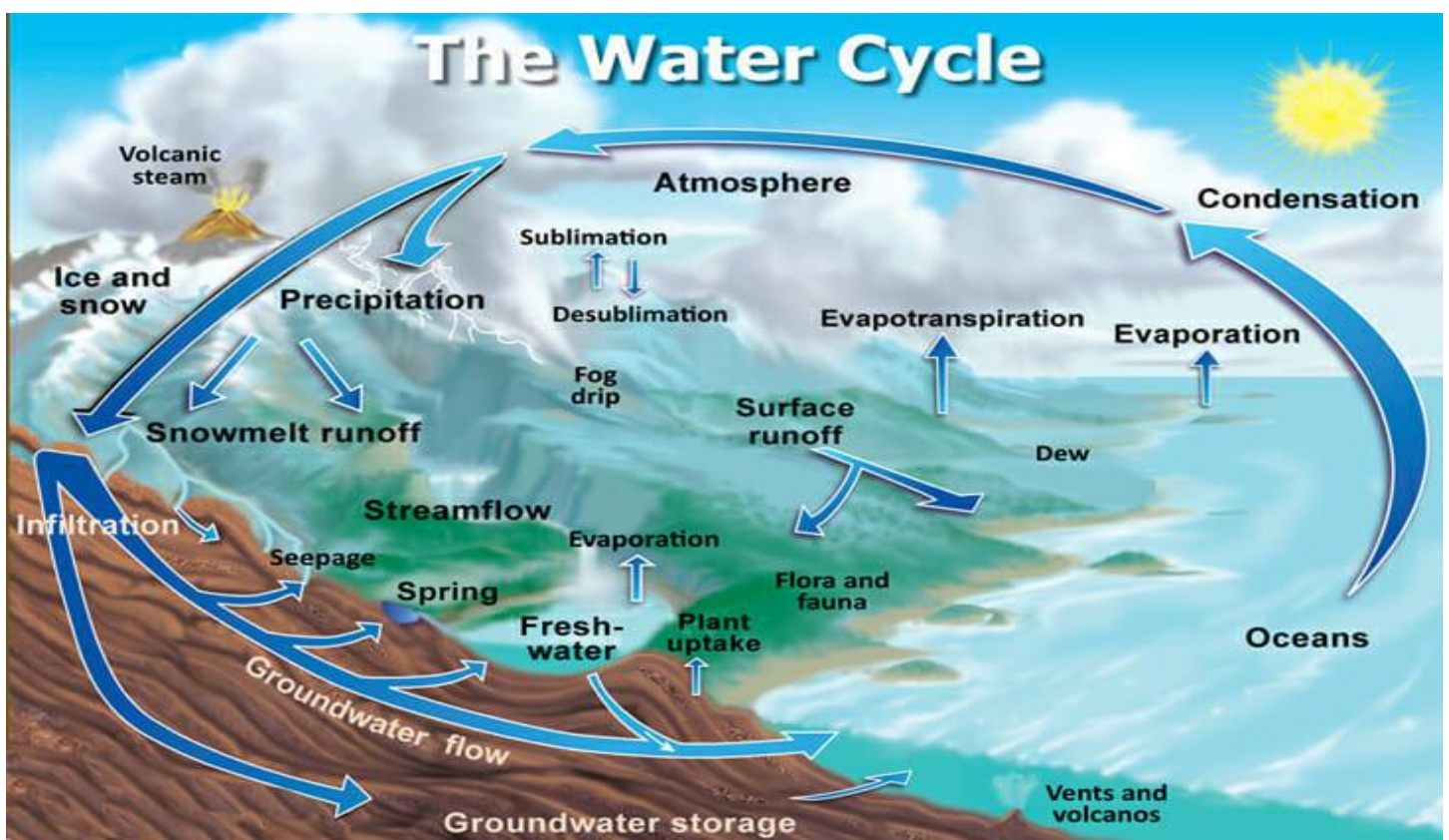
39 Biogeochemical Cycles-Hydrological Cycle

Definition

Movement of water from oceans (large reservoir) by evaporation into atmosphere (the smallest reservoir), then by precipitation (rainfall) back down to the surface of earth with infiltration and runoff from the continents and eventually return to the ocean

1. Evaporation, 2. Condensation 3. Precipitation

are the main processes involved in water cycle, these processes alternate with each other

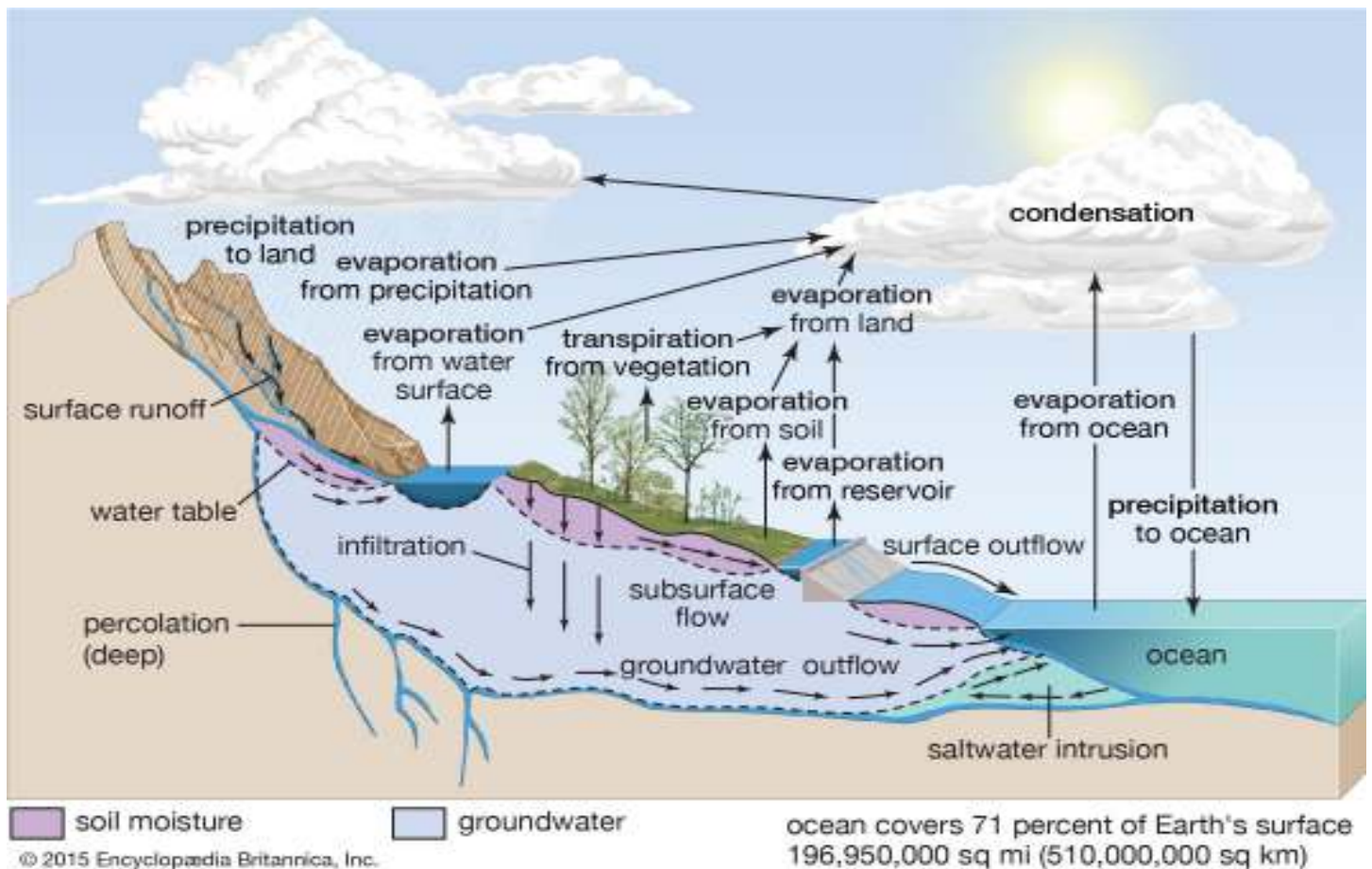


Facts of hydrological cycle

1. Nearly 97.3% is in the oceans and 2.1%

exists as polar ice caps, world's second largest reservoirs.

2. Only 0.6% is present as fresh water in, the form of atmospheric water vapors, ground and soil water



Facts of hydrological cycle

1. One third of all solar energy is dissipated in driving the water cycle or In terms of energy, uphill loop (evaporation) of water cycle is sun driven
2. More water evaporates from the sea than returns to it by rainfall and vice versa for land.
3. Human activities tend to increase the rate of runoff

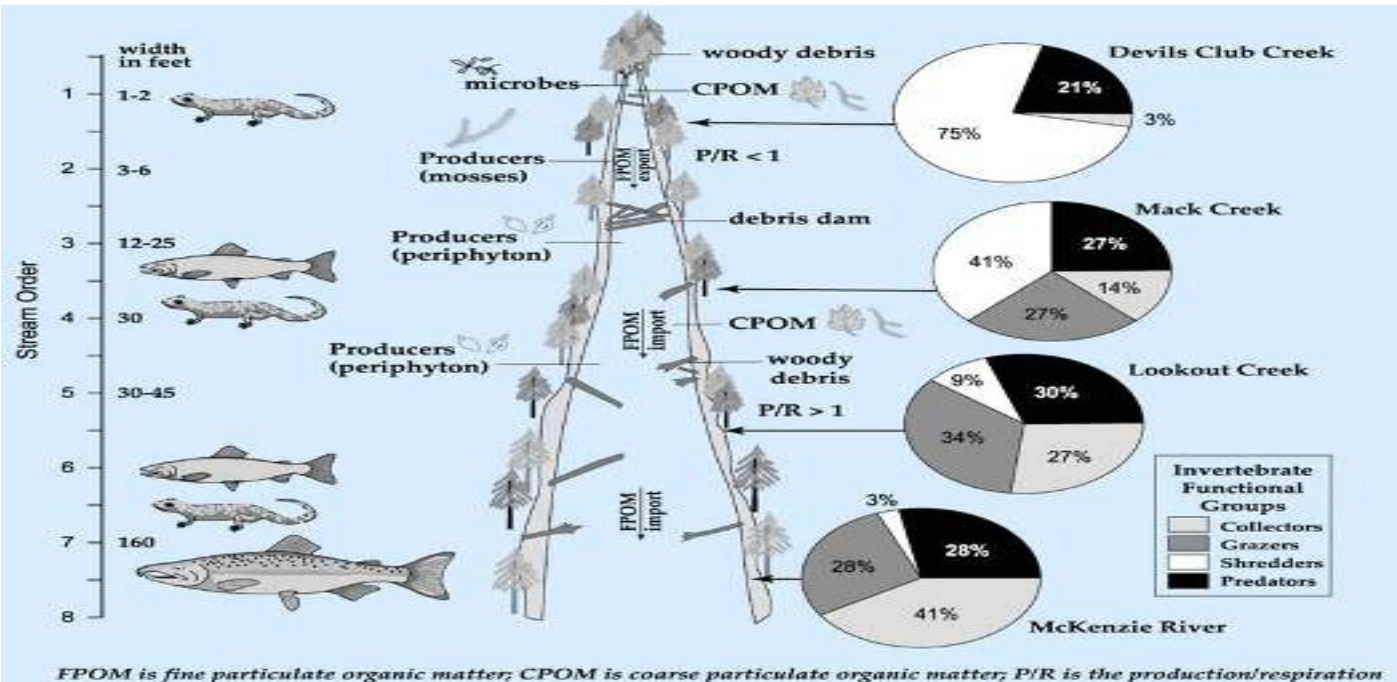
Facts of hydrological cycle

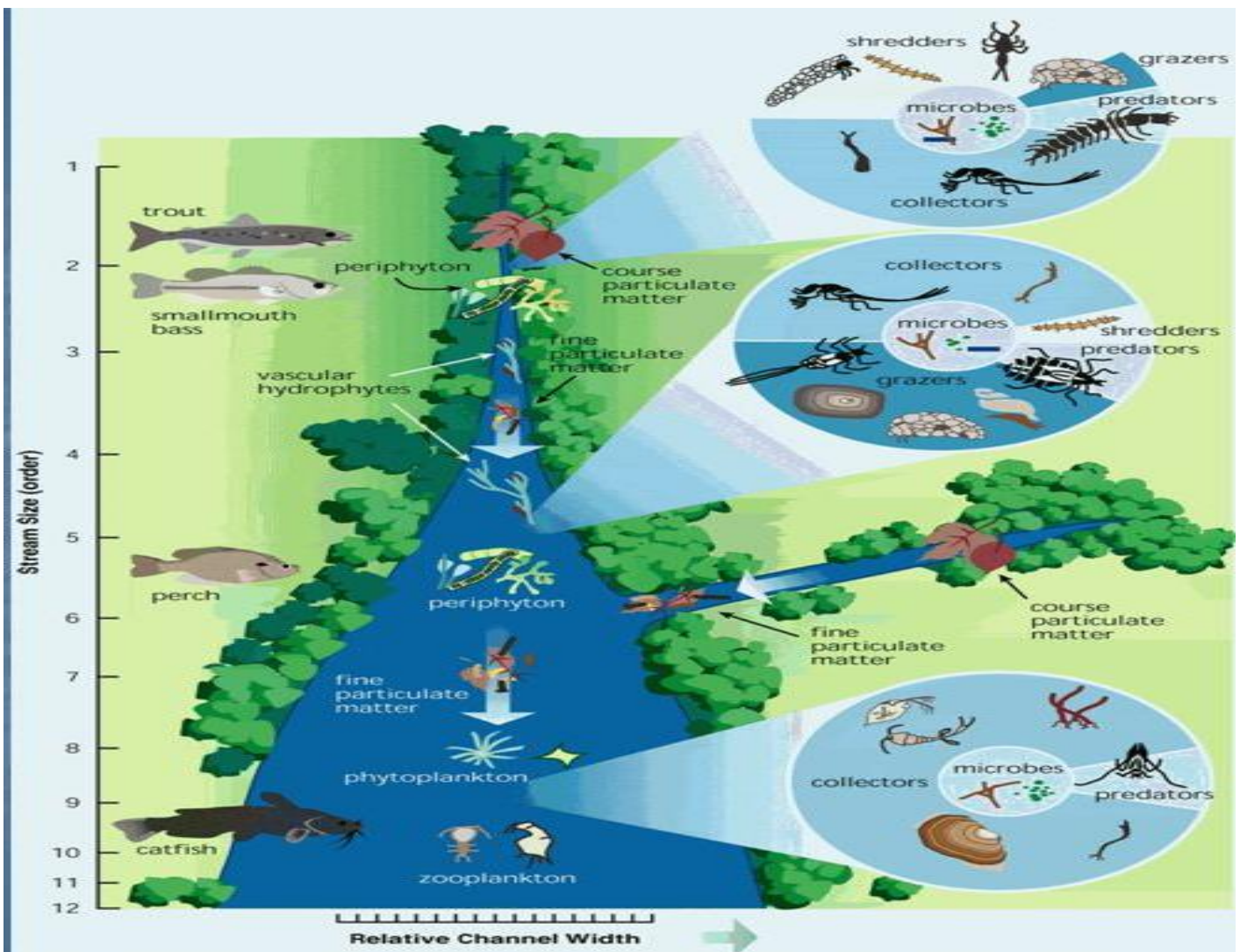
3. Down hill loop releases energy, used for electric power generation and used by ecosystem
4. Aquifers- under ground water-largest global water reservoir-porous underground strata mostly limestone, sand, gravel, clay that hold water like elongated tank

40 River continuum concept of hydrologic cycle

River continuum concept of hydrologic cycle

Diagram showing stream order depicting organisms by feeding type, change in particulate matter, change in community metabolism, diversity, particle size from headwater streams to large rivers

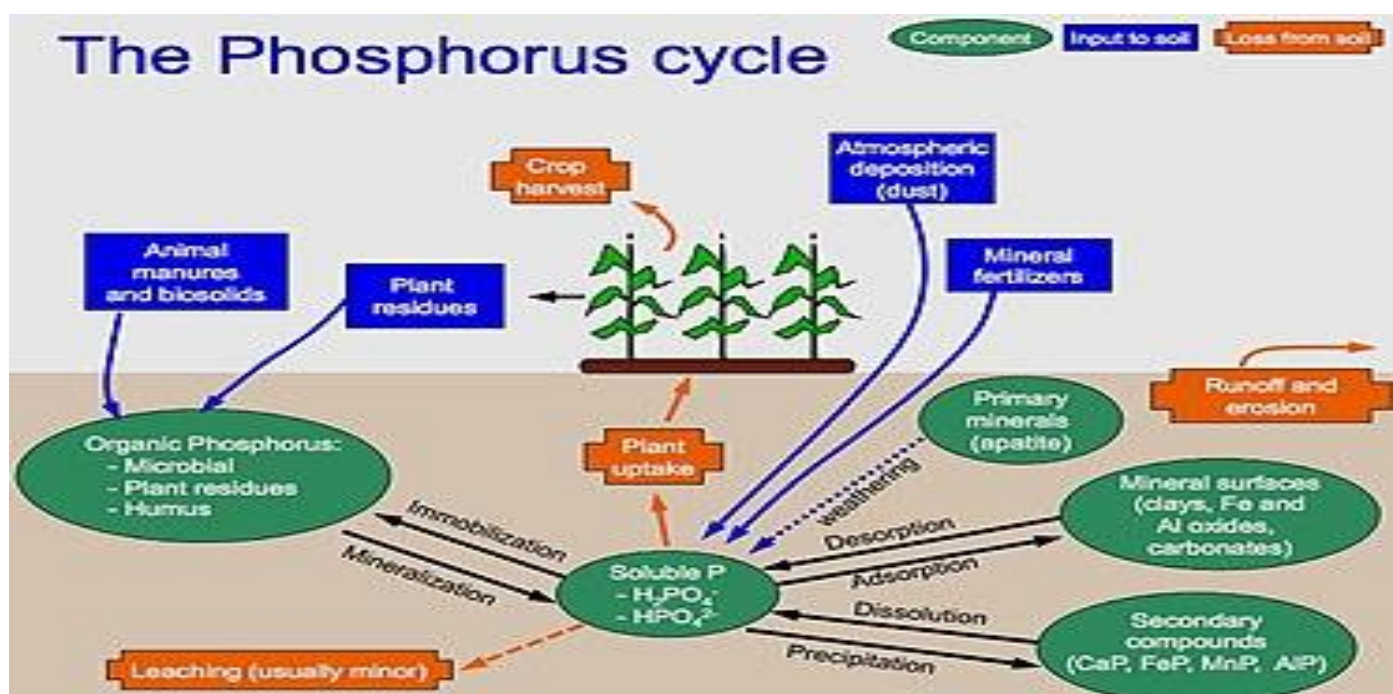




41 Biogeochemical Cycles-Phosphorous Cycle

Phosphorus is a necessary and important constituent of the protoplasm in the living organisms ATP, ADP, AMP, NADP, Phospholipids of cell membrane 85% P found in bones and teeth's

1. Reservoirs of phosphorus are the rocks-formed in past geological ages
2. Erosion of these deposits release phosphates in the ecosystem
3. Much of it escapes into the sea where part of it is lost to the deep sediments and some of it deposited in the shallow marine sediments
4. Plants take up inorganic phosphate as orthophosphate ions.
5. Available form of Phosphate (PO_4) returns to sea
6. Animal consume plants-phosphorous
7. Death and decay (decomposition), excreta of animals, bones and teeth -Phosphorous return to nature



42 Biogeochemical Cycles- Carbon Cycle

Sources of Carbon

1. Atmospheric carbon dioxide is the source of all carbon in both living organisms as well as in the fossils (used as fossil fuel).
2. It is highly soluble in water.
3. Oceans also contain large quantities of dissolved carbon dioxide and bicarbonates.

Important Steps in Carbon cycle

1. Photosynthesis
2. Respiration
3. Decomposition
4. Combustion

Impact of human activities

Carbon dioxide is continuously increasing in the atmosphere due to human activities such as industrialization, urbanization and increased use of automobiles. This increase in atmospheric CO₂ is leading to green house effect and global warming.

43 Population Ecology

Any group of organisms of the same species occupying a particular place and functioning part of biotic community, which in turn, is defined as assembly of populations functioning as unit, showing interactions due to coevolved metabolic transformations in particular physical habitat.

Population Ecology-Indices of Population density

Population density types

Crude density- the number of populations per unit of total space

Ecological density- number of populations per unit of habitat space (actual area where population colonize)

Changes in Population density (decrease or increase measurement)

Relative abundance-time related, e.g, no. of birds seen/hr

Frequency of occurrence- % of sample plots occupied by that species or single

44 Population Density.

Methods for estimating Population density

1. Lincoln or Petersen index-relies on capturing and marking some fraction of the total population and using this fraction to estimate the total population density

Lincoln index Equation

$$\text{Total Population (N)} = \frac{\text{Number of individuals caught \& released 1st time (M)} \times \text{Total of 2nd catch (n)}}{\text{Number of individuals recaptured who were marked (m)}}$$

Minimum known alive- another method of mark –recaptured method to estimate population densities over an extended period of time. **Also called calendar-of-catches method**

Total count-large or with organisms that aggregate into large breeding colonies

Quadrat or transect sampling-counting of organisms of a single species in plots or samples area.

Removal sampling- no. of organisms removed from an area in successive samples is plotted on y-axis and total number previously removed is plotted on x-axis

Plotless methods-applicable to sessile organisms such as trees, random points, distance of nearest individual measured

45 **Population Natality and Mortality**

Natality- ability of population to increase by reproduction-birth rate

Maximum natality- (absolute or physiological)-theoretical maximum production of new individuals under ideal conditions and constant of any population (no ecological limiting factors)

Ecological or realized Natality- population increase under actual or specific environmental conditions

e.g: 400 births/year among 10,000 couples

Crude birth rate is 400/year while realized natality is 4 per 100

Population Ecology-Population Mortality

Mortality- death rate of individuals in the population.

Ecological or realized mortality-the loss of individuals under a given environmental conditions

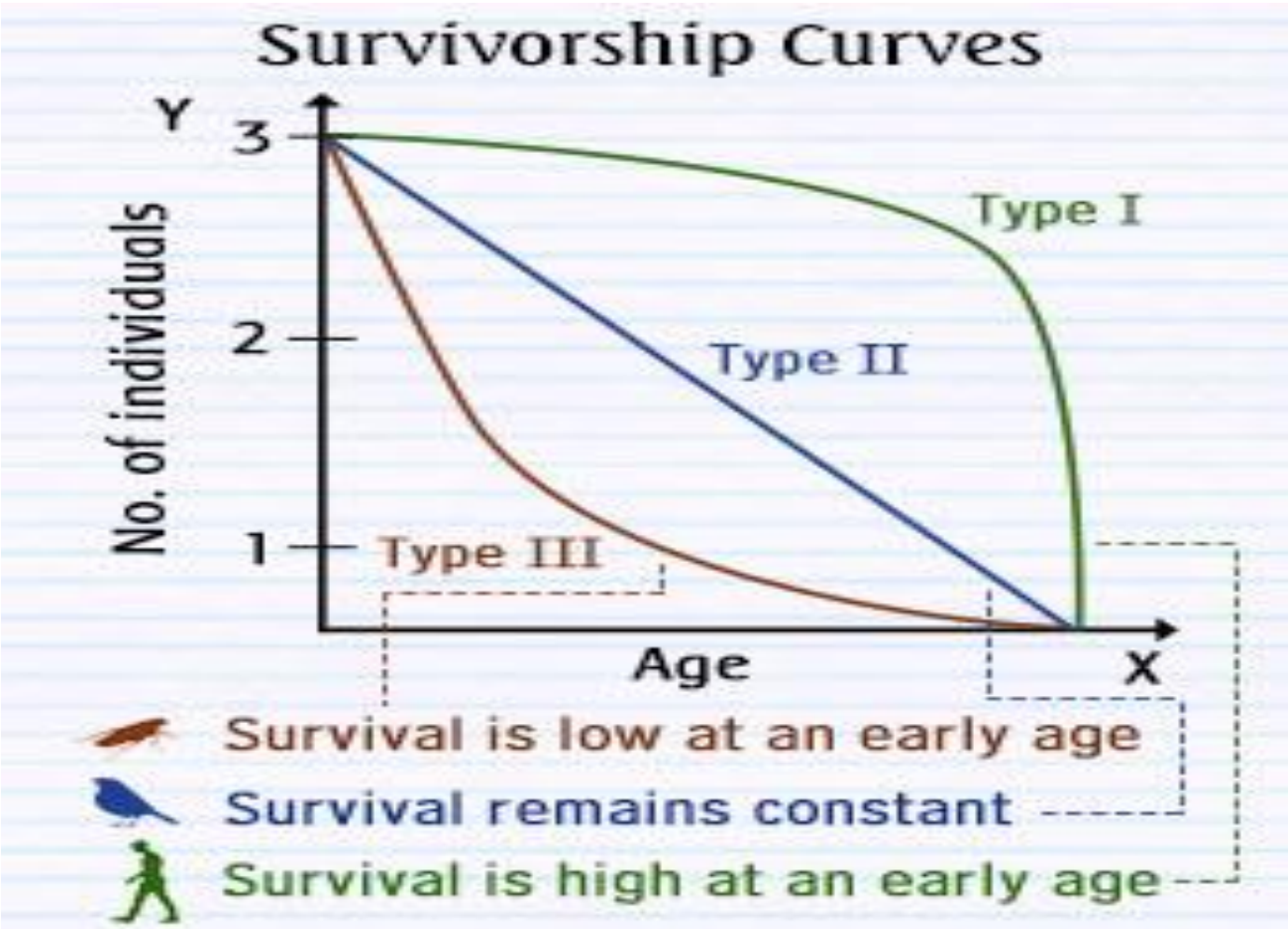
Minimum Mortality- constant for a population- represents the minimum loss under ideal or non-limiting conditions

46 **Survivorship curve and Carrying Capacity**

Population Ecology-Survivorship curve

Curves plotted from life table data, no surviving at beginning of age out of 1000 on vertical axis and time interval at x-axis, resulting curve is called survivorship curve

Three types of curves



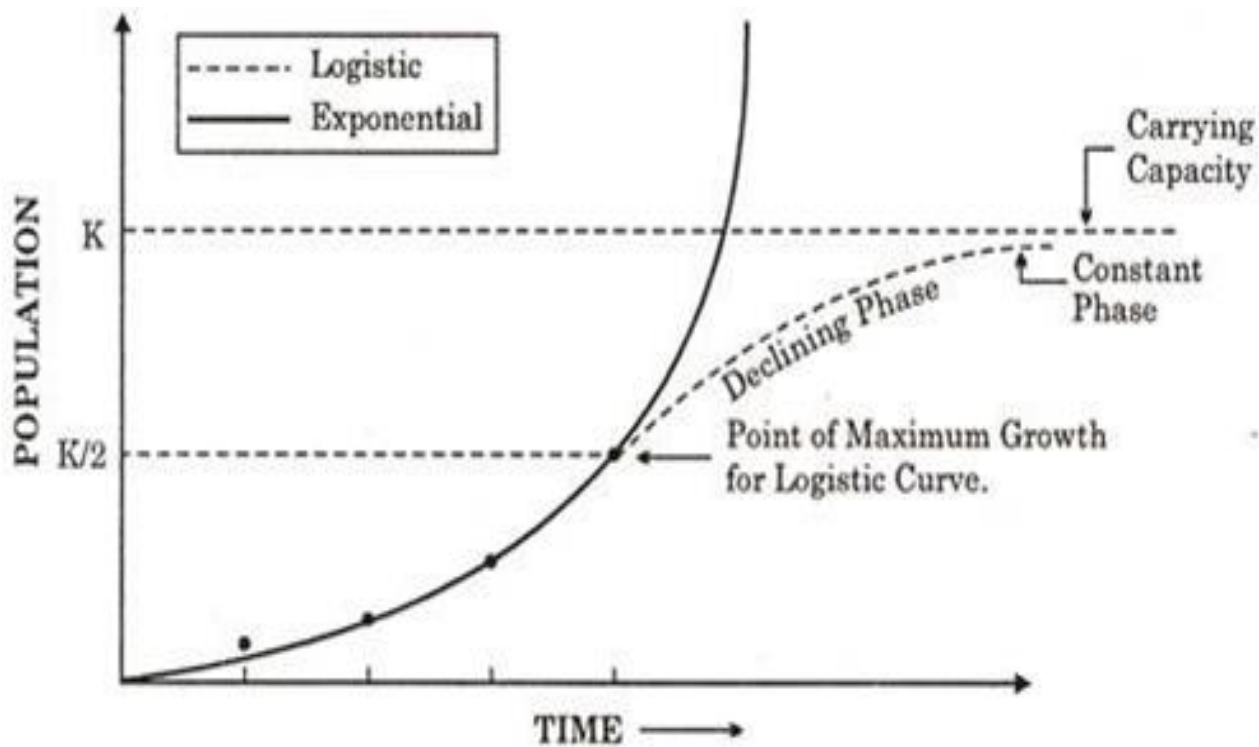
Population Ecology-carrying capacity

The population size that a particular environment can support is the environment's carrying capacity and is symbolized by "K"

Growth curves can be

J-shaped

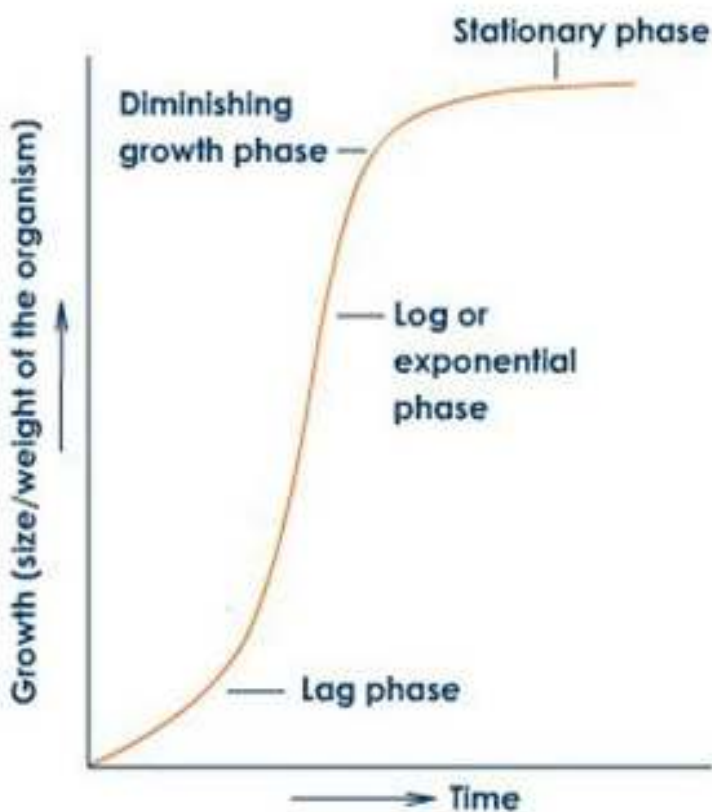
S (sigmoid) shaped



Exponential Growth or J-shaped Curve
(Characteristics of Unchecked Population)

Population Ecology-Survivorship curve

Logistic growth form (S-shaped curve)



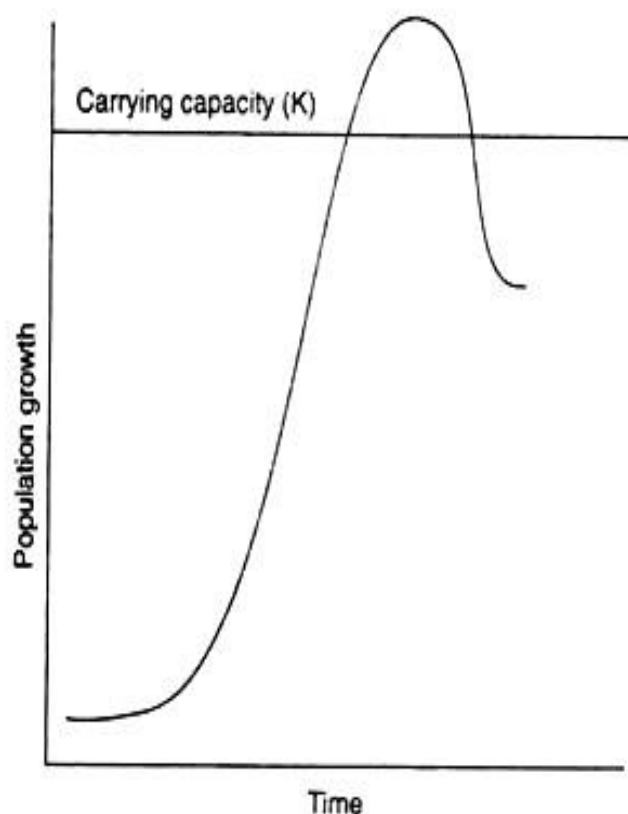
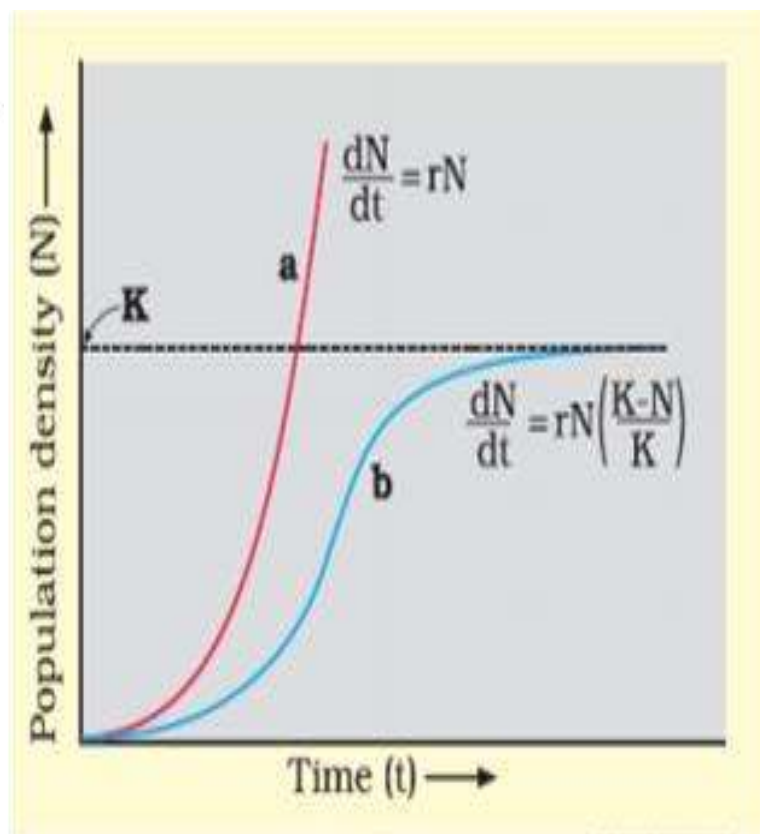
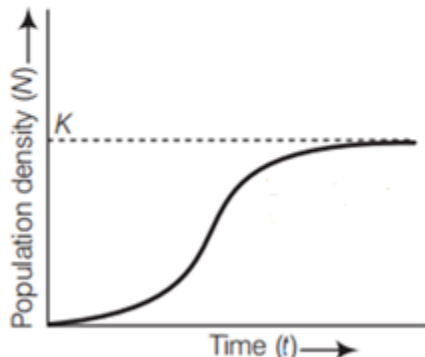
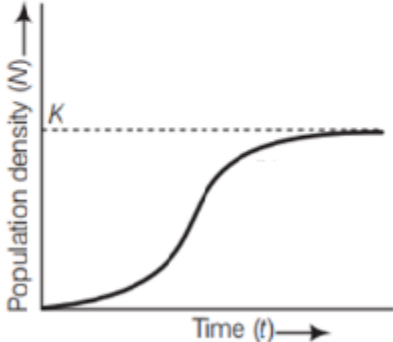


Fig. 4.43 : J-shaped growth curve



J- shaped growth	S- shaped growth
In this growth model, resources are unlimited in the habitat.	Resources are limited in a habitat.
Population occurs in J shaped growth manner	Population occurs in S shaped growth manner
The growth curve is initially lag phase followed by acceleration phase.	The growth curve initially in a lag phase followed by acceleration phase then in a steady state.
The J-shaped growth curve can be represented as:	The S-shaped growth curve can be represented as:
 K = carrying capacity	 K= carrying capacity

47 Community Ecology

Community Ecology-Definition

An ecological **community**

consists of all the populations of all the different species that live together in a particular area

Community Ecology

consists of all species that interact in a certain area

Community Ecology-Properties

Properties of Community or community structure

- Species Richness (number of different types of species, more in areas close to equator)
- Species evenness (abundance of each species)
- Species- Area Effect (large areas contain more species)
- **Community ecology** seeks to understand how species interact by studying many **different kinds of relationships** between organisms.

For example:

Animal-animal interactions, animal-plant interactions

plant-plant interactions

48 Community Ecology-Interactions

Each species interactions are analyzed by using **three key** themes

1. Species interactions can affect the distribution and abundance of a particular species

e.g: the effect of disease-carrying tsetse flies on the distribution of cattle in Africa

2. Species act as agents of natural selection when they interact
3. The outcome of interactions among species is dynamic and conditional

Concept of coevolution

Community Ecology-Types of Interactions

Interactions between same species in a community are called **intraspecific** —*intra-* means “same.”

- helps nature to keep the population under control
- results in the survival of the fittest

Community Ecology-Interactions

Types of Interactions

Interactions between different species in a community are called **interspecific interactions**—*inter-* means “between.”

The main types of interspecific interactions include

Competition (-/-),

Predation (+/-),

Mutualism, (+/+),

Commensalism (+/0), **Parasitism**(+/-).

49 Community Ecology-Competition

Competition (-/- interaction),

- where one or both inhibit the population of the other

1. Direct Competition for same resource

- Competition negatively affects both species

e.g: competition between birds for limited **seeds** for food, Woodpeckers and squirrels compete for nesting in the same holes and spaces in trees

2- Interference competition: occurs when an individual of one species directly interferes with an individual of another species.

e.g: a plant releasing [allelopathic](#) chemicals to impede the growth of a competing species.

Competition (-/- interaction),

Competition can be minimized if two species with overlapping niches evolve by natural selection to utilize less similar resources, resulting in **resource partitioning**

e.g: five species of warblers that all used the same caterpillar prey spruce tree.

50 Predation& Herbivory

Predation: (+ -) interaction

- One Wins, One Loses
- predator-prey interaction, in which one species kills and consumes another
- e.g: Lion is predator and deer is prey
- Predation shows cyclical patterns of predator/prey population sizes; predators increase in numbers when prey species are plentiful.

Herbivory: (+ -) interaction

- When Predation involves involve an animal or insect consuming part of a plant, known as **herbivory**.
- Animals that feed on plants by cropping portions of the plant, but usually not killing the plant, are herbivores
- Plants have spines and toxins-defensive

51 Community Ecology—Symbiosis

Symbiosis:

Interspecific interactions in which two species live together in a long-term, intimate association

- Symbiotic relationships keep a delicate balance
- can help individual species to evolve or change and even thrive

Symbiosis: mutualistic

- association between termite and their intestinal flagellates. Termites can eat wood but have no enzymes to digest it. However, their intestine contains certain flagellate protists (protozoans) that have the necessary enzymes to digest the cellulose of the wood eaten by termites and convert it into sugar.. Both termite and flagellates cannot survive without each other

Symbiosis:

- provide people with food, populate the planet with trees and plants, and keep animal and plant populations in balance
- Without symbiotic relationships, no coral reefs, trees might not proliferate as far and wide, aided by birds and insects that transport seeds afar

52 Community Ecology—Parasitism

Symbiosis:

Adaptations arising through coevolution come from two different species living showing various relationships or interactions

Parasitism

Commensalism

Mutualism

Parasitism: (+/- interaction)

two species have a close, lasting interaction that is beneficial to one, the **parasite**, and harmful to the other, the **host**

- Most of the time, the parasite feeds on the host's body but does not kill the host

Parasitism:

Two types of hosts

- definitive host (A definitive host provides a home to an adult parasite or sexual stages of parasite)
- intermediate host (host unknowingly offers a home to a juvenile parasite or asexual stage of parasite)

Parasitism:

Ecto-parasites:

Ticks- blood-sucking insects that thrive on the blood of its victims

Also transfer infectious diseases to healthy organisms

Endoparasites-tapeworm in human intestine

Parasitism examples

Plant parasite: Dodder (*Cuscuta*) plant is a parasitic

weed that obtains moisture and nourishment by attaching to a green, living plant.

Animal parasite: *Ascaris* or round worms are internal parasites found in the human intestine

53 Community Ecology-commensalism

Commensalism:

(+/0 interaction)

Two species have a long-term interaction that is beneficial to one and has no positive or negative effect on the other

Sucker fish, often attaches to a shark by means of its sucker which is present on the top of its head. This helps remora get protection, a free ride as well as a meal from the left over of the shark's meal



Commensalism: example- grazing cattle and cattle egrets. As the cattle graze in the grass, they stir up the insects living there, allowing the cattle egret a tasty meal. The cattle egrets get a meal, but the cattle receive nothing in return from the long-necked birds, nor are they harmed by the relationship.

54 Community Ecology-Mutualism

Mutualism: (+/+) interaction

- two species have a long-term interaction that is beneficial to both of them
- **Example-**
- Lichens **and** Mycorrhizae

Mutualism: examples

There are many different examples of mutualistic relationships:

- Plants and microbes *e.g.* **rhizobium in root nodules**
- Protists and fungi *e.g.* **lichen**
- Terrestrial plants and insects, *e.g.* **pollination**
- Animals and protists/bacteria *e.g.* **ruminants, corals**
- Animals and other animals *e.g.* **crocodile and plover bird**



55 Amensalism

Amensalism: (-/0, Interaction)

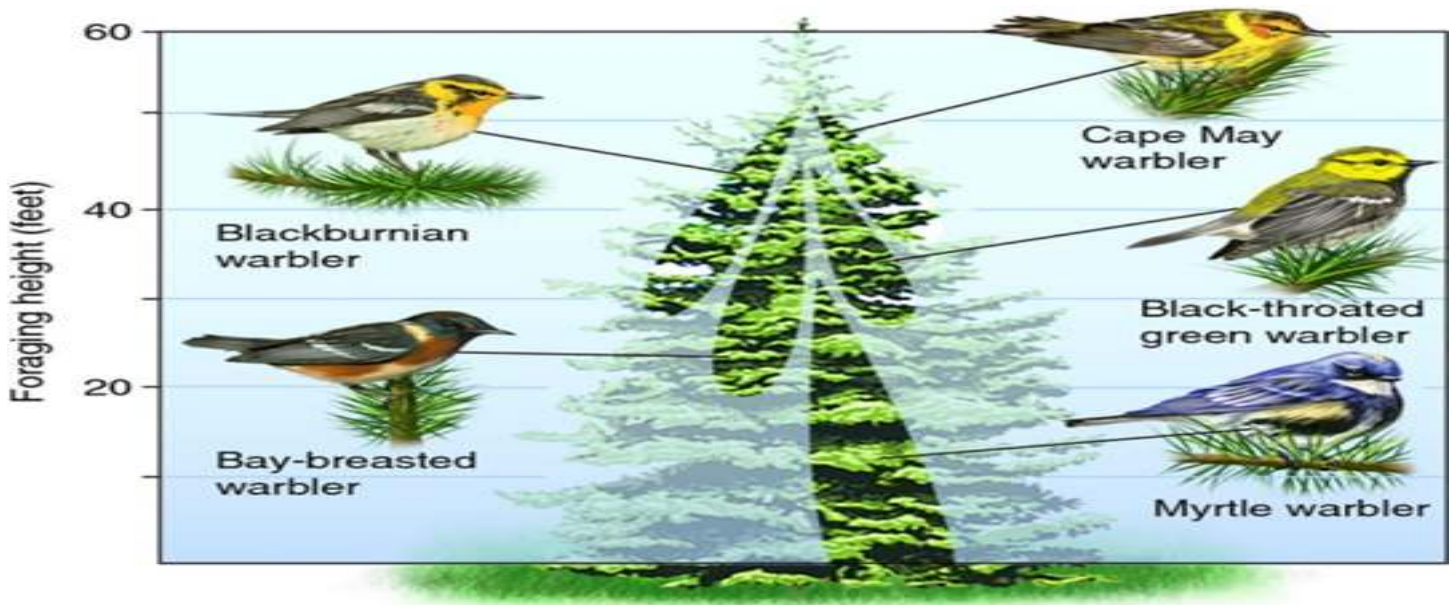
It describes an interaction in which the presence of one species has a negative effect on another, but the first species is unaffected.

Example: a herd of elephants walking across a landscape may crush fragile plants

56 Ecological Niche

an important concept of community structure.

Ecological niche involves both the habitat of organism, type of food it eats, where it lives, reproduce and its relationship with other species, the role it plays in its habitat.



57 Community Ecology-Ecological Niche

Succession

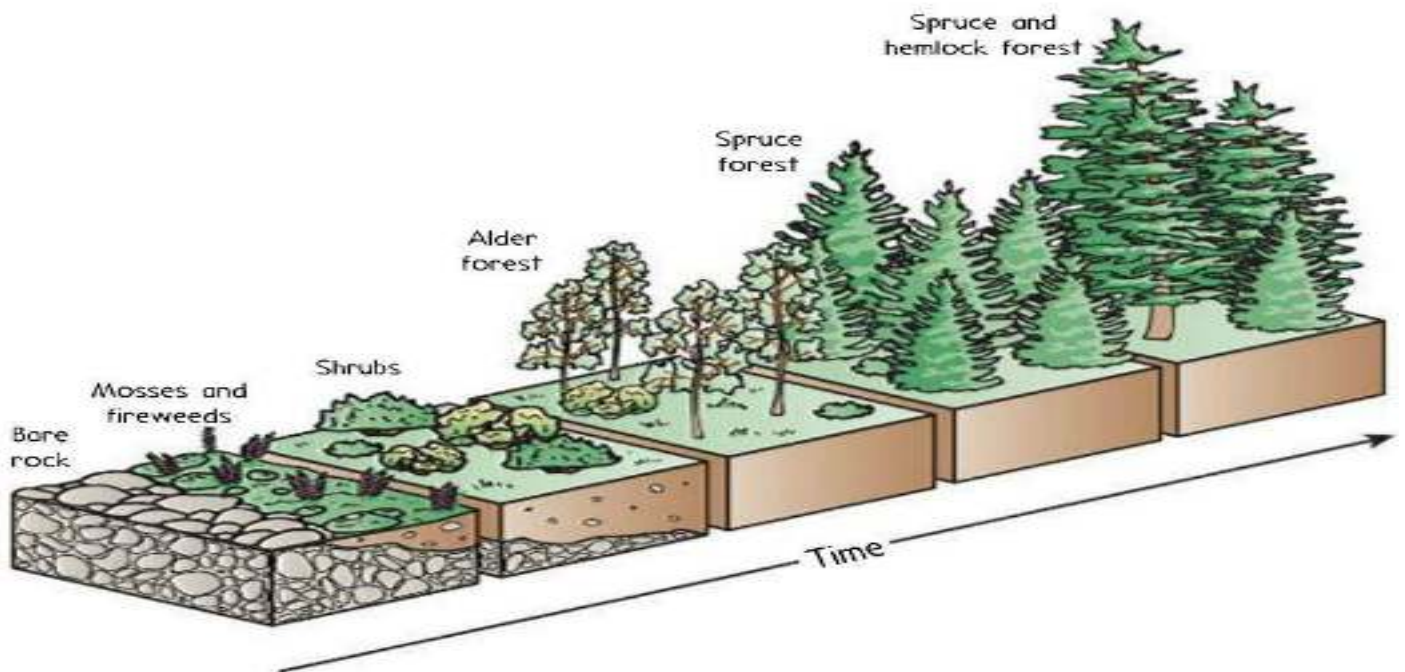
Succession • The process by which communities of plant and animal species in an area are replaced by another over a period of time is known as ecological succession

SUCCESSION • Sequential and gradual growth of a community **Or** The dominant members of a community often change a community in predictable ways in a process called **succession**

Pioneer community

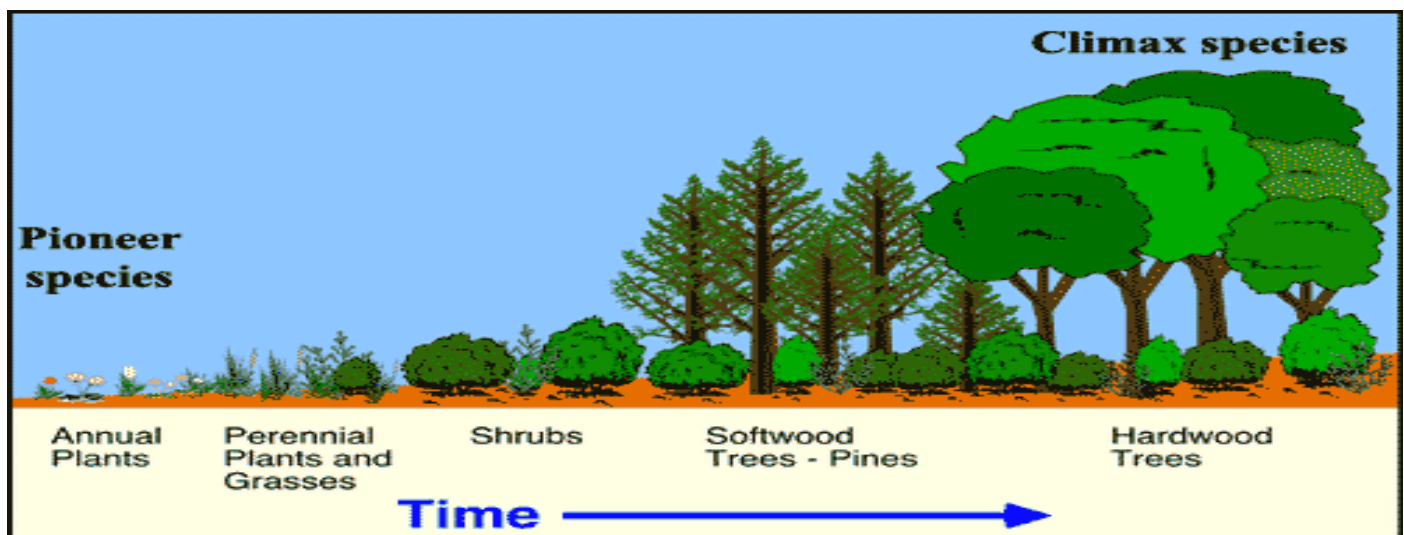
Seral stage

Climax community



Pioneer species and Primary succession

- Communities may begin in areas nearly devoid of life. The first community to become established in an area is called the **pioneer community**.
- Microbes, lichens and mosses create soil before other plants can grow



Seral stage

Over thousands of years nutrients accumulate, and the characteristics of the ecosystem change.

Each successional stage is called a **seral stage**, and the entire successional sequence is a **sere**

Primary Succession



**Unstable
PIONEER
Community**
[lichens,
mosses]

Time

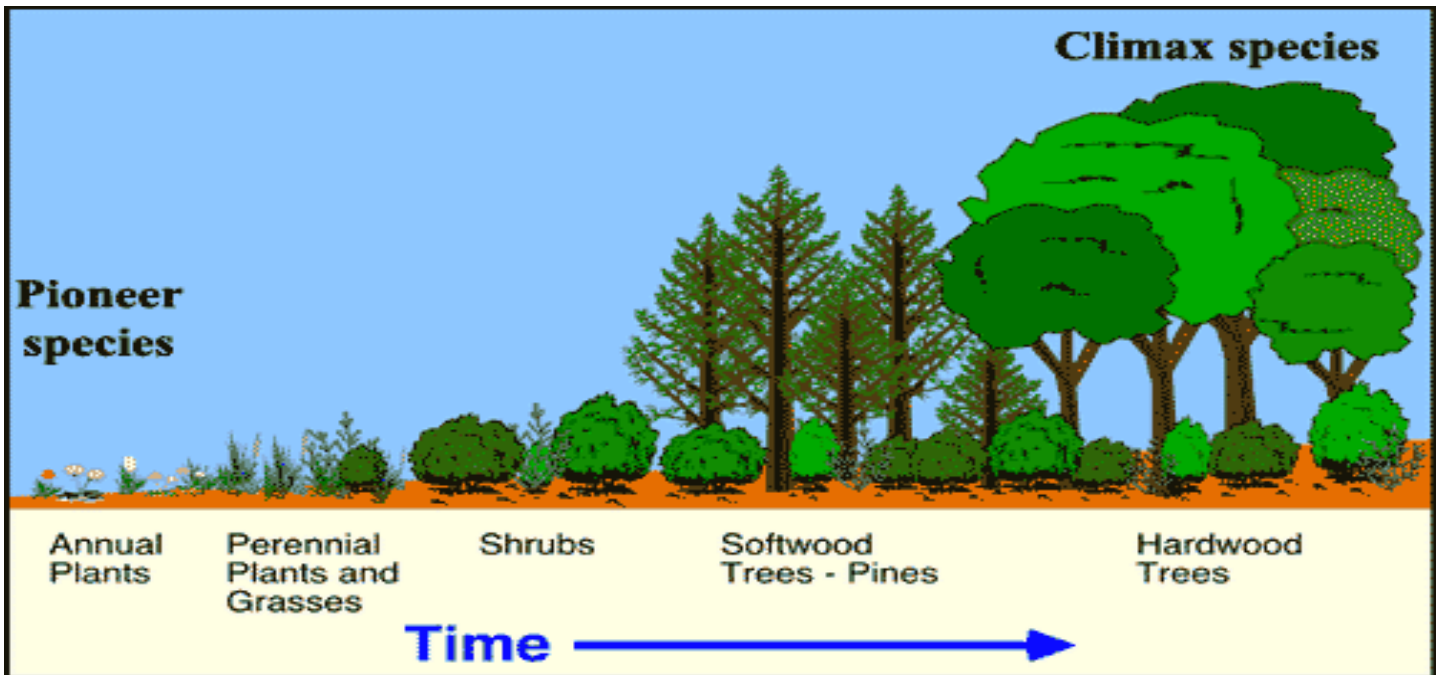
**Stable
CLIMAX
Community**
[Trees]

Primary Succession:

- Occurs on barren habitats *e.g. rock, sand, clay, ice* this means that there is **NO SOIL** present
- Pioneering organisms colonise and modify the environment until new niches occur
- Slow process - may take thousands of years

58 Community Ecology-Succession

Succession occurs because the dominant life-forms of a sere gradually make the area less favorable for themselves, but more favorable for organisms of the next successional stage. The final community is the **climax community**, usually have complex structure and high species diversity



Two types:

Primary and secondary

Primary succession occurs when land is first formed.

1. Microbes, lichens and mosses must create soil before other plants can grow. 2. Pioneer species: first species to dominate early in succession (small and fast growing)

Primary Succession

The diagram shows a cross-section of the ground over time, illustrating the stages of primary succession. It starts with a barren, rocky surface and progresses through various stages of plant growth, from small pioneer plants to a dense forest of trees. A green arrow labeled 'Time' points to the right. The first stage is labeled 'Unstable PIONEER Community [lichens, mosses]' and the final stage is labeled 'Stable CLIMAX Community [Trees]'.

Primary Succession:

- Occurs on barren habitats *e.g. rock, sand, clay, ice* this means that there is **NO SOIL** present
- Pioneering organisms colonise and modify the environment until new niches occur
- Slow process - may take thousands of years

Secondary succession occurs when succession must start over after the destruction of a climax community (marked by the domination of long-lived species and great diversity). - takes place on sites that have already supported life

59 World's Biomes

The natural broad biotic zones of the biosphere called, **Biomes**.

Each biome is characterized

by uniform life form of vegetation such as grass, desert plants, deciduous trees or coniferous trees.

A Biome is a large ecosystem which is embracing the large land scape, characterized by specific flora and fauna.

Ecosystem is defined as a functionally independent unit (of nature) where living organisms interact among themselves as well as with their physical environment.

Ecosystem is a self sustaining unit of nature.

60 World's Ecosystems

Types of Biomes/Ecosystem

Natural and Artificial

Natural-

- a) Terrestrial ecosystem
- b) Aquatic ecosystem

Artificial or Man-made

e.g: Crop

lands and aquarium

- a) Terrestrial ecosystem

Terrestrial : These are the biomes found on land e.g., Tundra, forest, deserts, grasslands

61 World's Ecosystems-Tundra Ecosystem



Tundra Distribution

Arctic tundra extend as a continuous belt below the polar ice cap and above the tree line on the northern hemisphere. It occupies the northern fringe of **Canada Alaska, European Russia, Siberia and island group of arctic ocean.**

Tundra

The word tundra means a “barren land” since they are found in those regions of the world where environmental conditions are very severe.

There are **two types** of a) **Tundra arctic** b) **Alpine.**

Tundra Distribution

Alpine tundra occur at high mountain peaks above the tree line.

Since mountains are found at all latitudes therefore alpine tundra show day and night temperature variations

62 World's Ecosystems-Tundra Ecosystem 2

Tundra Climate

A permanently frozen subsoil called **permafrost** is found in the arctic and antarctic tundra.

The summer temperature may be around 15°C and in winter, it may be as low as –57°C in arctic tundra .A very low precipitation of less than 400 mm per year

Tundra Climate

A short vegetation period of generally less than 50 days between spring and autumn frost Productivity is low.

Tundra Flora and fauna

Typical vegetation of arctic tundra is cotton grass, sedges, dwarf heath, willows birches, and lichens.

World's Ecosystems-Tundra Ecosystem

Animals in the Arctic Tundra



Seal



Arctic Fox



Snowy Owl



Snowshoe Hare



Caribou



Polar Bears

Many of these animals are white to ~~camo~~camouflage themselves in the snow. The white color makes them hard to see if they are being hunted because they blend in with the snow. Their fur or feathers are thick to protect them from the cold.

Their body is covered with fur for insulation, Insects have short life cycles which are completed during favorable period of the year.

Antarctic Tundra Animals



Rabbit



Penguin



Seal

Their body is covered with fur for insulation, Insects have short life cycles which are completed during favorable period of the year.

63 World's Ecosystems-Forest Ecosystem 2

Forests :

Forests are one of the largest plant formations, densely packed with tall and big trees. Forests are of many different types, depending on the climatic regime in which they are found.

Three main forest types are:

1. Tropical Rainforests
2. Temperate Deciduous forests
3. Boreal or north Coniferous forests

64 Coniferous Forests

Coniferous forests : Coniferous forests are also known as **Taiga** or **Boreal** forests. They extend as a continuous belt across north America and north Eurasia below the arctic tundra.

Coniferous forests : In the Himalayas, these are distributed above 1700 to 3000 metre altitude. They also occur at high altitude below the alpine tundra and tree line.

Coniferous forests :

Climate : Climate is cold. Long and harsh Winters is for more than six months. Mean **annual temperature** is below 0°C,

Soil is **poor in nutrients** and **acidic** in nature.

65 Coniferous Forests 2

Coniferous forests :

Flora and fauna : characterized by conifers

(gymnosperms). They are evergreen, drought resistant and woody. In many species the canopy is cone shaped. The common species of trees of these forests

are Spruce, fir and pine trees.

Coniferous forests :

Flora and fauna : The productivity is much less than other ecosystem. There are very few animals in these forests. The herbivores are red

squirrel, deer, goat, mule, moose etc.

66 Temperate Deciduous Forests

Temperate Deciduous Forests : Trees of deciduous forests shed their leaves

in autumn and a new foliage grows in spring. They occur mostly in **north-west, central and eastern Europe**, eastern north America, **north China, Korea, Japan, far eastern Russia** and **Australia**.

Temperate Deciduous Forests : Climate : These forests occur in the areas of moderate climatic conditions such as **Annual rainfall** is 75 to 150 cm, **Winter** lasts for four to six months, **Temperature** ranges between 10 to 20°C.

Soil is brown and rich in nutrients.

Temperate Deciduous Forests : Flora and fauna : Commonly found trees in this ecosystem are **oak, birch, hickory, chestnuts, pitch pine, cypress**. Invertebrate fauna comprises green **oak moth, bark beetle, green flies, aphids, sapflies, moths and butterflies**.

67 Temperate Deciduous Forests 2

Flora and fauna : Prominent

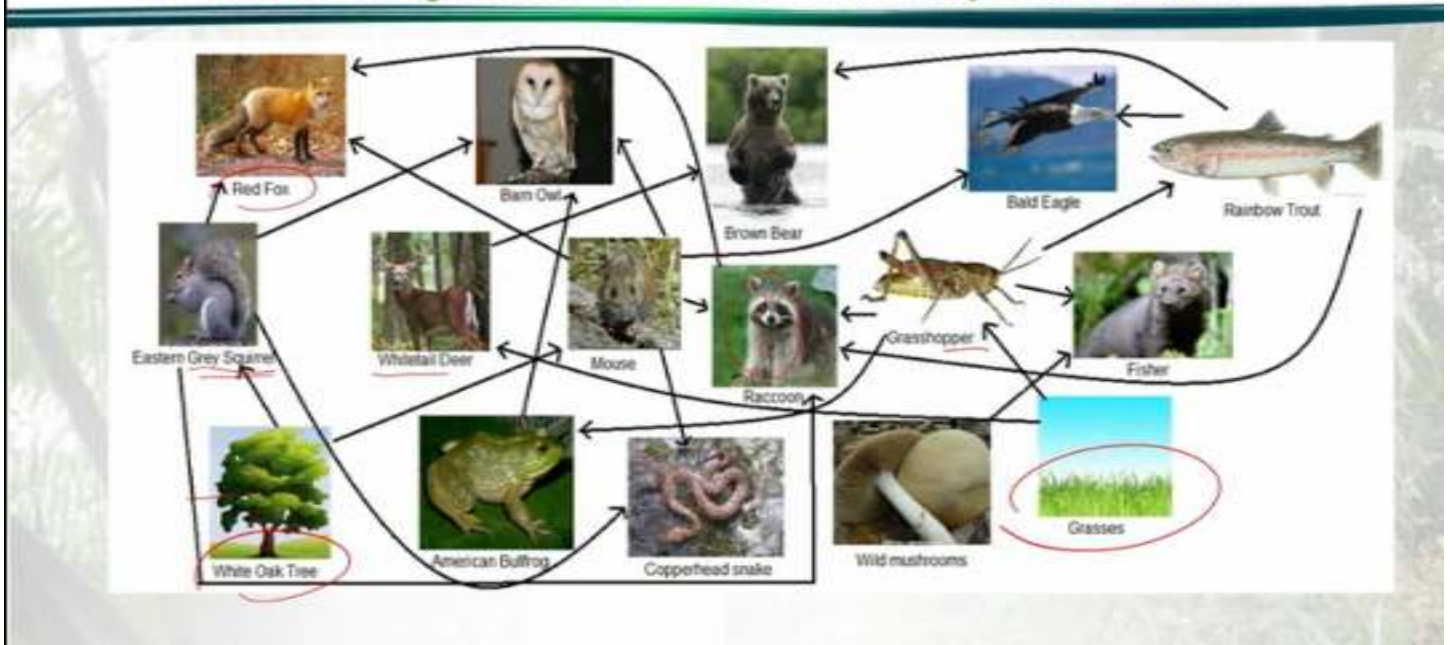
grazers are grass eating **rodents, deer and bison**. Rodents play a very important role in these forests. They feed on the seeds, fruits and leaves of the trees and consume much more food than the large sized grazers.

Flora and fauna Common carnivores in temperate forests are **wild cat, wolves, foxes, tawny owl and sparrow hawk**.

Black bear, raccoons and skunks are the omnivorous animals of these forests.

68 Food Web of Temperate forest

World's Ecosystems- Food web in temperate forest



69 Tropical Rain (Evergreen) Forest

Tropical Rain (Evergreen) Forest : These are in the tropical region of very high rain fall. Such forests are well developed over the western coast of **India** and **North eastern Himalayas** and scattered in **south east Asia**, **west Africa** and **north cost of South America**.

70 Tropical Rain (Evergreen) Forest 2

Tropical Rain (Evergreen) Forest : Main characteristics Temperature and light intensity very high
Rain fall is greater than 200 cm. per year. Soil is rich in humus,
The rate of **turnover** of the nutrients is very high leading to high productivity and have highest standing crop and biomass

Tropical Rain (Evergreen) Forest : The vegetation includes broad evergreen trees of about 200 feet like Health bamboos, ferns, shrub etc. Epiphytes and woody wines (liannas) are also abundant. Many tree species show buttresses (swollen stem bases) and leaves with drip tips.

71 Tropical Rain (Evergreen) Forest 3

Tropical Rain (Evergreen) Forest : Snails, centipedes, millipedes and many insect species are common near the forest floor

Rhacophorus (flying frog), aquatic reptiles, *Chameleon* and many birds. Mammals are sloths , monkeys, ant eaters, leopards, jungle cats and giant flying squirrels.

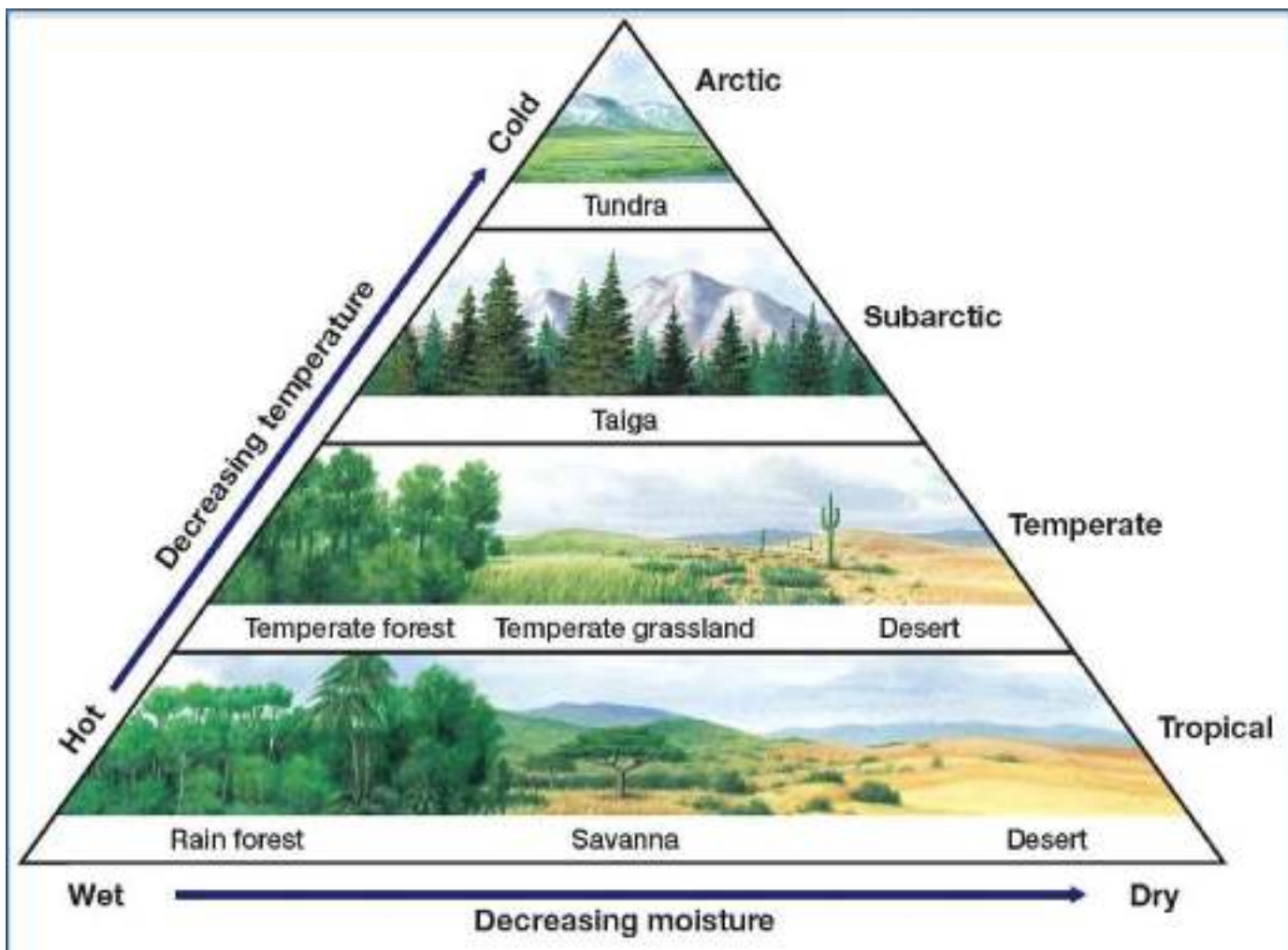
72 World's Ecosystems-Grassland Ecosystem

Grasslands:

Distribution : Grasslands are dominated by the grasses. They occupy about 20% of the land on earth's surface.

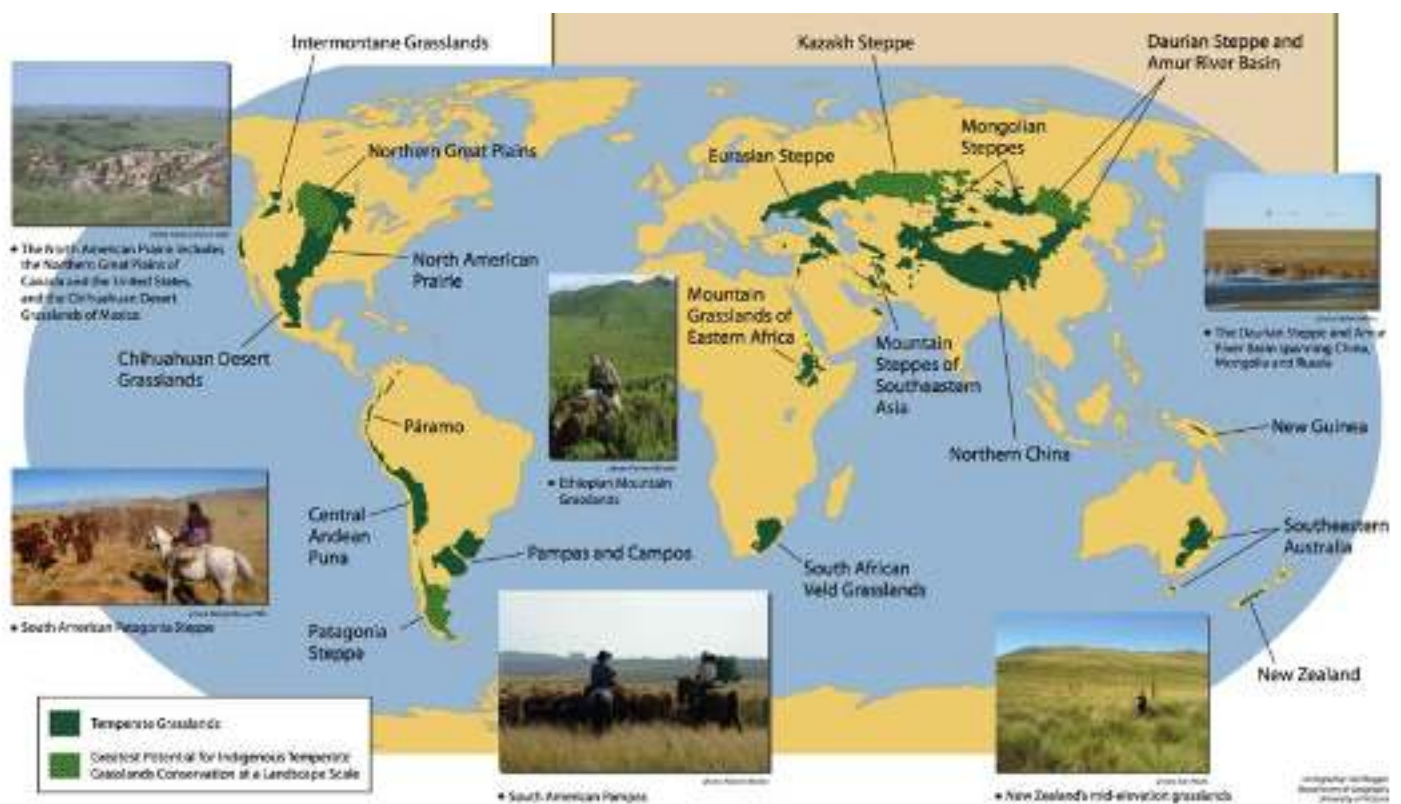
Grasslands Distribution : They occur in both tropical and temperate regions where environmental conditions are better than that of the desert but rainfall is not enough to support the growth of trees

Grasslands represent an **ecotone** (a zone in between two ecosystems) and are found between forest on one side and deserts on the other. Greater variation of temperature, moisture, wind and light intensity of the sun



73 World's Ecosystems-Grassland Ecosystem 2

Grasslands are known by various names in different parts of the world. For example they are called **prairies** in **Canada and North America**, **steppes** of **Russia**, **Savannas** in **Africa** and **Pampas** in **Argentina**.



74 Grassland Ecosystem- Tropical

Tropical grasslands are commonly called **Savannas**. They occur in **eastern Africa**

South America, Australia and India. Savannas-complex ecosystem-contain grasses with groups of trees. Soil of grassland is rich and fertile.

Tropical grasslands

Flora and fauna : Grasses are the dominating plants with scattered drought resistant trees in the tropical grasslands. Trees are less than 10 m in height.

Tropical grasslands

Three strata

- (i) Root layer-mostly root biomass-upper 16cm, roots may penetrate 1.7m down-underground stems or rhizomes
- (ii) Ground layer-mosses and dandelions

Tropical grasslands

Three strata

- (iii) Herbaceous layer-saesonlly short grasses, wild mustard, coneflower

Tropical grasslands

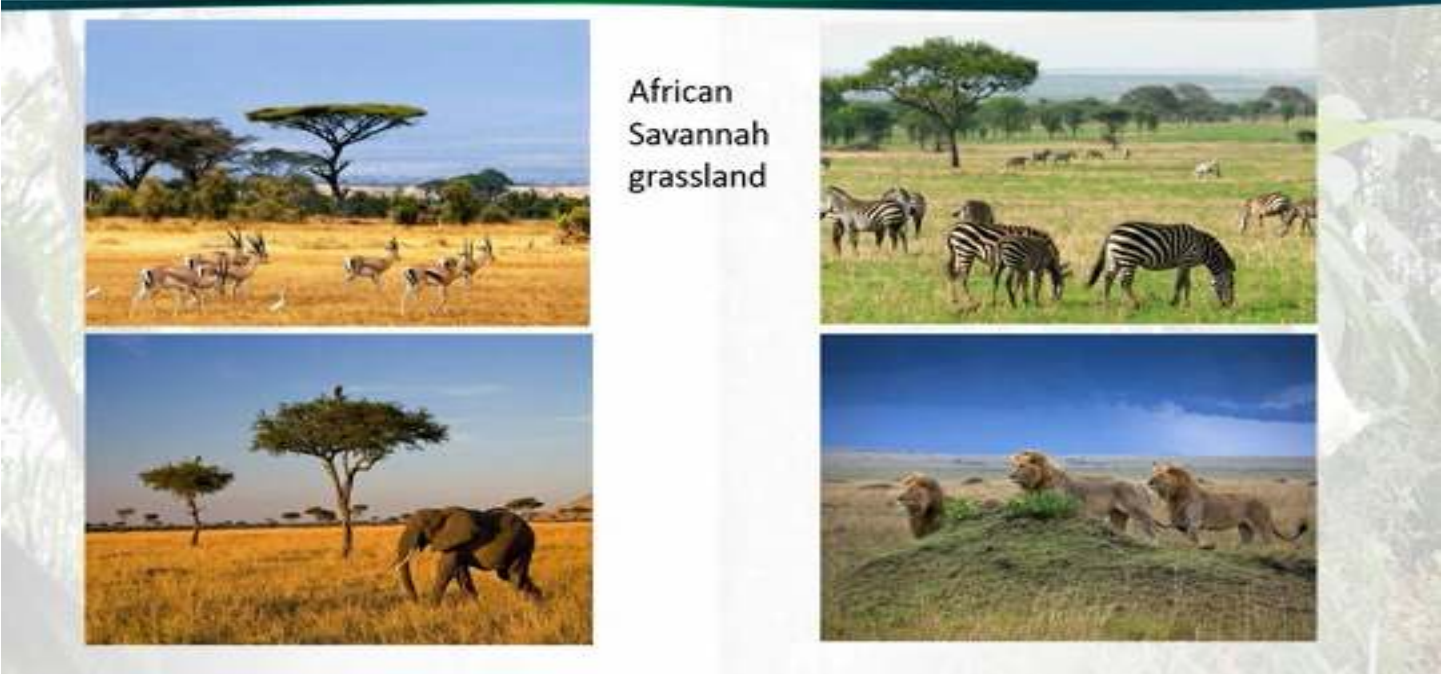
Flora and fauna :

Animals-much reduced- because there is no shelter The large herbivores of this biome are **bison, proghorn (North America) wild horse, ass, saiga (Eurasia) , zebra and antelope (South Africa)**

Tropical grasslands

Flora and fauna : Carnivores are quite small in number and size e.g: coyotes, weasels, badgers foxes and ferrets . Hawks, lark sparrows, warblers, Great Indian Bustard and peafowl are the common birds- Biomes has rich in reptilian and insect

World's Ecosystems-Grassland Ecosystem



World's Ecosystems-Grassland Ecosystem



Pampas
grassland
of South
America



World's Ecosystems-Grassland Ecosystem



Prairies
grassland
of North
America



World's Ecosystems-Grassland Ecosystem

- Largest temperate grassland extending from Hungary to China.
- The most famous trade route on the Eurasian steppe is the Silk road, connecting China, India, and Europe.

Plants: feather grass, fescue, wormwood, tipchak- an oat like grass, salt grass (solyanka), sage, haloxyon, steppe tulips, Veronica.

Animals: Antelopes, Bos taurus, Horse, two humped Camel, burrowing rodents like jerboas, marmots and pikas.

Birds: Bustards, quails, sand grouse, red-legged hobby

Steppes



Wild horse on the steppe of Kirgizstan, Central Asia



Antelopes



Feather grass

76 World's Ecosystems-Desert Ecosystem

- **Deserts Distribution :** Deserts are waterless barren regions of the earth.
- They occupy about $1/7^{\text{th}}$ of the land on earth's surface. Deserts form an extreme condition in sequence of ecosystems with respect to the climatic condition ..
- **Deserts Distribution :** They occur in two belts that encircle the northern and southern hemispheres roughly centered over the tropics of Cancer and Capricorn.
- **Deserts Distribution :** Sahara deserts of Africa are the largest
- Indian Thar deserts are an extensions of Sahara deserts through Arabian and Persian deserts

77 Deserts Climate , Flora and Fauna

Deserts Climate:

Annual rain fall is very little- less than 25 cm/annum. At some places if it is high it is unevenly distributed. Temperature may be very high in subtropical deserts and very low in cold deserts e.g. Ladakh. Winds have high velocity.

Deserts Flora:

Cacti, *Acacia*, *Euphorbia* and prickly pears



Deserts fauna:

Desert animals are insects, reptiles, and burrowing rodents. Desert shrew, fox, kangaroo, wood rat, rabbit, armadillo are common mammals in desert. Camel is known as the ship of the desert

78 Limnology

Aquatic Biomes

Water covers 70% Origin of life took place in aquatic ecosystem. Therefore, these ecosystems make an important component of our biosphere.

Aquatic Biomes

Aquatic ecosystems

are classified on the basis of salinity into following two types:

1. **Freshwater**
2. **Marine.**

Fresh Water Ecosystem

Water on land which is continuously cycling and has low salt content is known as fresh water.

The study of fresh water ecosystem is known as **limnology**

TYPES OF FRESHWATER HABITATS



Lentic
Standing Water or
lentic (calm)
ecosystems : lakes
and ponds



Lotic
Running water or
lotic (washed)
ecosystems :
springs, streams
and rivers



Wetlands
Wetlands where
water level
fluctuates up and
down, often
seasonally as well
as annually :
marshes and
swamps

Ground water although a large freshwater habitat reservoir but it does contain life that's why it is not considered as ecosystem

79 Types of aquatic ecosystem

Fresh Water Ecosystem

Fresh waters are classified into two types:

- (i) Standing or still water (**Lentic**) e.g. pond, lake, bogs and swamps.
- (ii) Running water (**Lotic**) e.g.. springs, mountain brooks, streams and rivers

Aquatic Ecosystems - Lentic

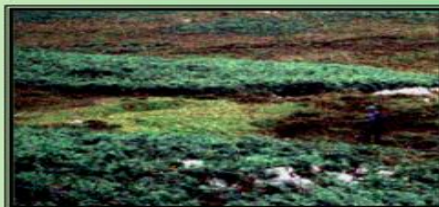
Lake



Pond



Bog



Swamp



Marsh



80 Flora & Fauna of freshwater ecosystem

Fresh Water Ecosystem

Common flora in ponds and lakes include (**Lentic**)

Phytoplankton (freely floating microscopic plants) such as algae, diatoms

- (ii) Floating plant : *Pistia*, water hyacinth, *Lemna*, *Azolla*

(iii) Rooted plant : Hydrilla, *Vallisnaria*, trapa and water lily.

Fresh Water Ecosystem

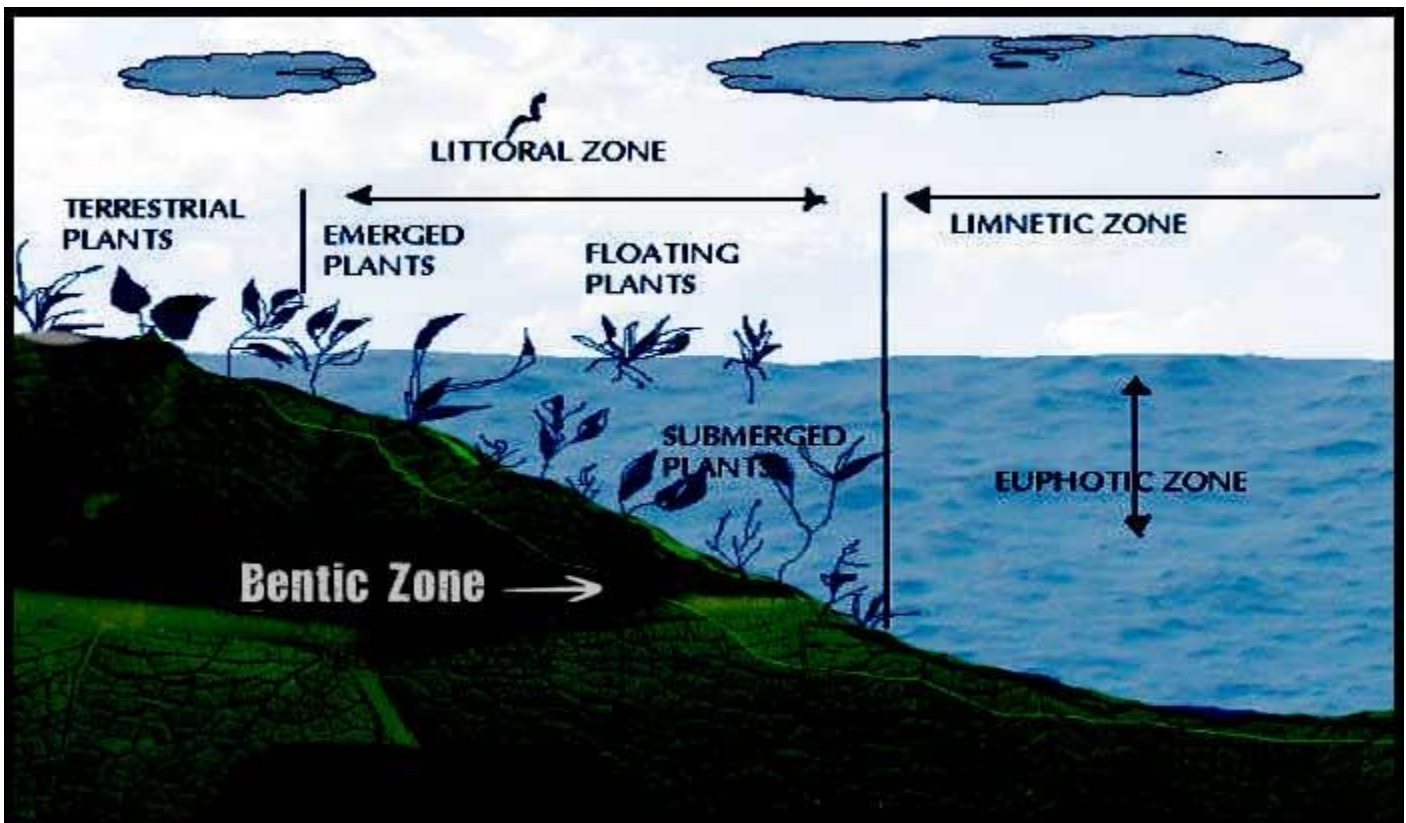
(iii) Bottom dwellers like hydra, worms, prawns crabs, snails.

(iv) Birds such as herons, water fowls and ducks occurs in and around water.

Fresh Water Ecosystem

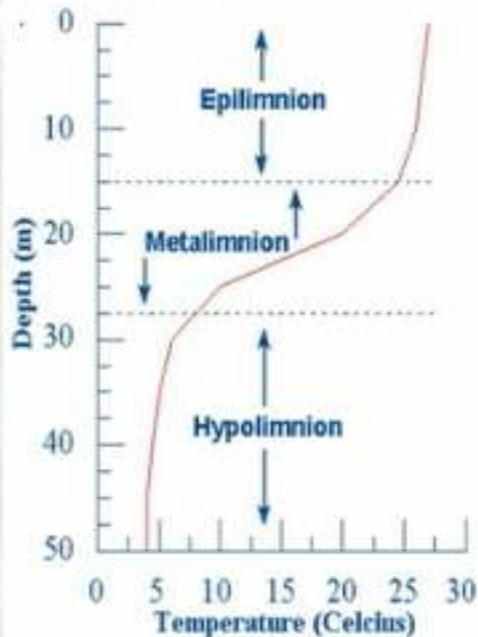
The common animals in ponds and lakes include

- (i) Zooplankton (freely floating microscopic animals) such a protozoans and crustaceans
- (ii) Actively swimming fishes, frogs, tortoises (Nekton).



81 Thermal stratification in lakes

World's Ecosystems-Lentic Aquatic Ecosystem



EPILIMNION

The surface layer of water that is constantly mixed by wind and waves and is warmed by the sun, from late spring to late fall.

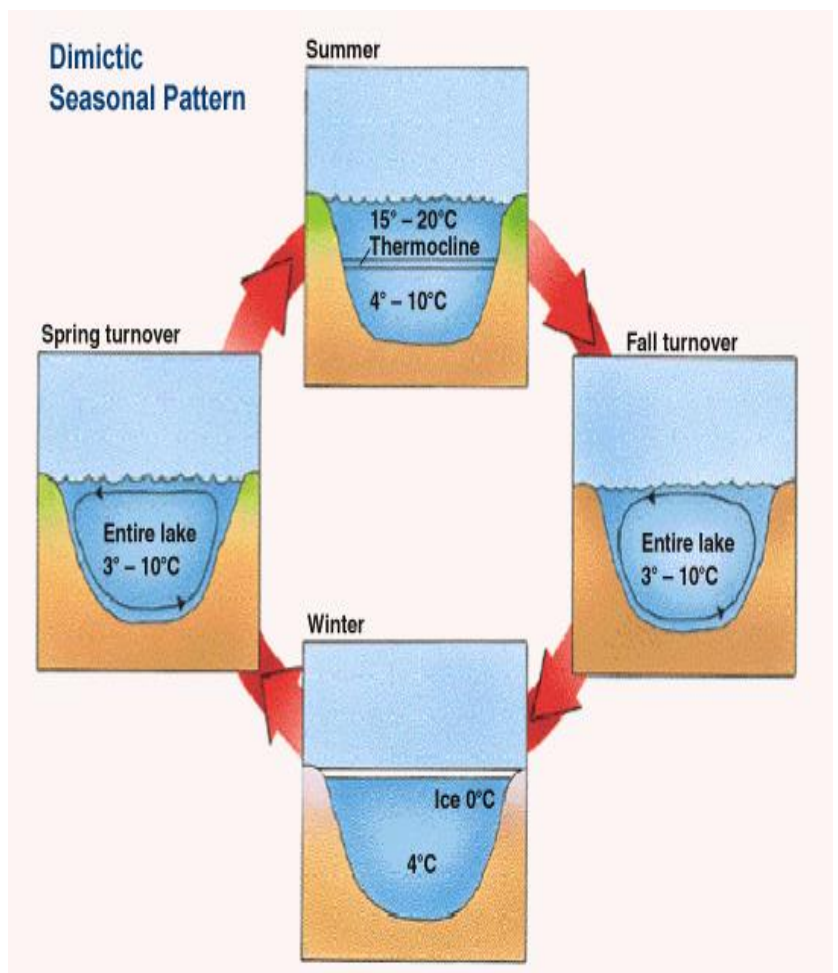
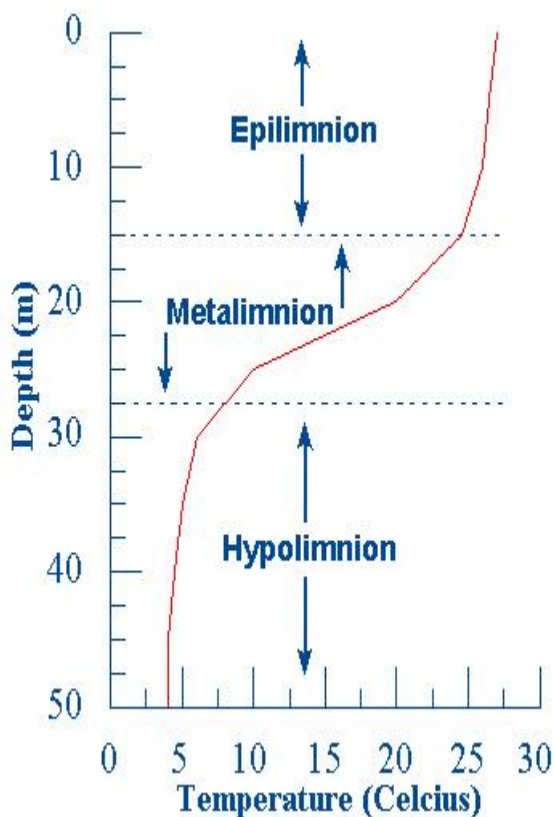
METALIMNION

The middle layer characterized by a steep gradient in temperature and demarcated by the regions above (epilimnion) and below (hypolimnion). The metalimnion is the barrier that prevents mixing and heat exchange between the epilimnion and hypolimnion.

HYPOLIMNION

The deepest layer of uniformly cold water that does not mix with the upper layers and has low circulation. The colder water within the hypolimnion is at its maximum density at a temperature of 39.2° F (4° C).

Thermal stratification in summer in lakes



82 Lotic freshwater Ecosystem

Lotic freshwater Ecosystem

(Rivers, Streams, Springs)

- Perennial or seasonal Species adaptive to live in condition of constant flow Variation is determined by
- Shape of stream, riverbed
- Stream or river gradient

Lotic Systems (Running Water)



- Rivers, streams, creeks



Lotic freshwater Ecosystem

- d) Quantity of water
- e) Velocity of current (faster moving water has more dissolved oxygen, support diversity)
- f) Light

83 Zones of Lotic freshwater Ecosystem

Lotic freshwater Ecosystem

- g) Temperature (most species-pilakotherm, internal temp. varies with surrounding environment)

Two Zones

- i) Rapid Zone
- ii) Pool Zone

84 Wetlands

Wetland are between aquatic and terrestrial ecosystem they show an edge effect and form a ecotone. Ecotone is a transitional zone between two ecosystem .

Mangrove forests:

Examples of wet zone are swamps, marshes, and mangroves

85 Marine ecosystem distribution

Marine Ecosystem

Distribution : Marine ecosystem covers nearly 71 % of the earth's surface with an average depth of about 4000 m.

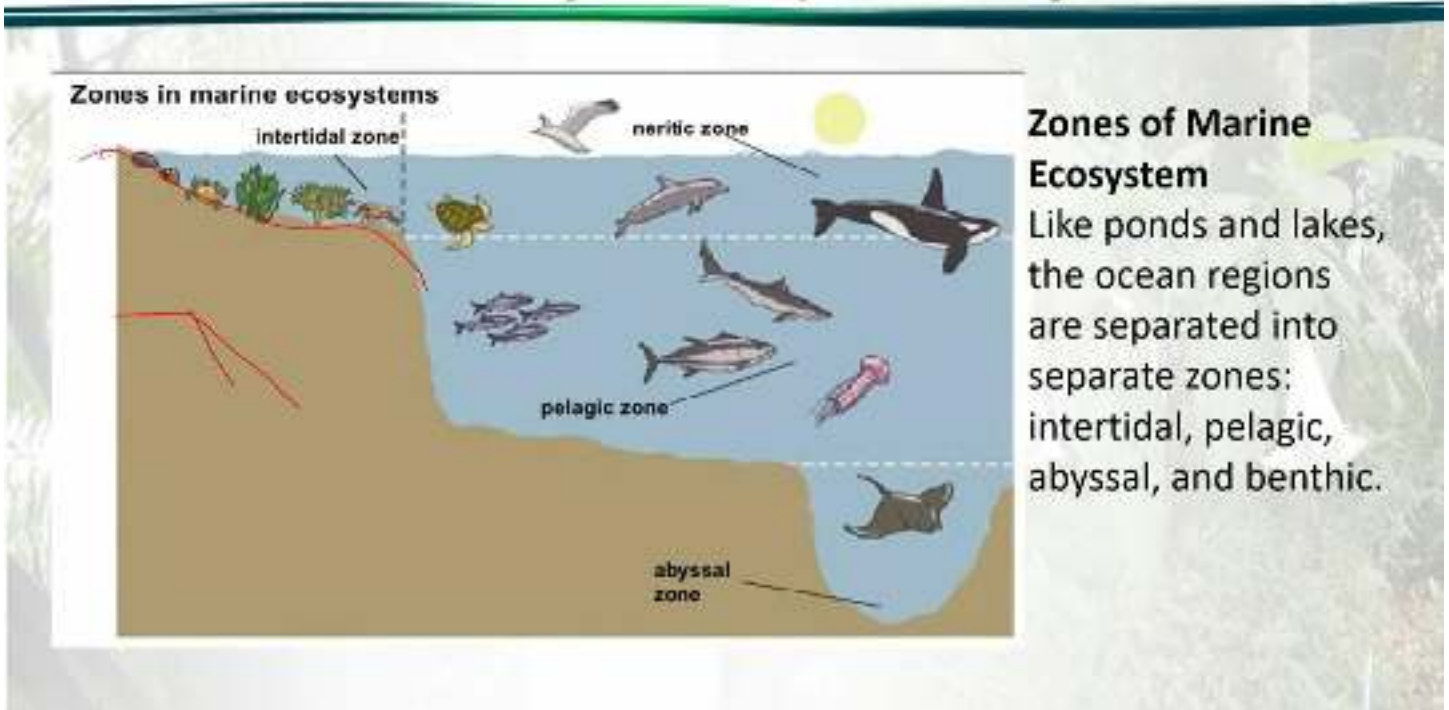
Fresh water rivers eventually empty into ocean.

Salinity of open sea is 3.6% is quite constant

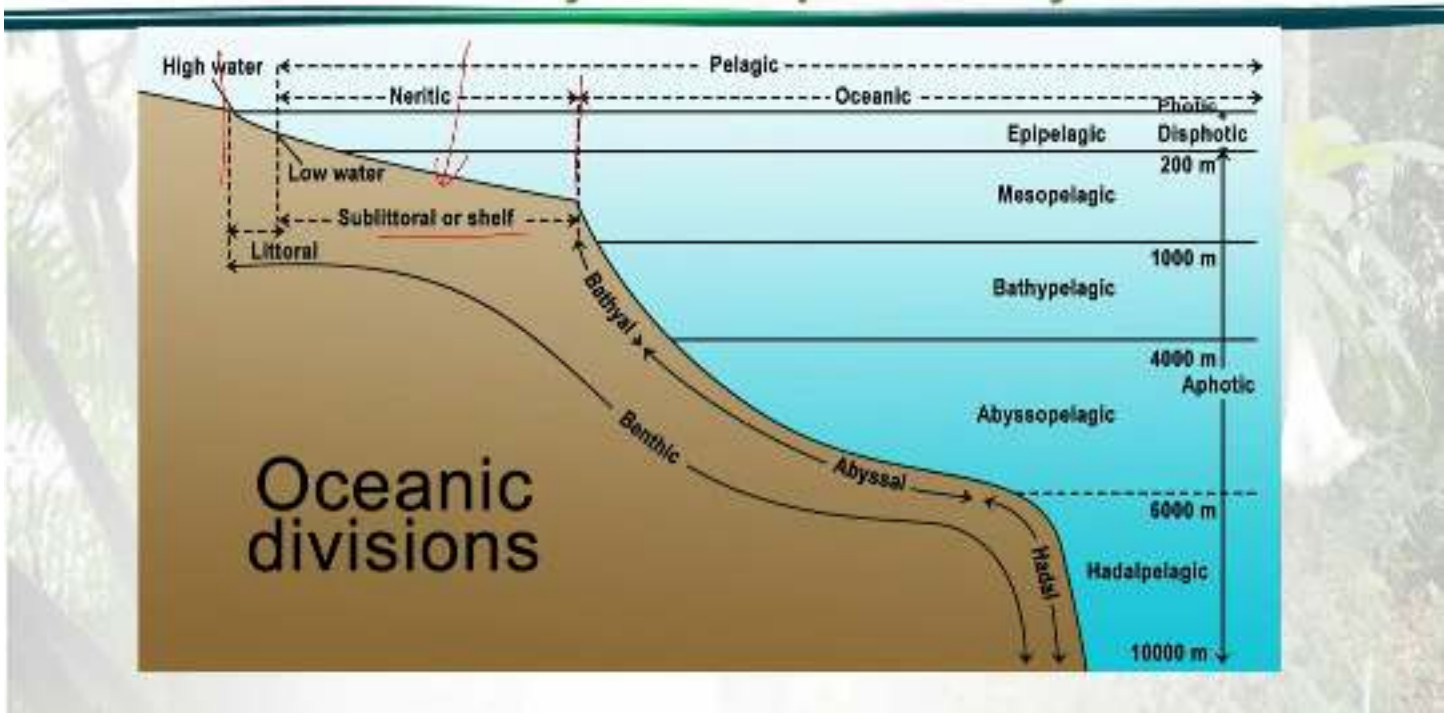
Marine Ecosystem

Distribution : Sodium and chlorine-86% of the sea salt and the rest is due other elements such as sulphur, magnesium, potassium and calcium

World's Ecosystems-Aquatic Ecosystem



World's Ecosystems-Aquatic Ecosystem



87 Pakistan's Geography

Geography of Pakistan:

24-38 north and 60-78 east longitude

Maximum length from north to south-1300 Km, east to West-500Km

Geography of Pakistan:

Four ecoregions.

1. Tropical ecoregion
2. Subtropical ecoregion
3. Temperate ecoregion
4. Alpine ecoregion



Coordinates:

Latitude:

24° N - 37 °N

Longitude:

61 °E - 75.5 ° E

Total Area:

796,096 sq km

Altitude:

Highest point:

K-2 (8611m)

Deepest point:

Dasu patan (6500m)

Lowest point:

Sea level 0 (feet)



88 Pakistan's Topography

Topography:

Study and description of surface features of land both natural and artificial.

Six major Topographic features:

1. Plains (Punjab and Sindh)
2. Mountains
3. Coastal areas
4. Deserts

5. Plateau (Baluchistan and Pothohar region)

- Subtropical arid Climate
- Four climatic zones

89 Pakistan's Geography Mountain ranges

Three distinct Mountain ranges:

1. Northern Mountains

- Karakoram Range
- Himalayas Range
- Greater Himalayas
- Lesser Himalayas
- Siwaliks

2. Northwestern Mountains

Hindukush Range

3. Western Mountains

- Safad Koh Range
- Sulaman Range-
- Waziristan Hills
- Koh Kirthar

Pakistan-3 large mountain ranges:

1. Northern Mountains:

I. Himalayas- 2400km long,

- Nanga Parbet (8126m high and world 8th highest peak)
- Mount Everest (8864m in Nepal)

II. Karakorum-Pakistan, India and China including Tibet Plateau- 500m long
-K-2 (8611m), Rakaposhi (7788m)

III. Siachen glacier- 72 km long

IV. World largest glacier outside polar regions.

2. Northwestern mountains:

I. Hindu-Kush- Pakistan and Afghanistan-966km long-

Highest peak-Turichmir in Chitral (7690m high)

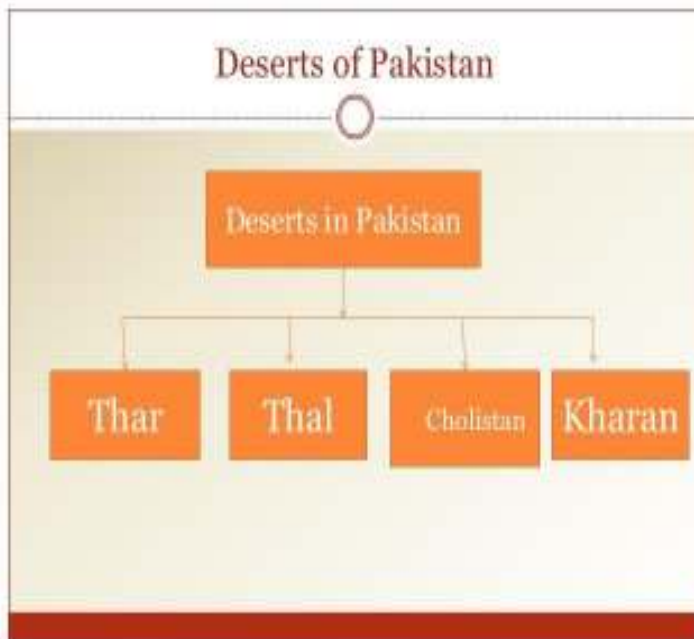
90 Pakistan's Geography Mountain ranges II



ii. Himalayas, Karakorum and Hindu Kush-united at Jaglot-40km away from Gilgit.

3. Western Mountains:

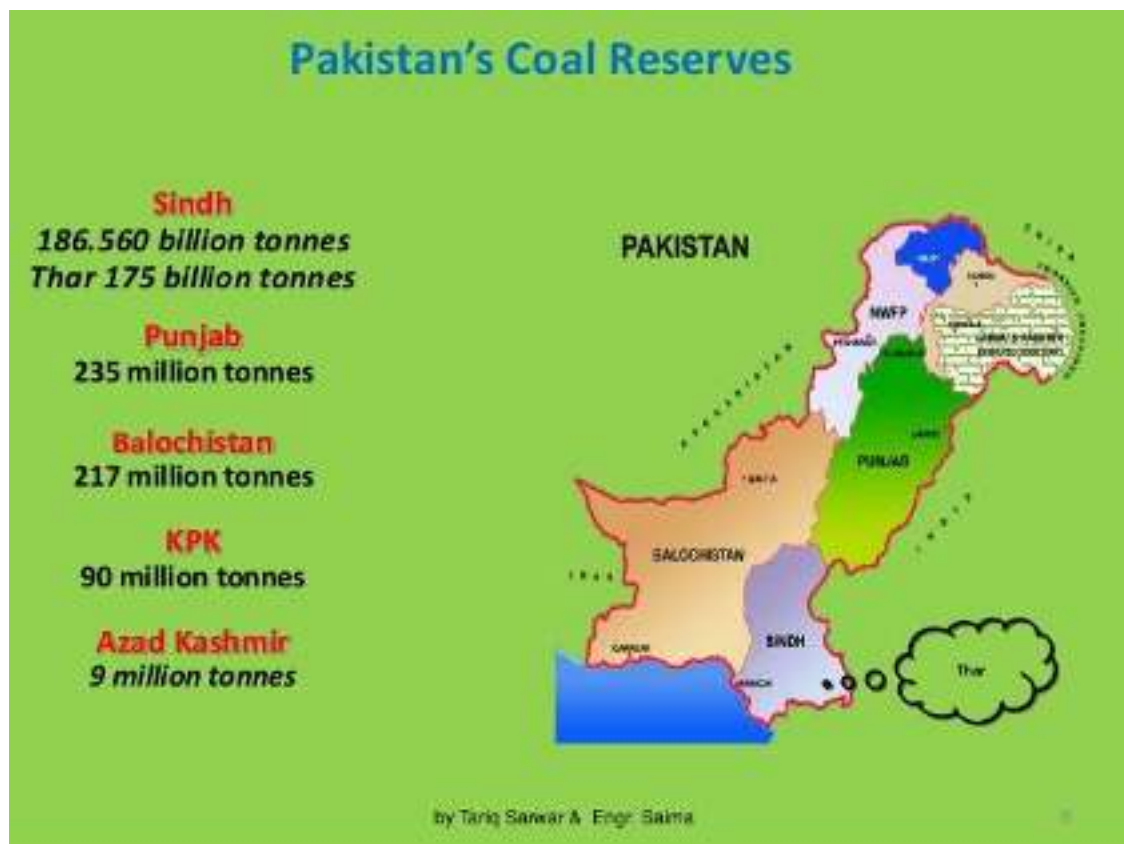
- i. Salt range-river Jhelum and Indus
- ii. Safad Koh Range
- iii. Sulaman Range- between Baluchistan and Afghanistan- Takhit Sulaman (3487m high)
- iv. Waziristan Hills
- v. Koh Kirthar-300km between Baluchistan to Arabian sea





92 Pakistan's Coal Reserves

- **Thar coalfield** is located in [Thar Desert](#), [Tharparkar District](#) of [Sindh](#)
- Discovered in 1991 by [Geological Survey of Pakistan](#) (GSP) and the [United States Agency for International Development](#)
- Seventh in the list of top 20 countries of the world after the discovery of huge [lignite](#) coal resources in Sindh
- Spread over more than 9,000 km²



93 Pakistan's Ecosystem

1. Permanent snow and cold desert:

Highest altitude-karakoram mountains, Hunza, northern chitral, highest Peaks, K-2, above 5000m, *Juniperus polycarpus*, Himalayan ibex, golden marmot, Snow leopard, snow pigeon, snow Partridge

94 Permanent snow and cold desert

1. Permanent Snow and Cold Desert:

1. Permanent snow and cold desert:

Highest altitude-karakoram mountains, Hunza, northern chitral, highest Peaks, K-2, above 5000m, *Juniperus polycarpus*, Himalayan ibex, golden marmot, Snow leopard, snow pigeon, snow Partridge

95 Alpine zone (Flora)

2. Alpine Zone (Flora):

- a) Location: Alpine meadows- north Hazara dist., Gilgit, Chitral, Swat and Kohistan
- b) Above coniferous forest tree line, 4000m

Flora:

The characteristic genera are *Salix*, *Lonicera* (Phut), *Berberis* (Sumbul, Sumblue), *Cotoneaster* with *Juniperus* and occasionally *Rhododendron* or *Ephedra* (Asmania). *Juniperus polycarpus*, *Poa* grasses

96 Alpine zone (Fauna)

2. Alpine Zone (Fauna):

- a) Alpine meadows- north Hazara dist., Gilgit, Chitral, Swat and Kohistan
- b) Above coniferous forest tree line, 4000m

Juniperus polycarpus, Himalayan ibex, Snow leopard, Brown bear, snow pigeon, snow Partridge, Monal Pheasant

97 Facts about Snow Leopard

Scientific name and origin:

Panthera uncia (previously: *Uncia uncia*)

The genus name, *Uncia*, is derived from the Old French word *once*, which was originally used for the European lynx. The snow leopard is still occasionally called ounce.

In its native lands, the snow leopard is known under many names, including as “wāwrīn prāng” (Pashto: واوړين پړانگ), “shan” (Ladakhi), “zigsa” (Tibetan), “irves” (Mongolian: ирвэс), “bars” or “barys” (Kazakh: барыс [‘barəs]), “ilbirs” (Kyrgyz: Илбирс), “barfānī chītā” (Hindi, Urdu: برفانی چیتا), palang-e barfi (Dari: پلنگ برفی) and “him tendua” (Sanskrit, Hindi: हिम तेन्दुआ).

Pakistan:

The snow leopard finds a home in the Hindu Kush and Karakoram mountains in Pakistan’s northern provinces of Khyber Pakhtunkhwa, Gilgit Baltistan, and Azad Kashmir.

Area of snow Leopard habitat:

- 80,000 km²

Snow leopard population:

- 200-420

Physical Features:

Height: 55-65 cm (22 – 26 inches)

Length: 90 – 115 cm (36 – 44 inches)

Tail: ca. 100 cm (40 inches)

- The snow leopard is perfectly adapted to the cold, barren landscape of their high-altitude

Physical Features:

- The snow leopard sports **excellent camouflage** thanks to its grey-white fur with its dark spots and rosettes.
- Its **extra long tail** helps the cat keep its balance and provides extra warmth when it's wrapped around the body.
- The snow leopard has **soft, dense fur** that grows extra-thick during the winter to keep the cat's body warm.
- Its extra-large paws keep the cat from sinking into the snow- like a pair of natural snowshoes.
- Its round, short ears **reduce heat loss**, and the wide, short nasal cavity warms the air before it reaches the cat's lungs.
- The cat has strong, short front limbs and longer hind limbs. They help launch the cat up to 30 feet (10 meters) in one leap!
- **Snow Leopard Facts:**
- The endangered snow leopard (*Panthera uncia*) is found in the rugged mountains of Central Asia.
- Despite a range of over 2 million km², scientist estimate that there may only be between **3,920** and **6,390** snow leopards left in the wild.

Snow Leopard Facts:

Threats to snow leopards:

- Habitat degradation and fragmentation
- Reduction of natural prey due to illegal hunting
- Retribution killing for livestock loss
- War and related military activities

98 Sub Alpine and Birch Forest (Flora)

Location:

Northeastern corner of Hazara district, Gilgit, Swat Kohistan. Narrow zone often to small ravines on upper slopes throughout higher mountain ranges of Himalayas.

Flora:

Evergreen conifers and mainly evergreen broad-leaved trees occurs throughout the Himalayas from about 3,350 m to the timber limit.

Abies spectabilis and *Betula utilis* (Birch, Bhuj) are the typical tree species *Rhododendron hypenanthemum* (Shurb), *Juniperus communis* (Dwarf junipers), *Poa* grasses with *Primula*

99 Sub Alpine and Birch Forest (Fauna)

Fauna:

Royle's high Mountain Vole, True's Vole, Chinese Birch mouse, Musk deer, Snow Leopard, Markhor Snow pigeon, Monal Pheasant, Western tragopan, Chukor (*Alectoris chukar*- National Bird of Pakistan), Himalayan griffon vultures, White winged snow finch.

100 Montane Temperate Forest

Pakistan's Ecosystem-

4. Montane Temperate Forest

- 4. The only real "tall tree" forest in Pakistan.

- a. Dry temperate Coniferous Forest
- b. Himalayan Moist Temperate Forest
- c. Sub-tropical Pine Forest

4. (a) Dry Temperate Coniferous Forest (Flora)

Upper reaches of Kaghan valley, Malam Jabba valley of Swat, Dir, Chilas and Naltar valley of Gilgit

- Open evergreen forest with open scrub undergrowth
- Coniferous and broad-leaved species present

a) Dry Temperate Coniferous Forest:

Upper reaches of Kaghan valley, Malam Jabba valley of Swat, Dir, Chilas and Naltar valley of Gilgit

Flora:

Cedrus deodara (National tree), *Pinus wallichiana* (Blue Pine), *Pinus gerardiana* (Chilgoza), *Indigofera gerardiana*, *Sorbaria tomentosa*, *Sambucus ebulus*

101 Dry temperate Coniferous Forest (Fauna)

Pakistan’s Ecosystem:

4. Montane Temperate Forest:

a) Dry temperate Coniferous Forest (Fauna)

Pakistan’s Ecosystem-Montane Temperate Forest

a) Dry temperate Coniferous Forest



Pakistan’s Ecosystem-Montane Temperate Forest

a) Dry temperate Coniferous Forest (Fauna)



Monal Pheasant, Western tragopan, Chukor (*Alectoris chukar*- National Bird of Pakistan), Himalayan griffon vultures, Breaded vulture, Golden eagle, Twany eagle, Goldren oriole, Eurasian cuckoo, Common rosefinch

102 Himalayan Moist Temperate Forest

Pakistan’s Ecosystem:

4. Montane Temperate Forest (Flora):

b) Himalayan Moist Temperate Forest

b) Himalayan Moist Temperate Forest (Flora):

Typical of Galis, Shogran, Neelum valley, mixed deciduous and coniferous forest, high monsoon season

Flora: *Quercus dilatata*, *Acer caesium*, *Populus ciliate*, *Pinus wallichiana*

5. Himalayan Moist Temperate Forest

Fauna: Yellow Throated Marten, Small Kashmir Flying Squirrel, Long Tailed Field Mouse, Himalayan Black Bear, Leopard Cat, Grey Langur, Rhesus Macaque, Porcupine

5. Himalayan Moist Temperate Forest

Fauna: Yellow Throated Marten, Small Kashmir Flying Squirrel, Long Tailed Field Mouse, Himalayan Black Bear, Leopard Cat, Grey Langur, Rhesus Macaque, Porcupine

Himalayan griffon vultures, Koklass pheasant, steppe eagle, Twany eagle, spotted dove, Himalayan woodpecker, Black bulbul, Jungle crow, Indian blue robin

103 Sub-tropical Pine Forest

Pakistan’s Ecosystem:

4. Montane Temperate Forest (Flora):

c) Sub-tropical Pine Forest

c. Sub-tropical Pine Forest:

Confined to 3000ft-6500ft. Typified by Batrasi Pass, Buner in Swat, Gora gali and Tret.

Flora: *Pinus roxburghii* (*Chir pine*), *Quercus incana*, grasses

c. Sub-tropical Pine Forest:

Fauna: Grey Goral, Panther, Tibetan Hare, Yellow Throated Marten, Himalayan Palm Civet

104 Deciduous Forests

7. Four types of Deciduous Forests

- a) Tropical Deciduous Forest
- b) Steppic Forest in Northern Latitudes
- c) Steppic Forest in Intermediate Latitudes
- d) Steppic Forest in Southern Latitudes

7. Tropical Deciduous Forest

Restricted to Jhelum valley, Rawalpindi foothills, Outer Margalla Hills, Kahuta, Lehtrar, early summer and spring hot & dry, 940mm rainfall/year

Flora: *Acacia modesta*, *Cassia fistula*, *Shorea robusta*, *Zizipus mauritiana*

Fauna: Nilgai, Wild Pig, Yellow Throated Marten, Common Leopard

105 Steppic Forest in Northern Latitudes

8. Steppic Forest in Northern Latitudes

Side valleys of Lower Chitral, parts of Gilgit, Kohistan and Dir

Flora: *Juniperus macropoda*, *Juniperus polycarpus*, *Pinus wallichiana*, *P. geradiana*

Fauna: Markhor (National Animal) *Capra felconeri*, Royle's Pika, Field Mouse, Migratory Hamster, Stone Marten, Forest Dormouse

106 Pakistan National Animal Markhor

- The markhor-national animal of Pakistan.
- Pakistan's national animal, "Markhor" symbol of bravery and sharp intelligence.
- Haven't any fear during prey and jump from the peak of the mountain to the base.
- It was one of the 72 animals featured on the WWF Conservation Coin Collection in 1976.
- Markhor is the National animal of Pakistan.
- Scientific name: *Capra felconeri felconeri*

Capra- Genus of wild goat:

Distinct five subspecies- based on horn shape

- *Capra falconeri falconeri*- Astor Markhor- (flare-horned markhor) confined to Gilgit
- *Capra falconeri cashmirensis*- Kashmir Markhor- chitral, swat and Azad Kashmir.
- *Capra falconeri megaceros*- Kabul Markhor- Malakand, swat Chitral
- *Capra falconeri jerdoni*- Suleman Markhor- mountain ranges of north and east of Quetta: October 29, 1988-PPO
- *Capra falconeri chiltanesis*- Chiltan Markhor- three hill ranges (Chiltan, Koh Murdar, Koh Maran) near Quetta.

107 Steppic Forest in Intermediate Latitudes

9. Steppic Forest in Intermediate Latitudes

Typified by Takht-i-Suleiman, Toba Kakkar range, Zhob, Part of Safed Koh, Malakand and Swat

Flora: *Juniperus macropoda*, *Fraxinus xanthoxyloides*, *P. geradiana*

Fauna: Markhor (National Animal) *Capra felconeri*, Collared Pika, Persian Jird, Migratory Hamster, Stone Marten, Forest Dormouse

108 Pakistan's Ecosystem: Arid Sub-Tropical Habitat

12. Less Pronounced

Monsoon influence:

Salt range, Kala Chitta Hills, eastern hills of Waziristan. Winter showers with frost regularly occurring and rather dry hot summers. Overgrazed area.

12. Less Pronounced

Monsoon influence:

Flora:

Acacia modesta (Phulai), *Olea cuspidate*, *Dodenea viscosa*, *Monothea buxifolia*

11. Monsoon influenced arid Sub-tropical

Fauna: Indian fox, Desert cat, Chinkara, Hyaena, Sindh wild goat, Sindh ibex, spiny mouse

11. Monsoon influenced arid Sub-tropical

Fauna: Indian robin, black myna, grey and see see partridge, Egyptian Vulture, Imperial and Tawny Eagle, Shikra, Booted Warbler,

11. Monsoon influenced arid Sub-tropical Fauna: Indian robin, black myna, grey and see see partridge, Egyptian Vulture, Imperial and Tawny Eagle, Shikra, Booted Warbler,

12. Less Pronounced Monsoon influence:

Fauna: Urial, Chinkara, Desert Fox, Porcupine, Desert Hare, Hegehog, Hyaena, Field Rats and Bat

109 Pakistan Geography: Urial

Distribution of **Urial**

Scientific name: *Ovis orientalis*

- The urial inhabits western central Asia from the northeast of Iran and the west of Kazakhstan to Baluchistan in Pakistan and the Ladakh regions in North India.
- It lives in steep grassy terrain below the tree line. It may also occur in agricultural fields and occasionally in partly wooded, mountainous areas.

Life style and habits

- Primarily diurnal, and forage for most of the day
- Do not maintain territories
- sheep are gregarious, forming herds of related individuals
- a herd is usually females, lambs, and juveniles
- Older rams form separate groups where the members are all male
- Herds maintain a social structure where dominance is based on an animal's body size

Life style and habits

- In ram herds, with dominance being based largely on horn size
- the bigger the horns, the higher up the ranking is the individual
- Dominant males are a stabilizing force for sheep society in that they prevent younger rams harassing females
- Dominant males are a stabilizing force for sheep society in that they prevent younger rams harassing females.

Facts about Urial

- The **urial** is the modern domestic sheep's ancestor, and is the oldest line of this species.
- Ewes and lambs recognize each other based on scent, olfactory communication thus playing an important part for this species
- Sheep can self-medicate when they are ill, by eating particular plants that can cure them
- sheep are both gregarious (preferring to be in a group) and precocial (highly independent from birth).
- The Chinese zodiac includes sheep among the 12 animals. They represent sincerity, righteousness, gentleness, and compassion.
- A sheep can show emotions, indicated by the position of its ears.

110 Arid Sub-Tropical Habitat

13. Baluchistan Desert Scrub Forests:

Usually associated with higher hills, stony plateaus. Very cold winters, no monsoon influence but occasional winter and spring showers.

13. Baluchistan Desert Scrub Forests:

Typified by Northern Kalat, lower parts of Suleiman hills, most of the Balochistan valleys, Kurram valley, most of Waziristan. Heavily overgrazed.

13. Baluchistan Desert Scrub Forests:

Fauna: Hill fox, Balochistan race of Black bear, Hyaena, Leopard, Marbled Pole Cat, caracal Cat, Urial, Goitred Gazella, Tibetan Hare, porcupine, Migratory Hamster, Bolachistan Gerbil

111 Pakistan’s Ecosystem: Tropical Thorn Forest

14. Indus Plains

Typified areas between Jhang and Shorkot Road, around Kasur on the border of India, in Sindh right bank of Indus around Kashmor

- 14. Indus Plains
- Flora: *Prosopis spicigera*, *Tamarix aphylla*, *Capparis decidua*, *Salvadora oleoides* and *Chenopodium album*
- 14. Indus Plains
- Fauna: Jungle cat,
- wild pig,
- Desert wolf, common grey Mangoose, long eared hedgehog, Yellow bellied Scotophil bat

112 Tropical Thorn Forest

15. Sand Dunes

Extensive areas of undulating sand dunes, absence of cultivation and extensive semi desert Thal desert, Thar and Cholistan desert, Nuski and Chagai sund dunes areas

- Flora:** *Calligonum polygonoides*, *Alhagi camelorum*, *Acacia jacquemontii*, *Prosopis spicigera*, *Pennisetum dichotomum*, *Capparis decidua*, *Taxmari articulata*
- Fauna:** Desert fox, Small Indian Civet, Desert Hare, Cheesman’s Gerbil, Hairy footed gerbil

113 Riverain Tract

16. Riverain Tract: The immediate vicinity of the Indus river and its tributaries up to the base of the foothills in the north

Fauna: Smooth coated Indian Otter, Hog deer, wild Pig, Jungle Cat, Desert Hare

114 Littoral or Inter tidal Zone

17.Littoral or Inter tidal Zone

Specifically Indus mouth and bays along Mekran Coast being characterized by Mangroves

Flora:

Avicennia officinalis,
Rhizophora conjugate,
Ceriops tagal

Fauna: Smooth coated Indian Otter, Hog deer, Fishing Cat, Plumbeous Dolphin and bandicoat rat

115 Importance of Mangrove Forests

Pakistan's Ecosystem-Littoral or Inter tidal Zone



Importance of Mangrove forests

Mangrove is a tropical tree that has roots which grow from its branches and that grows in swamps, low-oxygen soil, shallow or salty water.



ZOO502 TOPIC 11

Pakistan's Ecosystem-Littoral or Inter tidal Zone



Importance of Mangrove forests

1. Biodiversity
2. Water quality
3. Coastal defense
4. Support livelihood
5. Carbon storage



ZOO502 TOPIC 11

Pakistan's Ecosystem-Littoral or Inter tidal Zone



Rehabilitation of mangrove forests

Nursery of *Avicennia officinalis*



Pakistan's Ecosystem-Littoral or Inter tidal Zone



Rehabilitation of mangrove forests of Pakistan in Littoral or Inter tidal Zone by Pak- Navy

Team Leader
Lt. Cdr Ajaz Mohsin
Staff Officer (Environment and Horticulture)
Coastal Command



Pakistan's Ecosystem-Littoral or Inter tidal Zone



Digging the soil and plantation of seedlings



116 Pollution and its types

Definition:

The presence in or introduction into the environment of a substance or thing that has harmful or poisonous effects

Or

the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound, or radioactivity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form.

What kinds of pollution are there?

Three major forms of environmental pollution

- Air pollution
- water pollution
- land pollution
- light pollution
- litter
- Noise pollution
- Plastic pollution
- Soil contamination

- Radioactive contamination
- Thermal pollution
- Visual pollution

117 Air Pollution.

Air Pollution

Definition: The release of harmful chemicals and particulates into the atmosphere

Causes

gaseous pollutants - carbon monoxide, sulfur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides

Origin of causes

Burning fossil fuels in industry and motor vehicles releases gases and chemicals into the air

Impact on humans

- Respiratory infections, heart disease, COPD, stroke and lung cancer
- Indoor air pollution and poor urban air quality-world's worst toxic pollution problems in the 2008
- Outdoor air pollution -causes 2.1 to 4.21 million deaths annually
- Death rate due to air pollution-7 million people worldwide each year

118 Effects of Air Pollution

Effects of Air Pollution

- Smog
- Acid rain
- Eutrophication
- Global warming

119 Smog

Definition:

Smog is a mixture of air pollutants, mainly nitrogen oxides and some organic compounds, which combine in presence of sunlight to form Ozone

- **Ozone-** (allotrope) of Oxygen
- layer of ozone - stratosphere, 20- 30 km from the earth's surface + absorbs harmful UV radiation
- The thickness of this layer varies over geography.
- Ozone + air pollutants + presence of sunlight + close to Earth's surface = harmful.
- It hangs like a haze over the cities especially industrialized ones.

Causes of Smog

- Coal emissions
- Vehicular emissions-sulphur dioxide, nitric oxides etc
- Industrial emissions-volatile organic compounds and nitric oxides
- Natural phenomenon- such as volcanic eruption-sulphur dioxide

Effects of Smog

- health problems-respiratory system. Asthma, Emphysema, Chronic Bronchitis, Chronic Obstructive Pulmonary Disease (COPD) and lung cancer

- eye irritation
- reduced natural immunity of the body -colds and lung infections

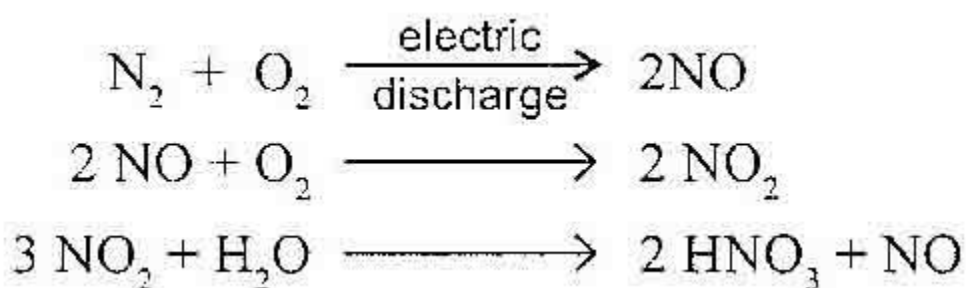
Effects of Smog

- Heart attacks
- Reduced life span because of premature aging of lungs.
- Alzheimer risk
- Low birth weight and birth defects of spinal column and brain in babies

120 Pollution-Acid Rain

Acid Rain

- Normal rainwater (pH- 5.3-6.0)
- $\text{CO}_2 + \text{H}_2\text{O} = \text{H}_2\text{CO}_3$ (carbonic acid)
- pH level of [rainwater](#) falls below this range, it becomes acid rain



Acid Rain Cause

1. Natural sources

- Volcanic emissions
- Wildfires
- Lighting
- Decaying vegetation

What causes Acid Rain? Natural Causes

Volcanoes



Lightening Bolts

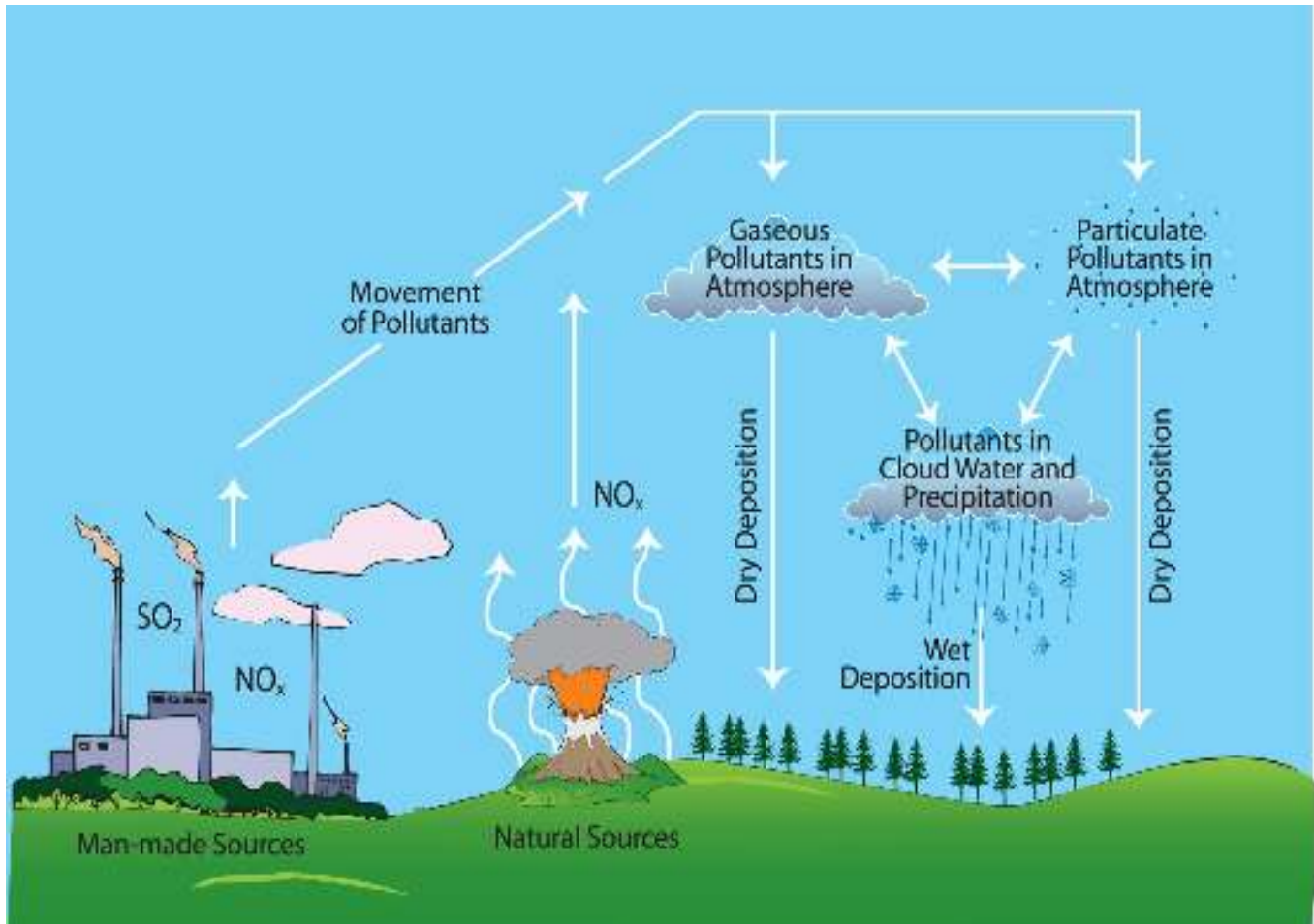


Forrest Fires

Acid Rain Cause

2. Man-made Sources

1. Factories
2. use of coal for electrical power generation
3. Automobiles



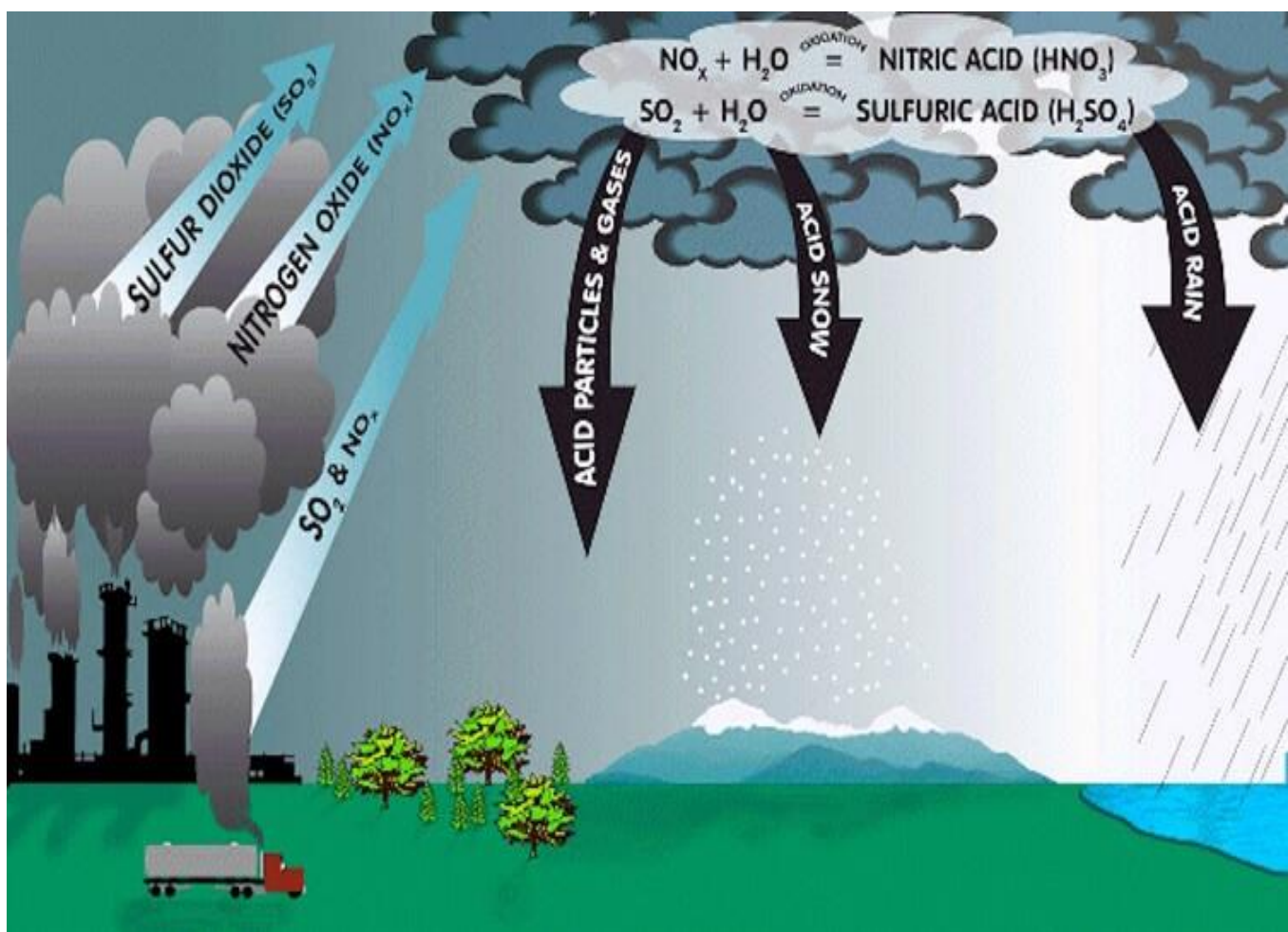
121 Pollution-Acid Rain Types

Acid Rain Types

- Wet acidic deposition
- Dry acidic deposition

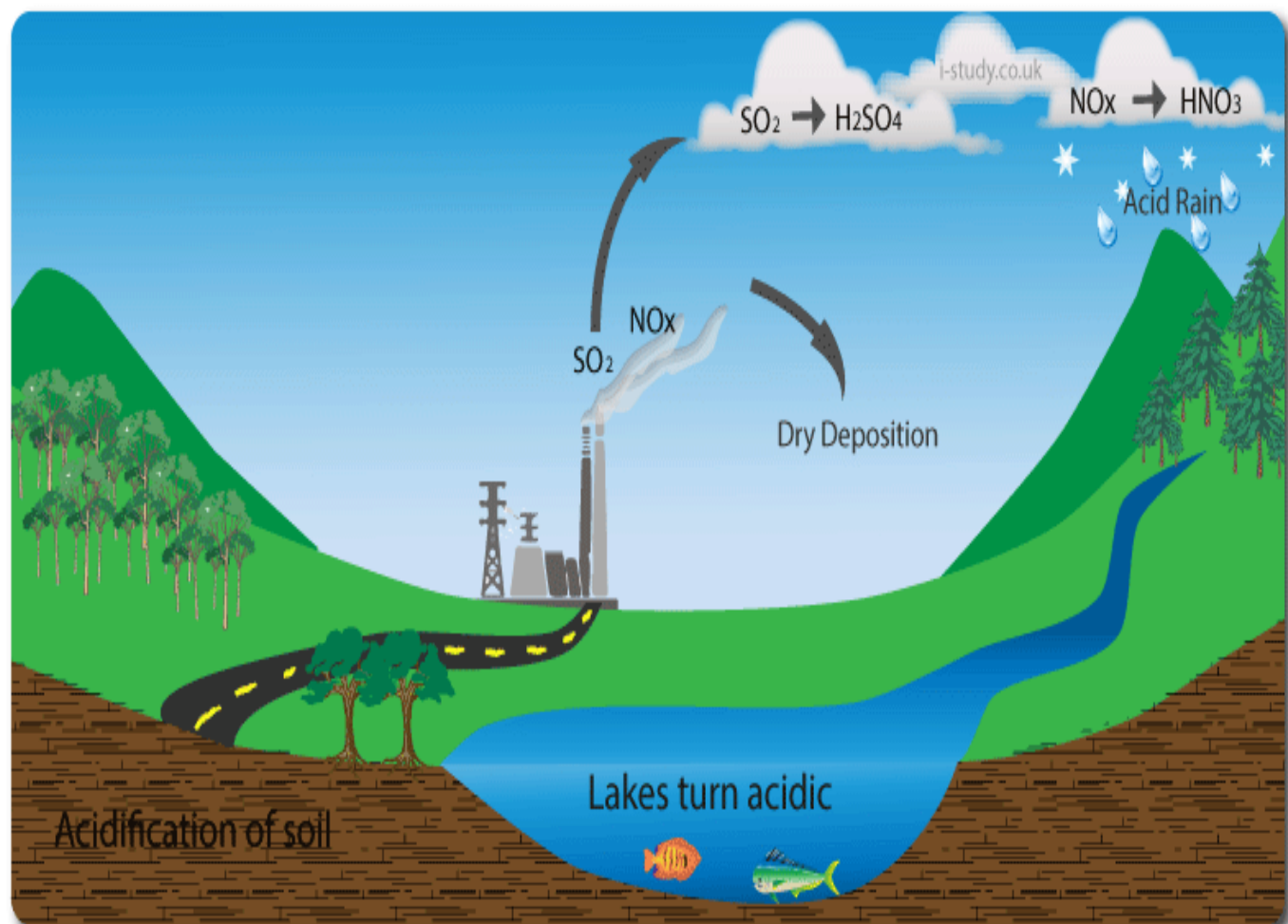
Wet Deposition

When the wind blows the acidic chemicals in the air move to the areas where the weather is wet, the acids fall to the ground in the form of rain, sleet, fog, snow or mist. It removes acid from the atmosphere and deposits them on the earth's surface

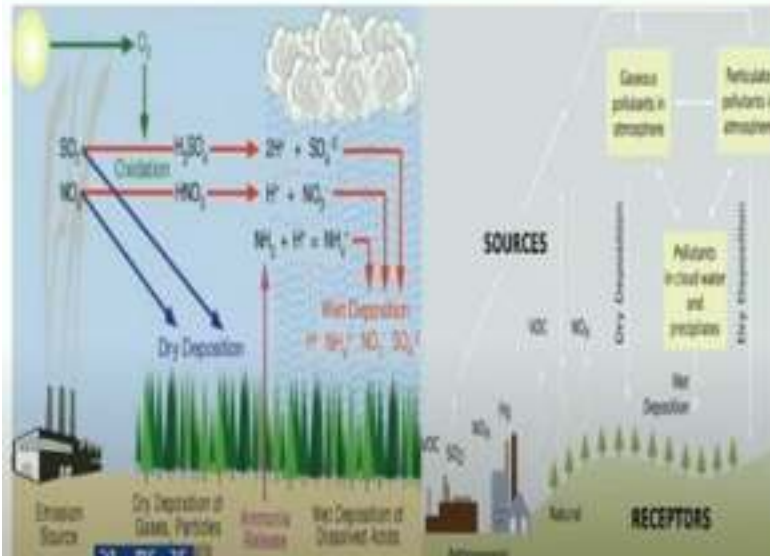


2. Dry Deposition

If the wind blows the acidic chemicals in the air to the areas where the weather is dry, the acidic pollutants slip into dust or smoke and fall to the ground as dry particles



Pollution-Effect of Acid Rain

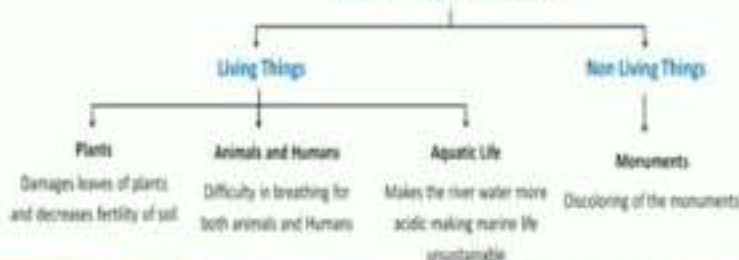


Effect of Acid Rain

1- Aquatic Life

- Aquatic plants and animals - particular pH level of about 4.8 to survive
- pH levels below 5, most fish eggs cannot hatch.
- Lower pH can also kill adult fish
- Reduced biodiversity in catchment area

Harmful effects of Acid Rain



2. Effect on Forests

- Damaging the bark and arresting the growth of trees
- Vulnerable to disease

3. Effect on Soil

- Impacts on soil chemistry and biology
- Change in pH
- Soil Microbes
- Denaturation of enzymes
- Leaching of vital minerals



4. Vegetation Cover and Plantations

- Dry depositions have endlessly damaged high altitude forests and vegetation cover
- Stunted growth
- Damaged Ecological harmony

5. Effect on Architecture and Buildings

- Buildings constructed with limestone
- Modern buildings, cars, airplanes, steel bridges and pipes

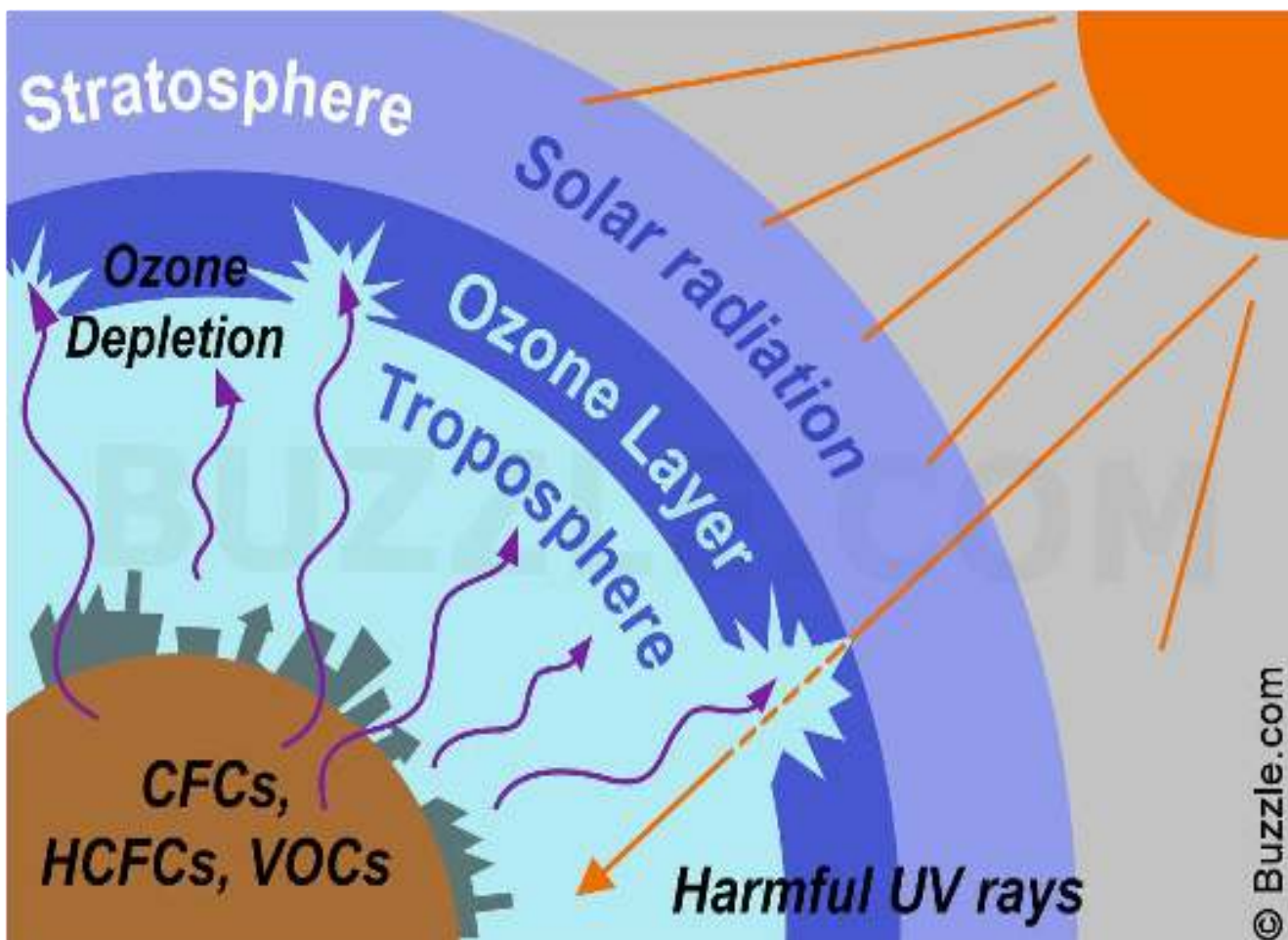
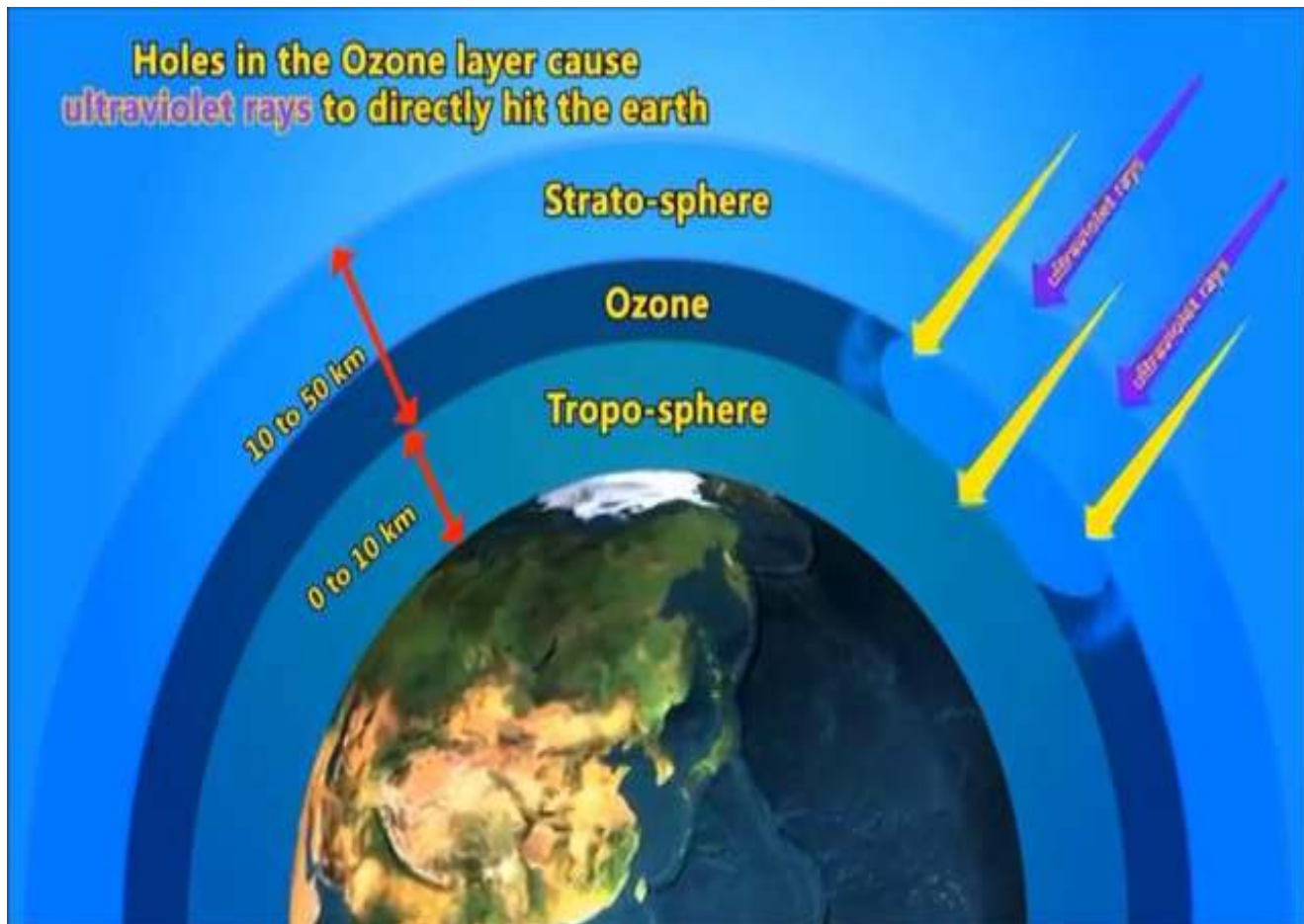
123 Ozone Depletion

1. Ozone- outer layer of atmosphere- 20-50km above the surface of earth- stratosphere
2. Consist of O_3
3. Ozone absorb UV light (99%)
 $\text{O}_3 \rightarrow \text{O}_2 + \text{O}$ (Splitting)

$\text{O}_2 \rightarrow 2\text{O}$

$\text{O}_2 + \text{O} \rightarrow \text{O}_3$

Ozone hole- thinning of Ozone layer over the Antarctica during Southern hemisphere spring



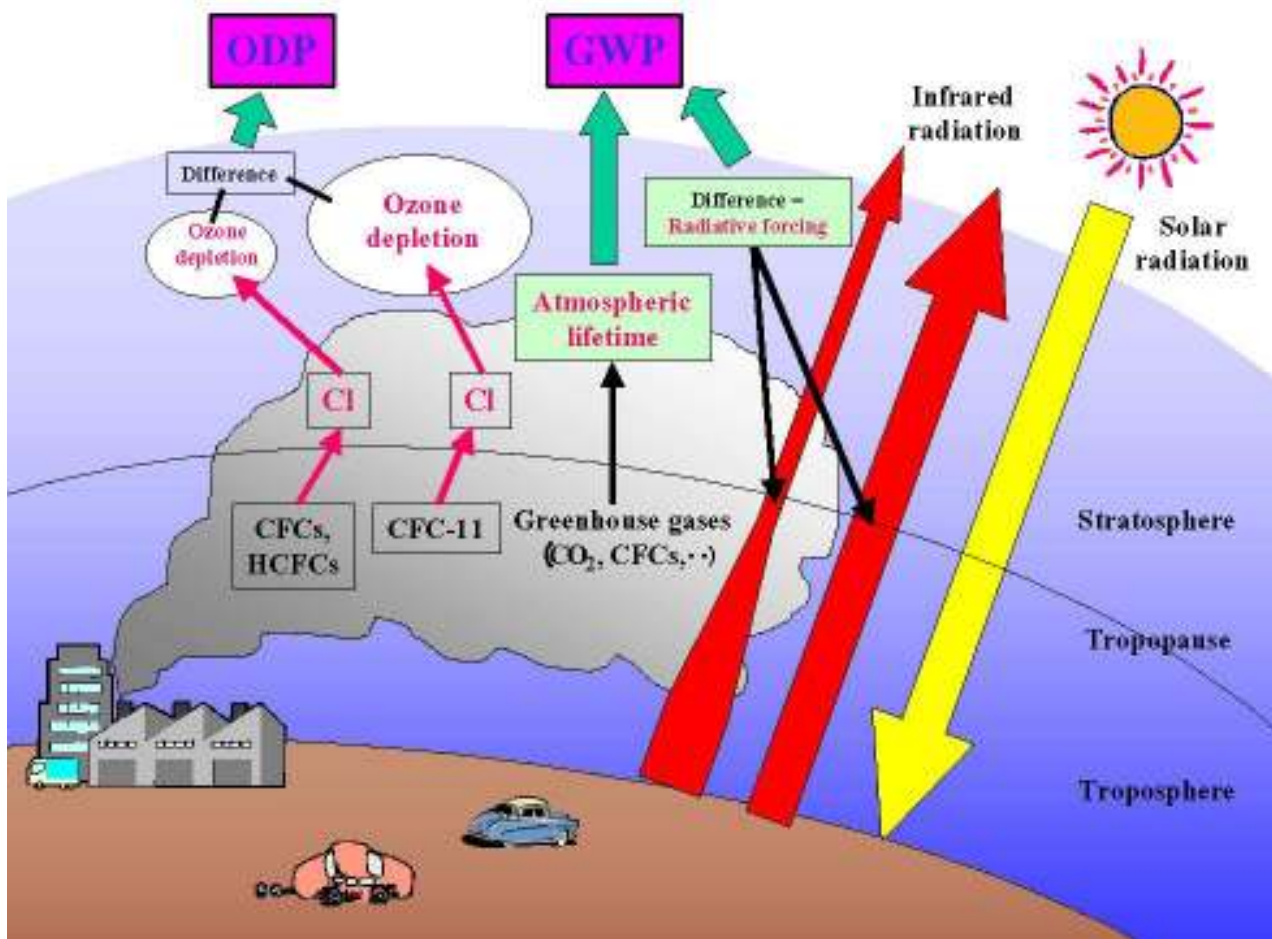
4. Chlorofluorocarbon

10-20 years to get into stratosphere can react with Ozone for up to 120 years

$\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2$

$\text{ClO} + \text{O} \rightarrow \text{Cl} + \text{O}_2$

Reduction in Chlorofluorocarbon production by 50 % by the year 2000-Montreal Protocol

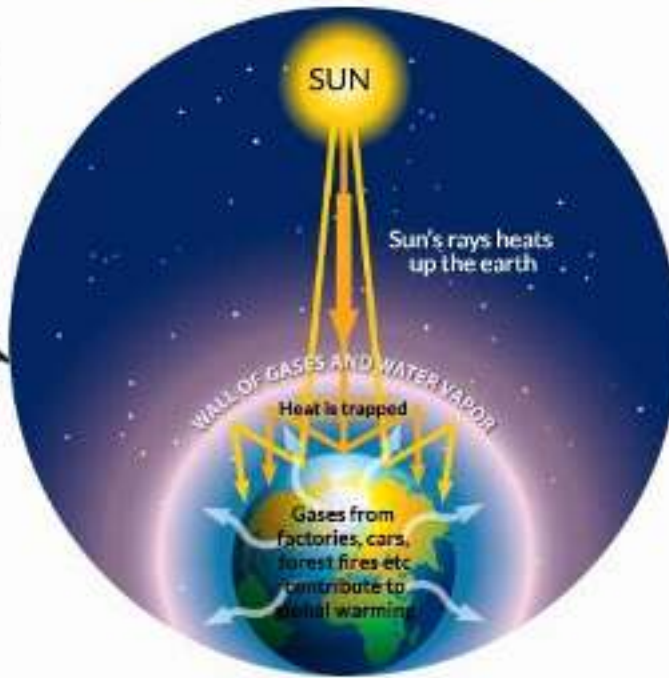
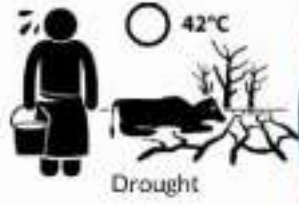
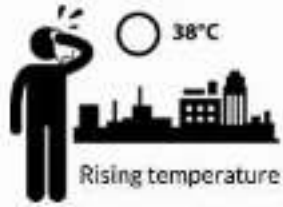


124 Green House Effect

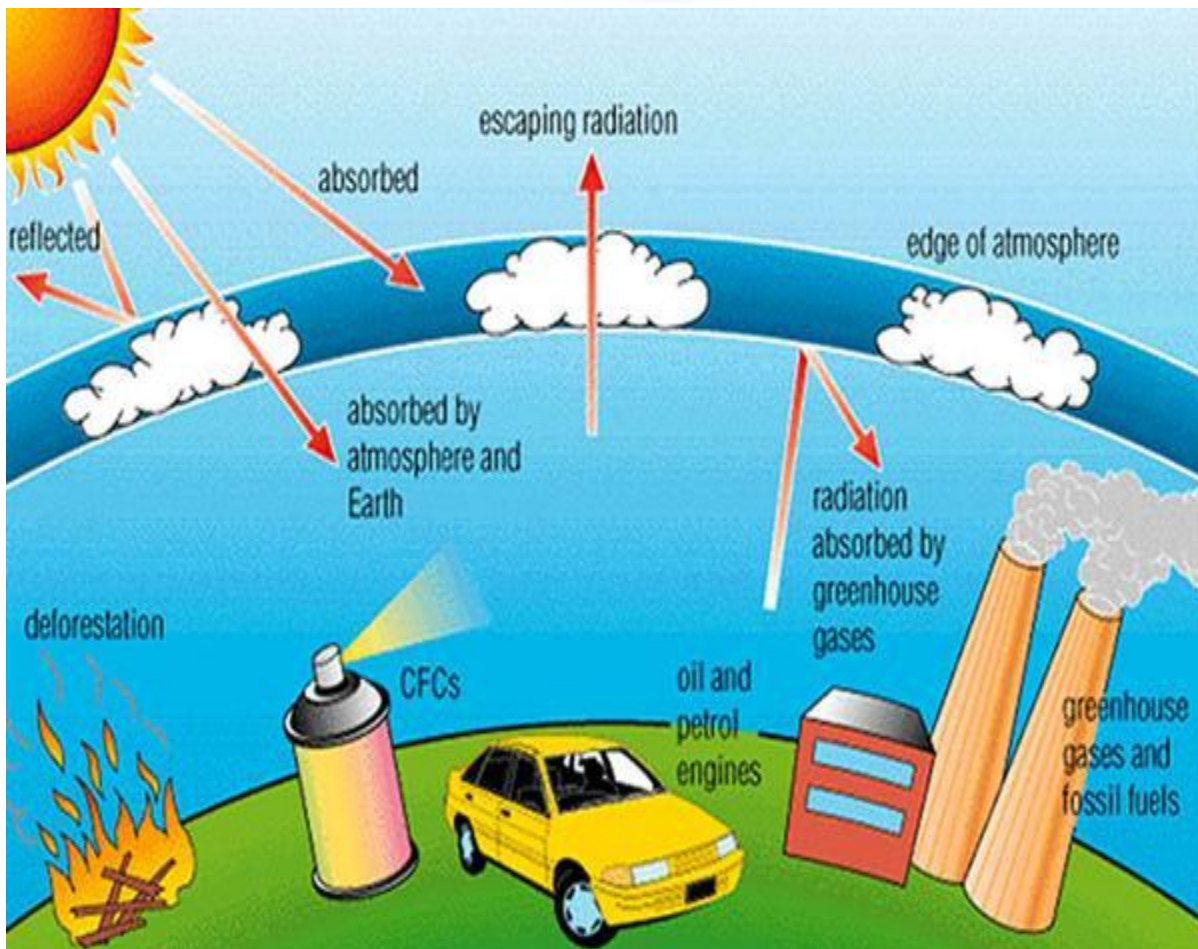
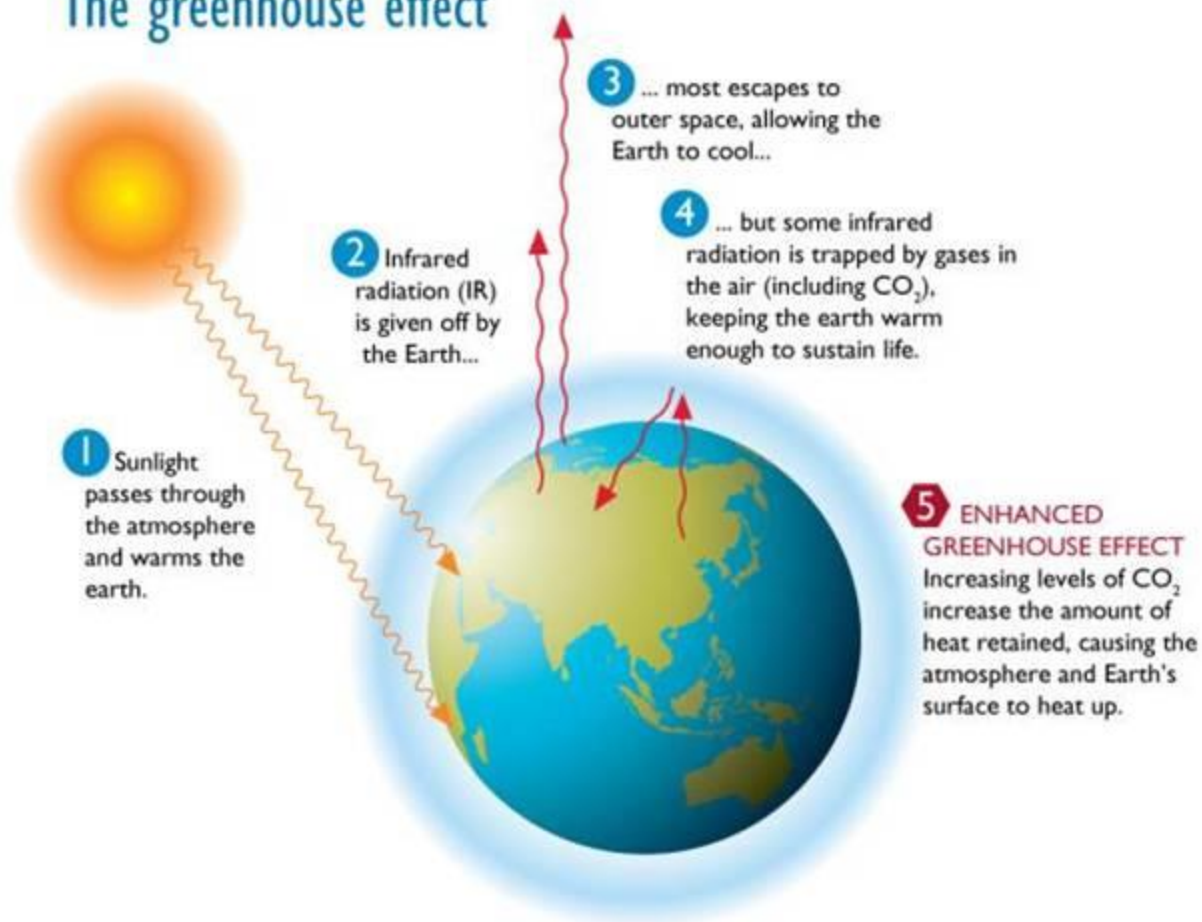
Light rays from sun penetrates- glass of green house – absorbed by the plant and soil-reradiate as longer wave infra red radiation (heat). Glass does not permit these rays to escape outside so heat remains within the green house

- Green house gases (CO₂) are those which prevent heat to escape out from them
- Temperature increases-greenhouse effect
- Global Warming
- Melting of ice and glaciers
- Floods

GREEN HOUSE EFFECT



The greenhouse effect



Earth long history. Earth early.

The past century, another force has started to influence Earth's climate: **humanity**

What is Global Warming?

Global warming is the unusually rapid increase in Earth's average surface temperature over the past century primarily due to the greenhouse gases released by people burning fossil fuels.

How Does Today's Warming Compare to Past Climate Change?

Earth has experienced climate change in the past without help from humanity. But the current climatic warming is occurring much more rapidly than past warming events.

Rise of Average temperature in Past 100 years= 0.3-0.6 degree celcius

Warmest years on record

1998

2002

2003

During the same period rise in sea level=4-10 inches

126 Effect of Water Pollution

Why Do Scientists Think Current Warming Isn't Natural?

In Earth's history before the Industrial Revolution, Earth's climate changed due to natural causes unrelated to human activity. These natural causes are still in play today, but their influence is too small or they occur too slowly to explain the rapid warming seen in recent decades.

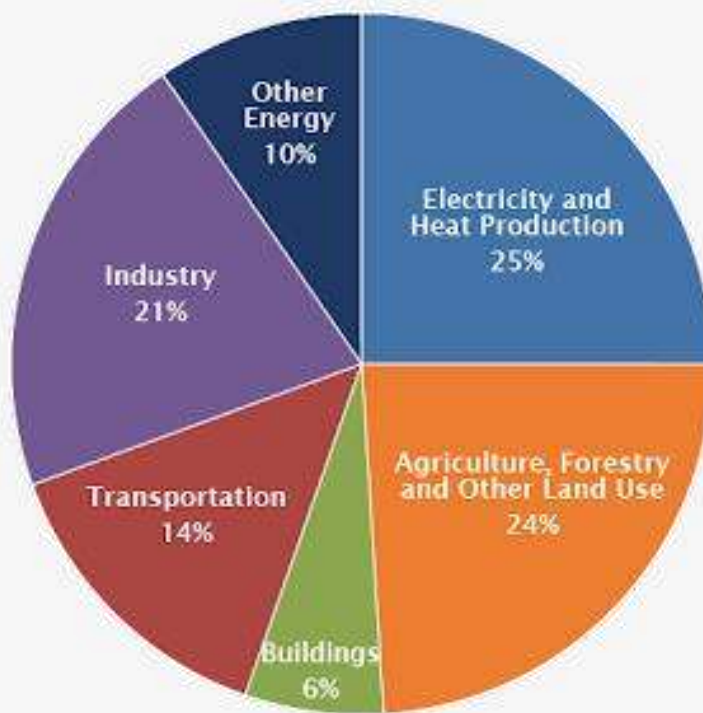
How Much More Will Earth Warm?

Based on plausible emission scenarios, average surface temperatures could rise between 2°C and 6°C by the end of the 21st century.

CO₂ -1100ppm-sea level rise 200cm/78.7 inches-depends on extent to which Greenland and Antarctic ice sheets melting

Causes of Global Warming

- Greenhouse gases increase through human activity
- Deforestation
- Use of fertilizers
- Burning of organic matter
- Burning of fossil fuels



CAUSES OF GLOBAL WARMING



**POLLUTION FROM COAL,
NATURAL GAS, AND OIL**



CO₂ FROM AIRPLANES & VEHICLES

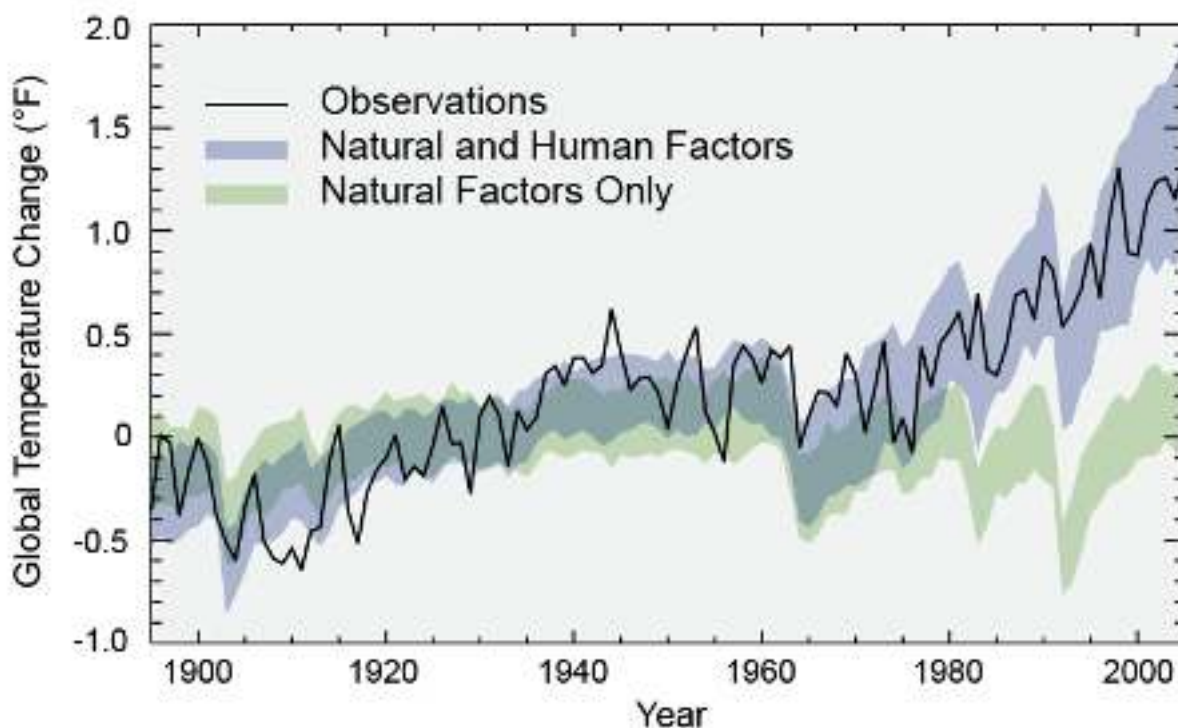


POPULATION INCREASE



DEFORESTATION

Separating Human and Natural Influences on Climate



127 Pollution- Climate Change

Climatic Change effect

- Disruption in hydrological cycle
- Navigation
- Hydropower
- Water supply and demand
- Flood
- Environmental quality and recreation
- Political issues

128 Pollution- Climate Change II

Climatic Change effect

Health effects

- Heart problems
- Respiratory issues
- Allergies
- Diseases spread
- Changing forest and natural areas
- Alteration in geographic distribution of vegetation type

129

Pollution- Climate Change III

Climatic Change effect

- **Changing forest and natural areas**
- Alteration in geographic distribution of vegetation type
- Shifting of North American species 500km towards north
- Coral reefs and wetland decline
- E.g wet lands of Minnesota, Noeth Dakota, South Dakota, Southern Manitoba, Alberta-half of waterfowl population- area diminish-loss of species
- **Challenges to Agriculture and Food supply**
- Increase in crop yield in one area but reduced in others
- Increase Irrigation demand
- Expansion of Pest range
- Increase use of Pesticide

130

Water Pollution.

Wastes substances—often chemicals or microorganisms—contaminate a stream, river, lake, ocean, aquifer, or other body of water, degrading water quality and rendering it toxic to humans or the environment.

Signs of Polluted Water

It has a very bad taste, very unpleasant odor, bad color and physical impurities floating on the surface like oil and grease

Sources Of Water Pollution

The key causatives of water pollution are:

- Urbanization.
- Deforestation.
- Industrial effluents.
- Social and Religious Practices.
- Use of Detergents and Fertilizers.
- Agricultural run-offs- Use of insecticides and pesticides.

131

Effect of Water Pollution.

Effects Of Water Pollution

- Urban Water bodies- extremely polluted.

- **Reason-** dumping garbage and toxic chemicals by industrial and commercial establishments.
- Water pollution drastically affects aquatic life.
- It affects their metabolism, behavior, causes illness and eventual death.
- Dioxin- a chemical that causes a lot of problems from reproduction to uncontrolled cell growth or cancer.

Effects Of Water Pollution

- **Bio accumulated** in fish, chicken and meat.
- Chemicals such as this travel up the food chain before entering the human body.
- Effect of water pollution-huge impact on the food chain. It disrupts the food-chain.
- Toxic Heavy metals (Cd & Pb) enter in food chain through animals (fish when consumed by animals, humans) can continue to disrupt at higher levels.
- Humans- diseases such as hepatitis through faecal matter in water sources.
- Poor drinking water treatment and unfit water can always cause an outbreak of [infectious diseases](#) such as cholera, etc.
- The ecosystem can be critically affected, modified and destructured because of water pollution.

132 Five types of water pollution

Five types of water pollution

1. Groundwater Pollution

Water present below the surface of the earth is known as groundwater.
More than **90% of freshwater** is groundwater

2. Surface Water Pollution

3. Lake Water Pollution

4. River Water Pollution

5. Sea water pollution

Effects on the Economy

The most devastating economic fallout from water pollution, according to the U.S. Environmental Protection Agency, occurs in four main areas:

133 Lake Water Pollution-

Five types of water pollution

3. Lake Water Pollution- Lakes are the rich source of water but due to following reasons, lake water gets polluted:

- i) Discharge of organic waste of homes and factories.
- ii) Discharge of organic matter of sewage treatment plants.
- iii) Dumping of garbage of villages and cities.
- iv) Inorganic pollutants of fertilizers and pesticides used in agriculture

134 Types of water pollution

Five types of water pollution

4. River Water Pollution- Purest water in the Past.

1. Anthropogenic activities
2. Chemical, fertilizers, runoff

5. Sea water pollution

- 1. 70% of Earth's surface is seawater
- 2. Salty nature so unfit for Humans
- 3. Discharge of excessive oil during the accident of oil carrying ship.

Five types of water pollution

- 4. Oil leakage from malfunctioned pipelines.
- 5. Discharge of oily waste from oil refineries present in the ocean.
- 6. Discharge of oily waste during tank washing

135 Point sources Pollution

Point sources Pollution

A point source is a single, identifiable source of pollution

e.g a pipe or a drain of Industrial wastes discharged to rivers and the sea

[Deepwater Horizon oil spill, Gulf of Mexico](#) — Releasing about 134 million gallons of oil in 2010- largest point source of oil pollution in United States history.

[Mosaic Acidic Water Release, Florida](#)- 2005 acidic water released during Hurricane Frances from Mosaic Fertilizer-

- 10 acres of seagrass beds
- 135 acres of wetland habitats
- 80 acres of mangroves

136 Non-Point Solution Pollution

Non-Point Solution Pollution

Runoff from urban and suburban areas is a major origin of non-point source pollution

Non-point sources

- i) Urban Land use- rainfall run-off as [stormwater](#)
- ii) Agriculture Land Use
- iii) Forestry Land Use

Non-Point Solution Pollution

Runoff from urban and suburban areas is a major origin of non-point source pollution

[Tijuana River, California](#) — The large amounts of trash and larger debris that wash downstream threaten and degrade the Tijuana River Valley's valuable ecological, cultural, recreational, and economic resources

[Shuyak Island, Alaska](#)-40,000 pounds of marine debris from Shuyak

- A remote island
- critical habitat for numerous species of birds, fish, and marine mammals

137 Management of Water Pollution

Management of Water Pollution

1. Point water Pollution

EPA (Environmental Protection Agency)

regulates high-risk point source waste discharges by

i) [works approval](#)

ii) [licensing system](#)

iii) associated [compliance and enforcement](#) activities.

2. Non-Point water Pollution

i) more difficult to control

ii) In urban areas the provision of reticulated sewerage systems and adequate street cleaning are important measures

iii) in farming and forestry areas, soil conservation practices and the controlled application of pesticides

iv) Control application of fertilizers are necessary if pollution of waterways is to be avoided.

138 Effects of Water pollution on the Economy

Effects on the Economy

According to the U.S. Environmental Protection Agency, four main areas:

1. Cost of treating drinking water
2. Losses to tourism (swimming, snorkeling, boating)
3. Damage to commercial fishing and shellfish harvests
4. Lower real estate values

139 Land Pollution

Definition

- It refers to the deterioration of the earth's land surfaces, at and below ground level.
- land pollutants are usually called **MSW** (Municipal Solid Waste).

It can be

- Can be rubbish, trash, garbage, factories waste, food waste, plastic, and other materials. Pesticides, fertilizers, metals, lead, and hydrocarbons
- Soil Pollution-degradation of land quality due to unwanted chemicals and other factors in the soil-
- Change in soil's chemical and biological properties, thus affecting [plant](#) growth.
- Green plants, being the primary producer, absorb those pollutants, which are then passed through the food chain, affecting the whole ecosystem.

140 Types of Land Pollution

1. Mining waste

Generated by 3 main ways

a) Mining operations- large rocks needs to be removed to get valuable ore. Waste material kleft at site

b) Milling operations- through various technologies

Waste material is called tailing

c) Failure of earthen dams

2. Agricultural Waste-

- 2nd most common form of waste
- Consist of waste from raising animals
- Harvesting and processing of crops and trees

- Animal manure 1240million metric ton/year
- Other associated agricultural waste (peeling, seeds, straw, stems, sludge etc)-1500 metric tons/year

141 Types of Land Pollution.

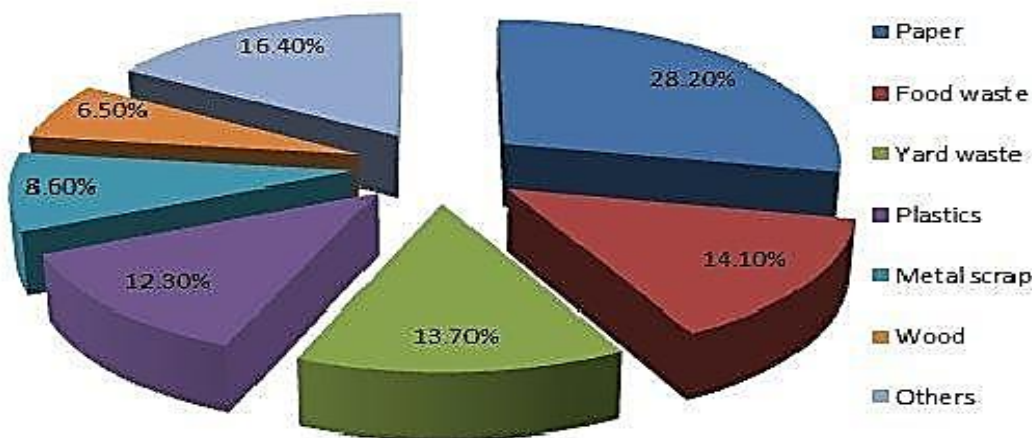
3. Industrial Waste

- Demand for food and shelter
- 200-600million metric tones/year
- e.g demolition material, foundry sand, scraps, sludge, ash from combustion

4. Municipal Solid Waste

- Litter and Garbage
- Household waste, broken items, etc
- Commercial establishments
- 240 million metric tones/year

Municipal Solid Waste



142 Effects of Land Pollution

Effects of Land Pollution

- Land pollution touches essentially every area of the living world, including:
- Water that isn't safe to drink
- Polluted soil, which leads to a loss of fertile land for agriculture
- Increasing the salinity of the soil, making it unfit for agriculture
- Causing respiratory problems, neuromuscular blockage, and various forms of cancer, especially lung cancer
- Causing nausea, headache, eye irritation, skin rash, and depression
- Increased air pollution, which burning waste contributes to
- Climate change, which causes an onslaught of disastrous problems, including flash floods and irregular rainfalls
- The endangerment and extinction of species in wildlife
- Habitat shifting, where some animals are forced to flee where they live in order to survive
- An increase in wildfires, due to polluted areas often becoming very dry

143 Preventive Measures for Land Pollution

Solutions to Land Pollution

- Use of organic matures instead of artificial fertilizers in agriculture
- Planting of trees (Afforestation)
- Treating solid wastes such as garbage, domestic refuse, and industrial materials before dumping them in landfills
- Recovering and recycling of materials such as plastics, cloth, and glass before dumping

144 Light Pollution

A worldwide cloud-free mosaic from the [Suomi NPP](#) satellite, showing the extent of visible lights in 2016. The effects of light pollution—especially [skyglow](#)—spread far beyond the light sources visible here.

Definition

- Light pollution is an unwanted consequence of outdoor lighting-also called **photo pollution**.
- It occurs due to excessive, misdirected, and inefficient lighting systems by humans.

Sources/Causes

- Increased energy consumption through over-illumination from artificial light sources such as street lighting, domestic lighting, and garage
- Poor planning by engineers while placing street lights and signage

145 Types of Light Pollution

Types of Light Pollution

1) [Sky glow](#), Sky glow is a brightening of the sky caused by both natural and human-made factors. The key factor of sky glow that contributes to light pollution is outdoor lighting.

2) [Light trespass](#), Light trespass is light being cast where it is not wanted or needed, such as light from a streetlight or a floodlight that illuminates a neighbor's bedroom at night making it difficult to sleep.

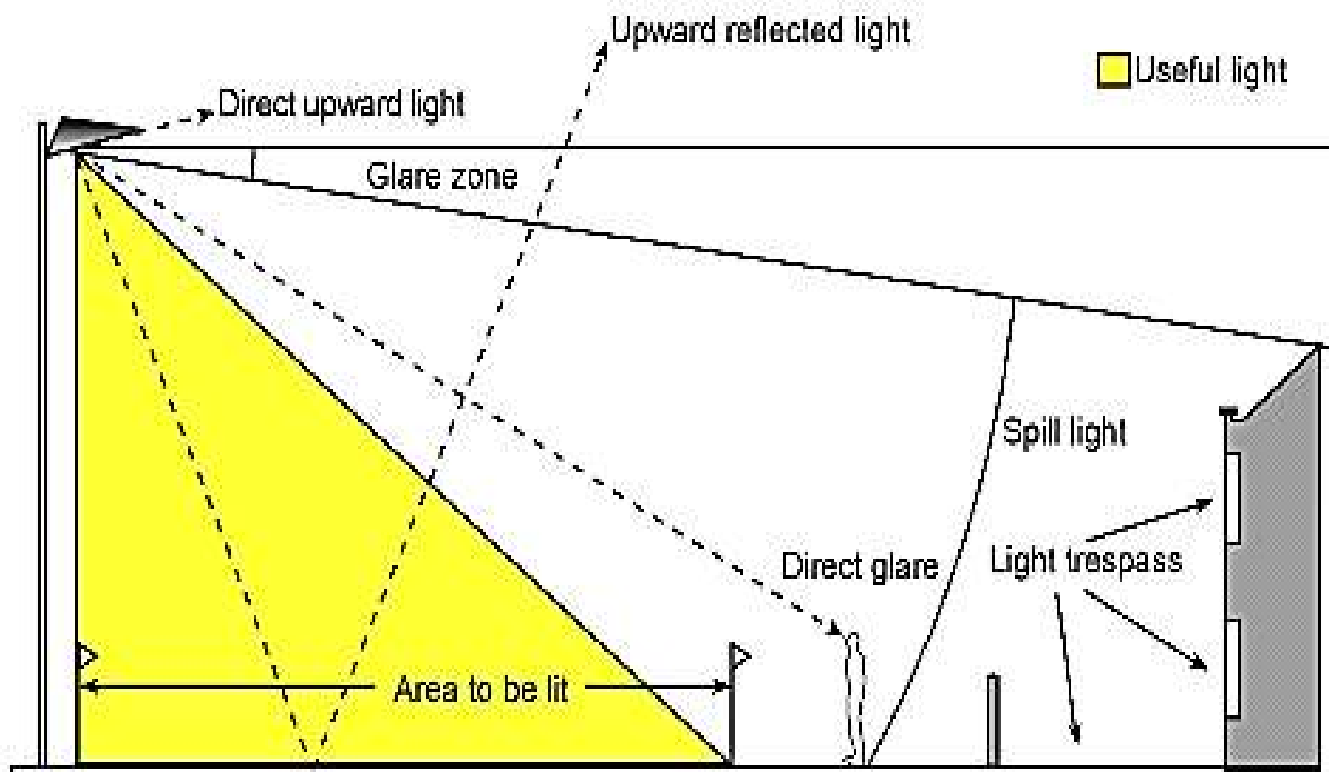
Types of Light Pollution

3) [Glare](#)-Glare can be thought of as objectionable brightness. It can be disabling or discomforting.

Blinding glare describes effects such as that caused by staring into the Sun. It is completely blinding and leaves temporary or permanent vision deficiencies.

Disability glare describes effects such as being blinded by oncoming car lights, or light scattering in fog or in the eye, reducing contrast, as well as reflections from print and other dark areas that render them bright, with a significant reduction in sight capabilities.

Discomfort glare does not typically cause a dangerous situation in itself, though it is annoying and irritating at best. It can potentially cause fatigue if experienced over extended periods.



Light pollution is often caused by the way light is emitted from lighting equipment. Choosing proper equipment and carefully mounting and aiming it can make a significant difference.

An office building is illuminated by [high-pressure sodium \(HPS\)](#) lamps shining upward. Much light goes into the sky and neighboring apartment blocks, causing light pollution

146 Types of Light Pollution.

4) From satellites

[Satellite flare](#)

Another source of light pollution are [artificial satellites](#). With future increase in numbers of [satellite constellations](#), like [OneWeb](#) and [Starlink](#), it is feared especially by the astronomical community, such as the [IAU](#) that light pollution will increase significantly, beside other problems of satellite overcrowding.

5) Light clutter refers to excessive groupings of lights. Groupings of lights may generate confusion, distract from obstacles (including those that they may be intended to illuminate), and potentially cause accidents. Clutter is particularly noticeable on roads where the street lights are badly designed, or where brightly lit advertisements surround the roadway

147 Global Impact of Light

Europe

- Inspection of the area surrounding Madrid reveals that the effects of light pollution caused by a single large conglomeration can be felt up to 100 km (62 mi) away from the center.
- The entire area consisting of southern England, Netherlands, Belgium, West Germany, and northern France have a sky brightness of at least two to four times normal.
- The only places in continental Europe where the sky can attain its natural darkness are in northern Scandinavia and in islands far from the continent

East Asia

- Light pollution in Hong Kong was declared the 'worst on the planet' in March 2013. (Victoria Harbor, Hong Kong)
- In June 2016, it was estimated that one third of the world's population could no longer see the Milky Way, including 80% of Americans and 60% of Europeans.
- Singapore was found to be the most light-polluted country in the world.

148 Consequences of Light Pollution

- 80% of the world's population, and 99% of Americans and Europeans, live under sky glow
- Nocturnal light interrupts sleep
- Confuses the circadian rhythm
- Disturb Biological Clock- affects physiological processes in nearly all living organisms.
- Production of the hormone melatonin at night
- Melatonin inhibited in light
- Sleep deprivation, fatigue, headaches, stress, anxiety, and other health problems
- Connection between reduced melatonin levels and cancer
- American Medical Association (AMA)
- Control of light pollution
- Blue light- mobiles, computer devices and LEDs
- Impacting on animal behaviors
- As migration patterns, wake-sleep habits, and habitat formation
- Sea turtles and birds- moonlight during migration get confused, lose their way, and often die
- Large numbers of insects-primary source of birds food- artificial light- die
- Blackbirds (*Turdus merula*) in Germany

Bring Back the Dark Sky

- U.S.-based International Dark Sky Association (IDA), formed in 1988 to preserve the natural night sky
- In 2017, the IDA approved the first U.S. dark sky reserve
- December of 2018, IDA lists thirteen dark sky reserves on their site.

149 Noise Pollution

Definition:

Noise is the unpleasant and undesirable sound which leads to discomfort in human beings.

- **The intensity of sound is measured in decibels (dB).**
- The faintest sound which can be heard by the Human ear is 1 Db

Sources of noise

- Natural sources
- Human-made sources

Natural Sources: volcanic eruption, the wild sea waves, a rush of rivers, thunder, roaring of animals, etc., They occur occasionally, but sometimes they are very damaging.

Man-made Sources: Man invented many machines for his convenience, which is now the primary cause of noise pollution

150 Types and Causes of Noise Pollution

Types of Noise Pollution

Following are the three types of pollution:

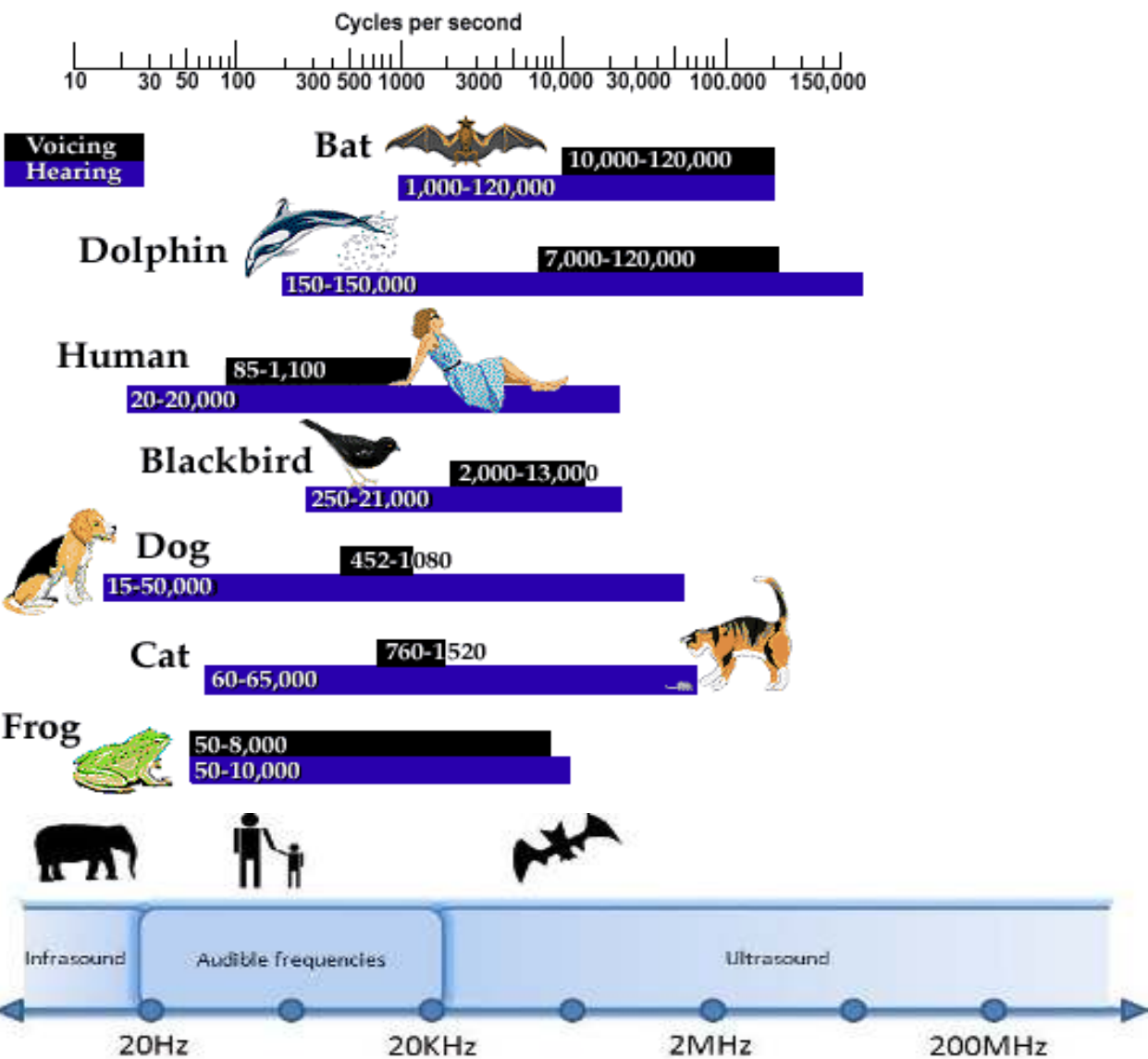
- Transport Noise-** consists of traffic noise with the increase in the number of vehicles. leads to deafening of older people, headache, hypertension.
- Neighborhood Noise-** household utensils, musical instruments, transistors, loudspeakers, etc.

iii) **Industrial Noise**-heavy industrial machines, industrial noise pollution damages the hearing ability to around 20%

Causes

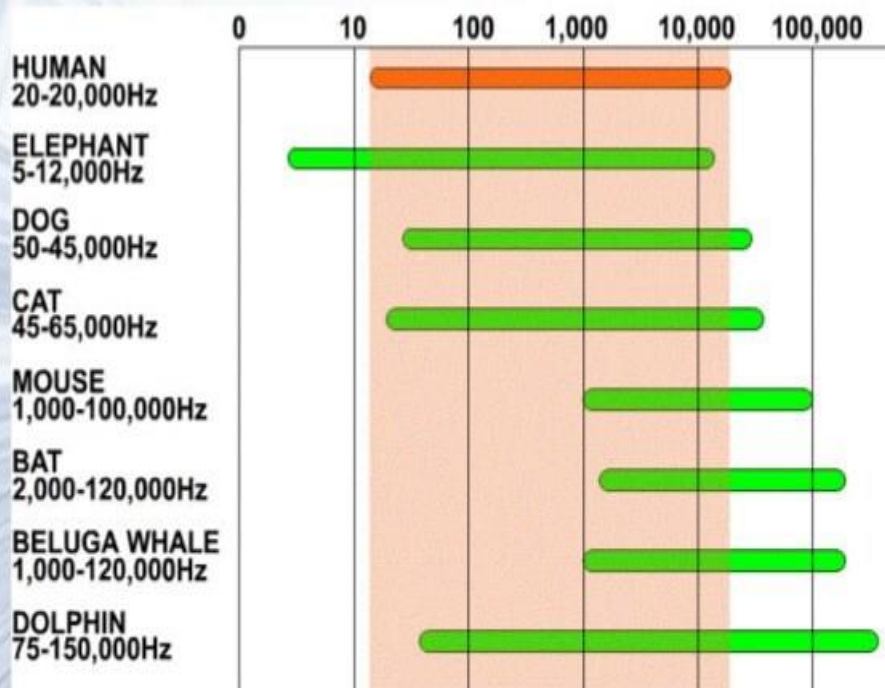
- Generators, mills, huge exhaust fans
- vehicles on the roads
- Weddings, fire works, public or Political or religious gatherings involve loudspeakers
- Mining, construction of buildings
- Noise from railway and aircraft

151 Hearing and Human Ear

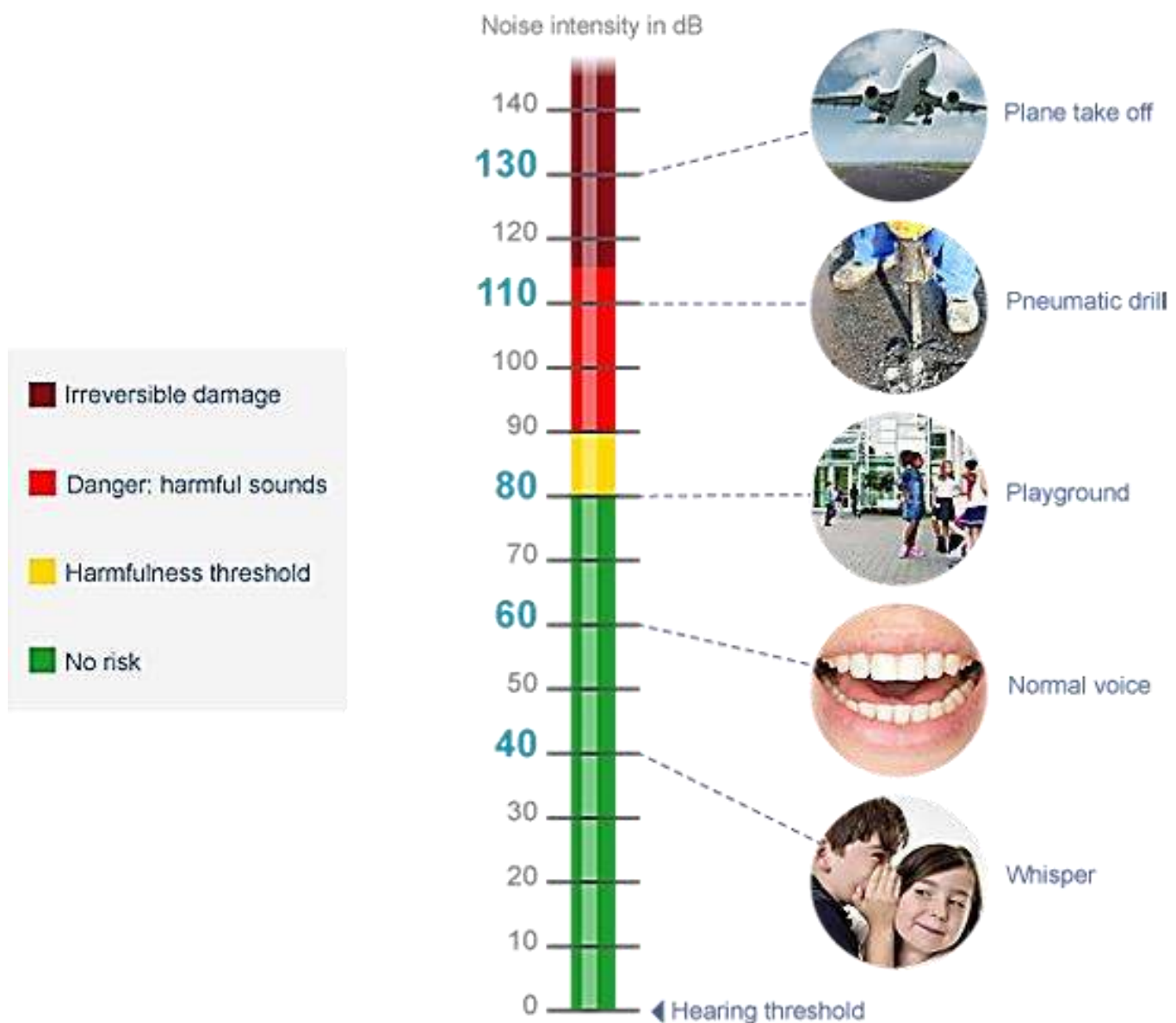


Limits of Human Hearing

Frequencies ABOVE what humans can hear are **ultrasonic** waves (20,000+ Hz).



Frequencies BELOW what humans can hear are **infrasonic** waves (0 to 20 Hz).





152 Effects of Noise Pollution on Human Health

Hypertension:

Direct result of noise pollution- caused due to elevated blood levels for a longer duration.

Hearing loss:

Constant exposure of human ears to loud noise that are beyond the range of sound that human ears can withstand damages the eardrums, resulting in loss of hearing.



Sleeping disorders:

Lack of sleep might result in fatigue and low energy level throughout the day affecting everyday activities. Noise pollution hampers the sleep cycles leading to irritation and an uncomfortable state of mind.

Cardiovascular issues:

Heart-related problems such as blood pressure level, stress and cardiovascular diseases might come up in a normal person and a person suffering from any of these diseases might feel a sudden shoot up in the level.

153 Radioactive Pollution

Definition

“Radioactivity is a phenomenon of spontaneous emission of protons (alpha particles), electrons (beta particles) and gamma rays (short wave electromagnetic waves) due to the disintegration of atomic nuclei of some elements. These cause **Radioactive Pollution**”

Radioactive element

Rubidium - 87. Uranium - 238. Thorium - 232.

Identified Thirty-nine radioactive

- Radioactivity was discovered by Antoine Becquerel in 1896 while experimenting with the fluorescence of uranium
- Ernest Rutherford discovered the existence of two types of nuclear radiation, which he called α and β . This experimental finding was published in 1899.
- Irene Joliet-Curie and Frederic Joliot, Nobel laureates (1934), were the first to create a radioactive isotope
- Bombarded $^{27}_{13}\text{Al}$ (aluminum) with α radiation, a helium atom (^4_2He), and generated a radioactive phosphorus atom ($^{30}_{15}\text{P}$).
- [Cobalt-60](#), a radioactive isotope used in the treatment of cancer, is a man-made radioactive element.
- **Radioactive contamination**
 - Also called radiological contamination, is the deposition of, or presence of radioactive substances on surfaces or within solids, liquids or gases (including the human body), where their presence is unintended or undesirable (from the International Atomic Energy Agency definition)
 - Living organisms are continuously exposed to a variety of radiations called background radiations.
 - If the level of radioactive radiation increases above a certain limit, it causes harmful effects to living beings. This harmful level of radiation emitted by radioactive elements is called **radioactive pollution**.
 - The effect of radiation on human health was first demonstrated and detected in the early \ (1900\) Century when the workers of certain Uranium miners were found to suffer from skin burns and cancer.

154 Types of Radiations

Types of Radiations

i) Non-ionizing Radiations

- They affect only those components which absorb them and have low penetrability.
- They include short-wave radiation such as **ultraviolet rays**, which forms a part of solar radiation.

Types of Radiations

i) Non-ionizing Radiations

- They damage eyes which may be caused by reflections from coastal sand, snow (snow blindness), directly looking towards the sun during an eclipse.
- They cause injury to the cells of skin and blood capillaries producing blisters.

Ionising Radiations

- They have high penetration power and cause the breakage of macromolecules. They are often lethal.
- They include **X-rays**, **Cosmic rays** and **Atomic Radiations** (radiations emitted by radioactive elements).
- The molecular damage may produce **short-range** (immediate) or **long-range** (delayed) effects.

155 Effects of Radiations

Short-range effects

- Burns
- Impaired metabolism
- Dead tissues
- Death of the organisms.
- Selectively deposit ^{90}Sr .

Long-range effects

- Mutations
- Increased incidence of tumors and cancer
- Shortening of life-span
- Developmental changes.
- Selectively deposit ^{90}Sr .

Long-range effects

- Selectively deposit ^{90}Sr .
- Some species of animals and plants preferentially accumulate specific radioactive materials. For example, oysters deposit ^{65}Zn , fish accumulate ^{55}Fe , marine animals

156 Types of Radiation Particles

Three types of major radiation particles

Alpha Particles- blocked by a piece of paper and human skin.

Helium nuclei $({}^4_2\text{He})$ least harmful to living objects.

Beta Particles- can penetrate through the skin, while can be blocked by some pieces of glass and metal. negatively charged.

Three types of major radiation particles

Gamma Rays- can penetrate easily to human skin and damage cells on their way through.

The most dangerous rays of any radioactive element which is lethal.

157 Effects of Radioactive Radiation on Living Beings

Type of Radiation	Effect on the Body
α particles	Generally, they cannot penetrate the skin. But if their source is inside the body, they can cause damage to bones or lungs.
β particles	It can penetrate the skin but cannot damage the tissues. They can cause damage to the skin and eyes (cataract).
γ radiation	It can easily penetrate the body and pass through it. They cause damage to cell structure, cancer.
X-rays	It can travel very far and pass through the body tissues except for bones. They can cause damage to the cells.

158 Sources/Causes of Radioactive Pollution

Two types of sources of Radioactive

- i) Natural Sources of Radiation
- ii) Anthropogenic Sources of Radiation
- i) **Natural Sources of Radiation**
 - Cosmic rays are high energy ionizing electromagnetic radiation and originate from the stars in our galaxy by virtue of nuclear reactions primarily in their cores.
 - The cosmic rays are constantly reaching the Earth from outer space.
- i) **Natural Sources of Radiation**
 - Naturally occurring radioisotopes such as Radon²²² found in soil in small quantities is another source of radioactive radiations.
 - Rock, soil, living cells may contain certain radioactive nuclei as their constituent, like Thorium potassium 40, radium 224, radon 222, thorium 232, uranium 235, uranium 2

159 Sources/Causes of Radioactive Pollution II

ii) Anthropogenic Sources of Radiation

1- Diagnostic Medical Applications: Radiations are employed for diagnostic and therapeutic applications. X-rays are used in general radiology and CT scan. Gamma rays are used in the treatment of cancer. In all these procedures, we are exposed to varying doses of radiation.

ii) Anthropogenic Sources of Radiation

2- Nuclear Tests: Nuclear explosion tests, especially when carried out in the atmosphere, are a major cause of radiation pollution.

ii) Anthropogenic Sources of Radiation

3- Nuclear Reactors: Radiations may leak from nuclear reactors and other nuclear facilities even when they are operating normally. It is often feared that even with the best design, proper handling and techniques, some radioactivity is routinely released into the air and water.

ii) Anthropogenic Sources of Radiation

4- Nuclear Explosions: Nuclear explosions are a serious source of radiation hazard. The effects of atomic explosions in Nagasaki and Hiroshima are still not forgotten.

ii) Anthropogenic Sources of Radiation

5- Nuclear Wastes: When the Uranium²³⁵ nucleus split in a nuclear reactor, they break into fission products which are also highly radioactive. Since one Uranium atom splits into two radioactive products, there is a doubling of the number of radioactive atoms on the Earth

ii) Anthropogenic Sources of Radiation

6- Nuclear Material Processing: Many radioactive minerals are processed to extract radioactive metals. Several compounds of radioactive elements are also produced and processed, for various uses. All those who handle these materials are at a greater risk of man-made radioactive pollution

160 Thermal Pollution

Definition

Thermal pollution is defined as a sudden increase or decrease in temperature of a natural body of water, which may be ocean, lake, river, or pond by human influence. This normally occurs when a plant or facility takes in water from a natural resource and puts it back with an altered temperature.

- Layman's terms -Thermal pollution is a real and persistent problem in our modern society.
- "Thermal enrichment" is the degradation of water quality from any process that changes the ambient temperature of the water body
- Sudden change in temperature will reduce oxygen supply and affect the composition of the ecosystem.

161 Sources/Causes of Thermal Pollution

1. Water As A Cooling Agent In Power, Manufacturing And Industrial Plants

- Production and Manufacturing .
- Draw water from a nearby source to keep the machines cool
- Then return it to the source at higher temperatures.
- Which rises the water temperature sharply.

2. Soil Erosion

Due to the ongoing soil erosion, the waters rise and are more exposed to sunlight. The high temperature could prove fatal to aquatic biomes as it can lead to anaerobic conditions.

3. Deforestation

Trees and plants prevent sunlight from falling directly onto lakes, ponds or rivers.

With deforestation, these bodies of water are exposed directly to sunlight, absorb more heat and increase temperature.

Deforestation is also the main cause of the higher concentrations of greenhouse gases, i.e. Global warming in the atmosphere.

162 Sources/Causes of Thermal Pollution ii

4. Runoff From Paved Surfaces

- Urban runoffs discharged into surface water from paved surfaces such as streets and parking lots can make the water warmer.
- During the summer season, the pavement gets quite hot, creating warm drains that enter sewers and bodies of water.

5. Natural Causes

- Volcanoes
- Geothermal springs
- Hot springs under the oceans and seas can trigger warm lava to raise the temperature of the waters.
- Lightning can also add a large amount of heat to the oceans.

5. Natural Causes

- This means that the overall temperature of the water source increases and has a significant impact on the environment.

6. Retention Ponds

Retention Ponds can be another source of thermal shock as the relatively small and shallow bodies of water can absorb some of the thermal energy from the sun.

7. Domestic Sewage

- Domestic wastewater- discharged into rivers, lakes, canals or streams without treating the waste.
- The usually higher temperature of municipal wastewater comparative to the receiving water.
- Temperature of the absorbing water increases, the dissolved oxygen (DO) decreases and the oxygen demand increases, which leads to anaerobic conditions.

163 Effects of Thermal Pollution

1. Decreased Dissolved Oxygen

- Warm water contains less oxygen than cold water.
- When oxygen levels drop, animals that cannot move to another area can begin to die.
- In deeper waters, injecting warm water can prevent oxygen from dispersing in deep water.
- This may be good for bacteria, but dangerous for aquatic animals.

2. Migration

- Fish and amphibians can move away from the warm water to a more suitable location and disrupt the ecosystem for remaining animals. Breaking of food chain
- Birds may also be forced to go in search of areas with more food.
- Plants and certain animals get stuck in the area, which can lead to enormous losses.

3. Increased Toxins

- Toxins in water- side effect of sanitation than a direct effect of thermal pollution.
- Chemical pollution is an almost inevitable side effect of using water for cooling. Solvents, heating oil, and dissolved heavy metals end up in the lake or river, where the cooling water is drained off.

164 -Effects of Thermal Pollution ii

Effects of Thermal Pollution

4. Loss Of Biodiversity

- The sudden warming can kill or drive off endangered organisms.
- This is one of many serious problems for threatened and endangered species

5. Ecological Impacts

- “Thermal shock” can kill insects, fish, and amphibians.
- This sudden loss of life creates further problems with the ecosystem. Important food sources are no longer sufficient.

6. Reproductive Effects

- Warmer water can affect the fertility of some organisms.
- Other species may experience birth defects or lay deformed eggs due to chemical changes in the body caused by warmer water.
- Defective eggs and birth defects affect the general fertility of the animal population and can reduce the population.

7. Increased Metabolic Rate

- Warmer water can be good for cold-blooded fish and amphibians, but only for a limited time.
- Warm water can cause is faster metabolism, which means animals need more food.
- The local ecosystem may not be able to support a significant increase in food consumption
- The warmer water gives certain organisms an advantage while it harms others.