Virtual University of Pakistan

Federal Government University

UPDATED 2021 TOPIC 1 TO 95

World-Class Education at Your Doorstep

MSC-ZOOLOGY

ZOO507-Principles-of-Animal-Ecology

HANDOUTS TOPIC NO 1 TO 95

MUHAMMAD IMRAN

Principles of animal Ecology

Lecture No. 1 Introduction

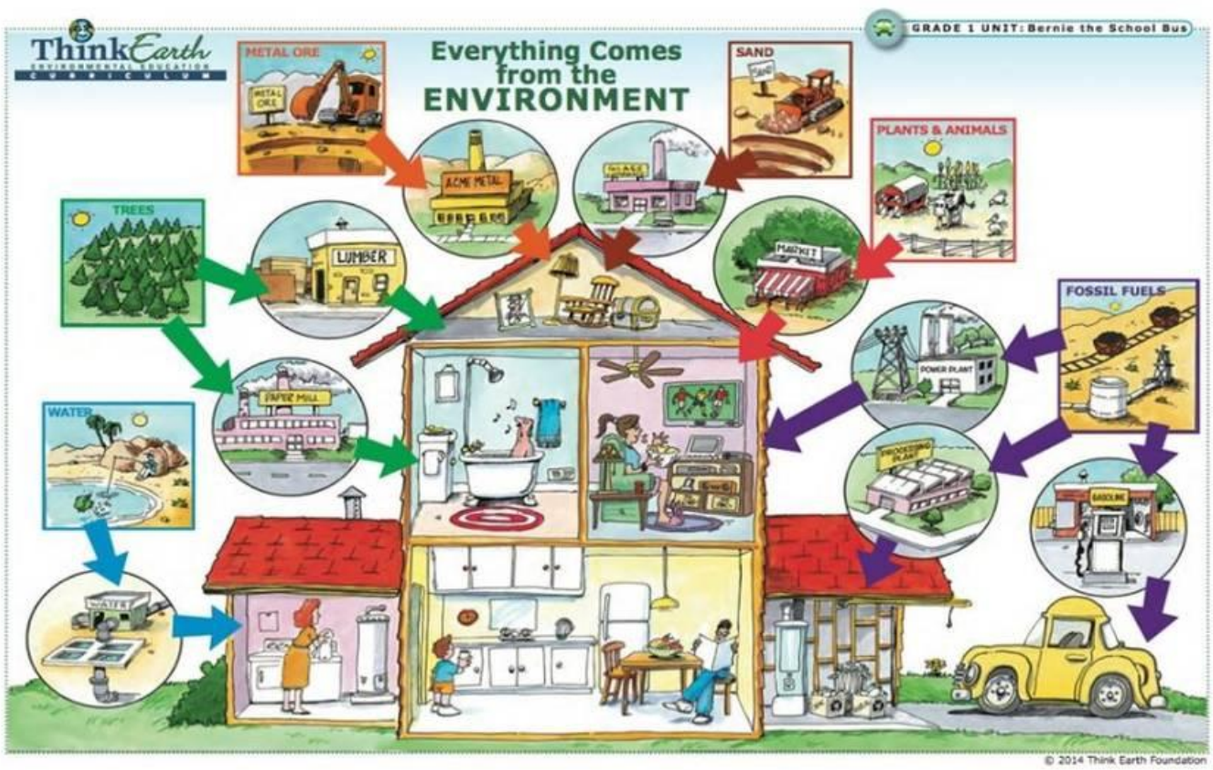
Agenda

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

Topic 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

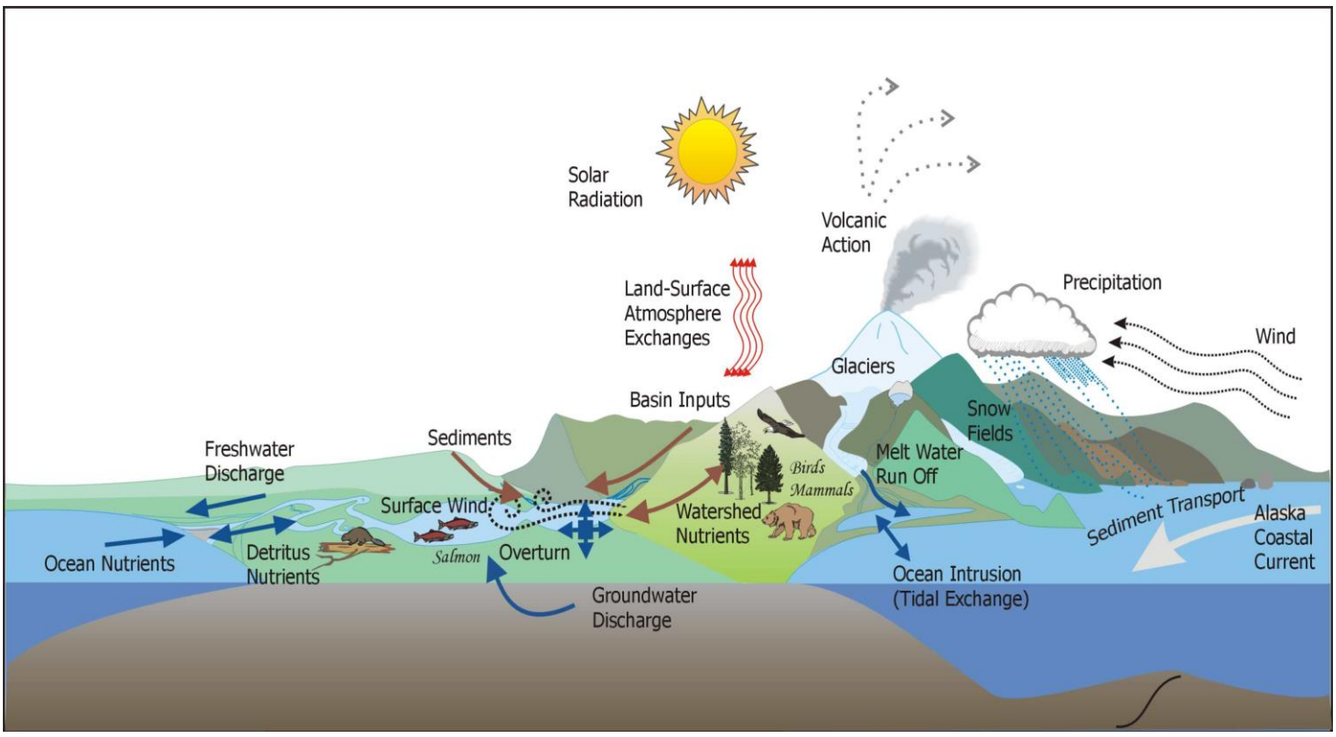
Topic 3 Ecology and Environment: Importance

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.



Topic 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,

Topic 5 Ecology and Environment: Relevance

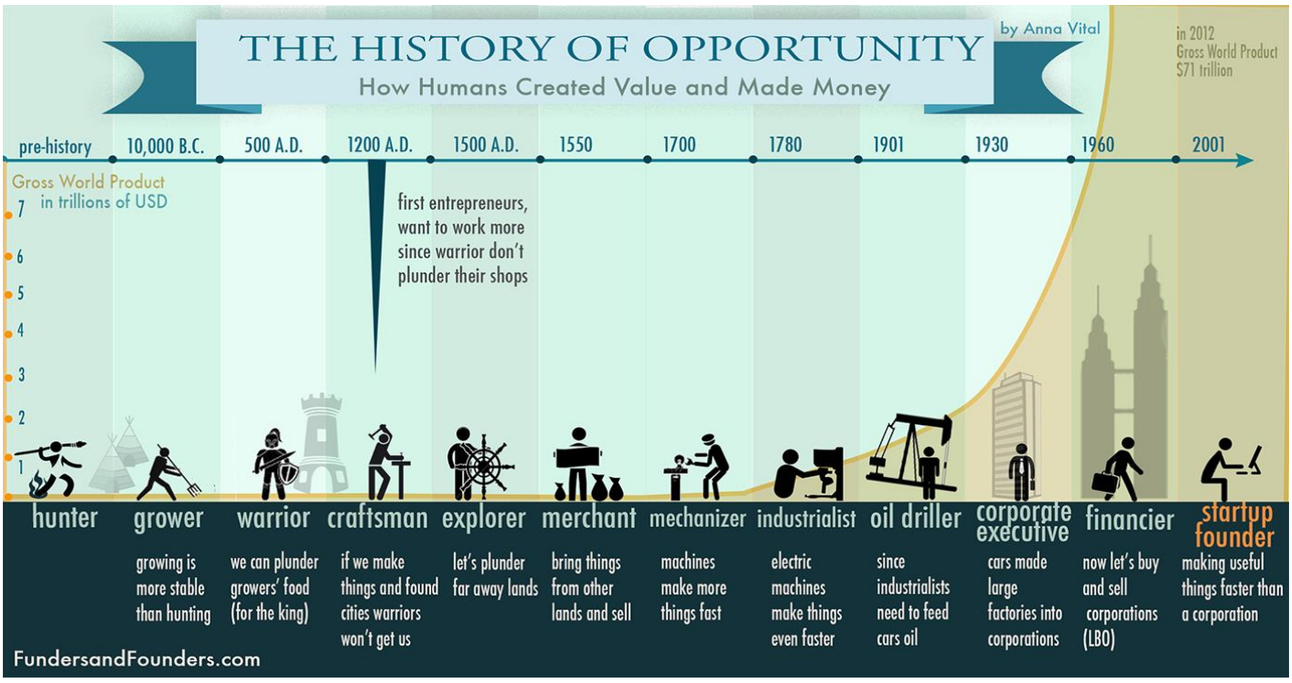
Relevance to man kind

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



Topic 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

Topic 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

Topic 8 Level of organization

Four levels of biological organization—

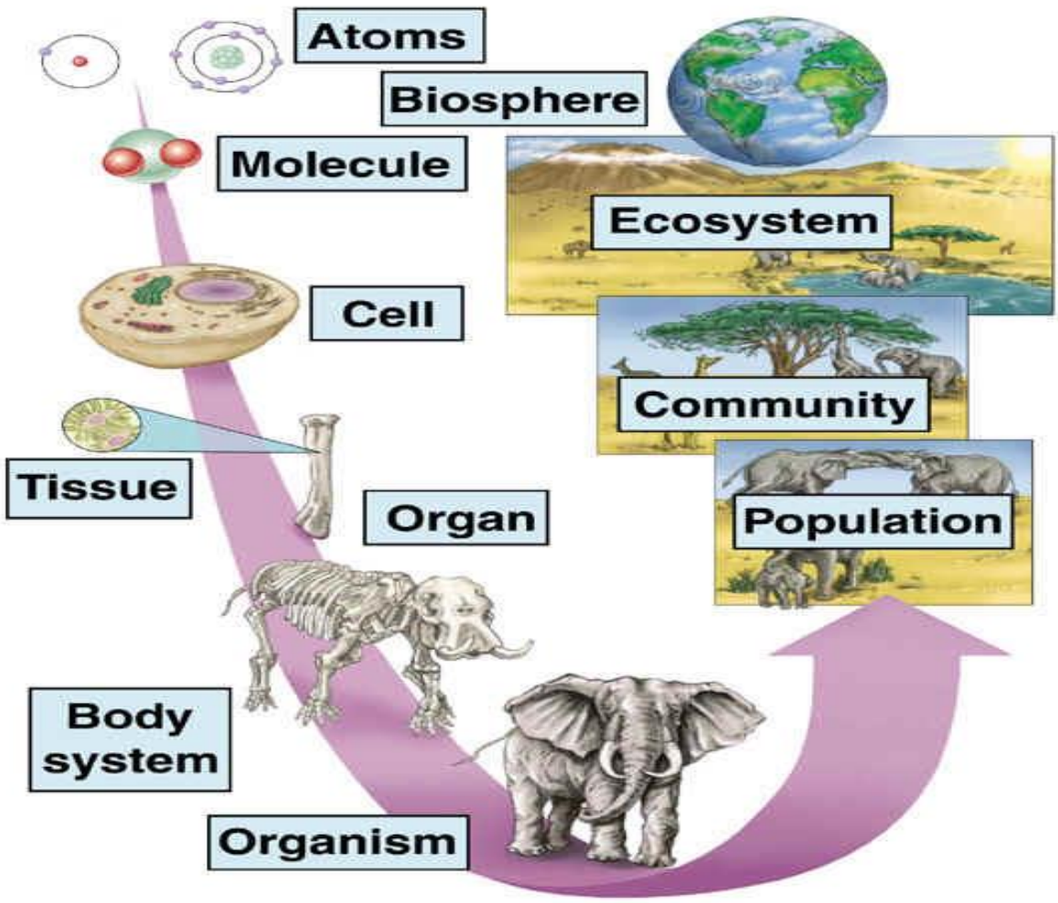
a) **organismal**, organisms interactions with their environments

b) **Population**, how populations changes over time

c) **Community**, different populations interactions in a community

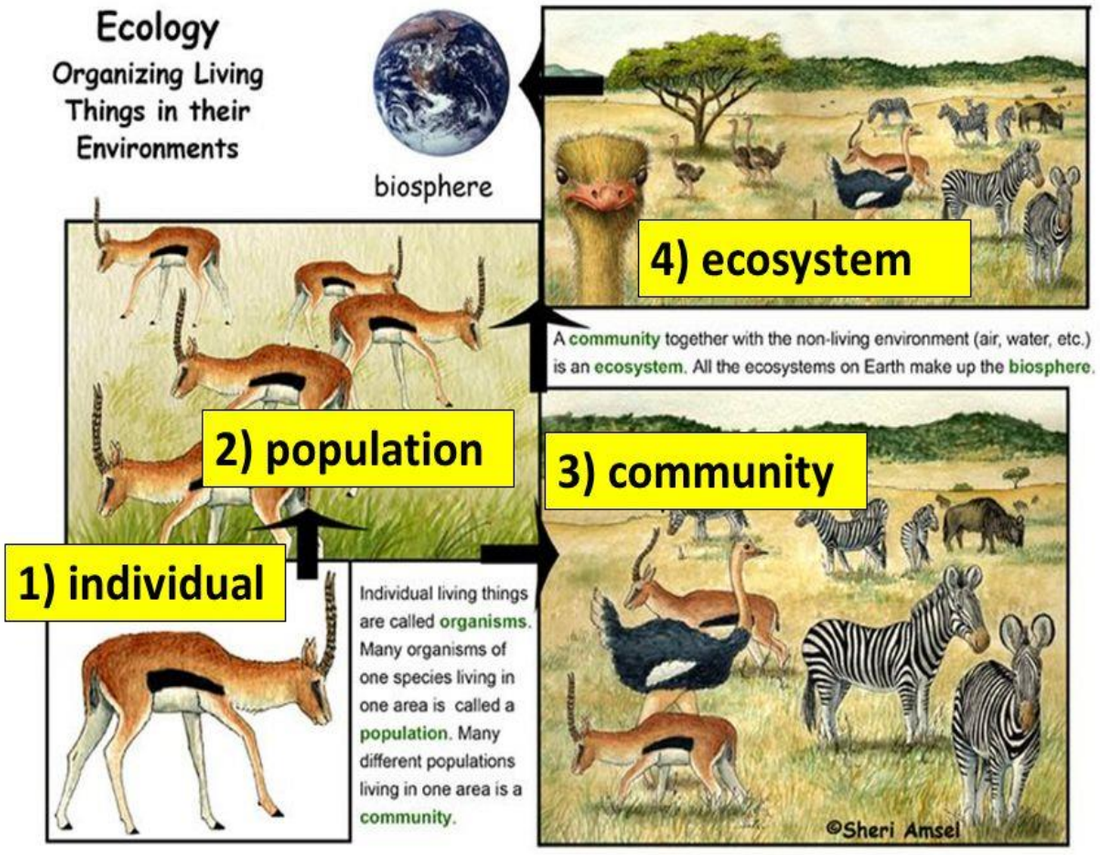
d) **Ecosystem**, examine the living species (the biotic components) of the ecosystem and the nonliving portions (abiotic components), such as air, water, and soil, of the environment.

Raven/Berg, Environment, 3/e
Figure 4.1



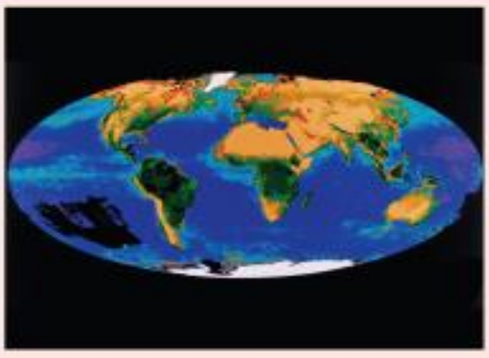
Harcourt, Inc.

4 levels of organization



Organisms, Populations, and Communities: In a forest, each pine tree is an organism. Together, all the pine trees make up a population. All the plant and animal species in the forest comprise a community.

Ecosystems: This coastal ecosystem in the southeastern United States includes living organisms and the environment in which they live.



The Biosphere: Encompasses all the ecosystems on Earth.

Topic 9 Level of organization

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"

Topic 10 Level of organization

Level of organization: Characteristics of Ecosystem

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

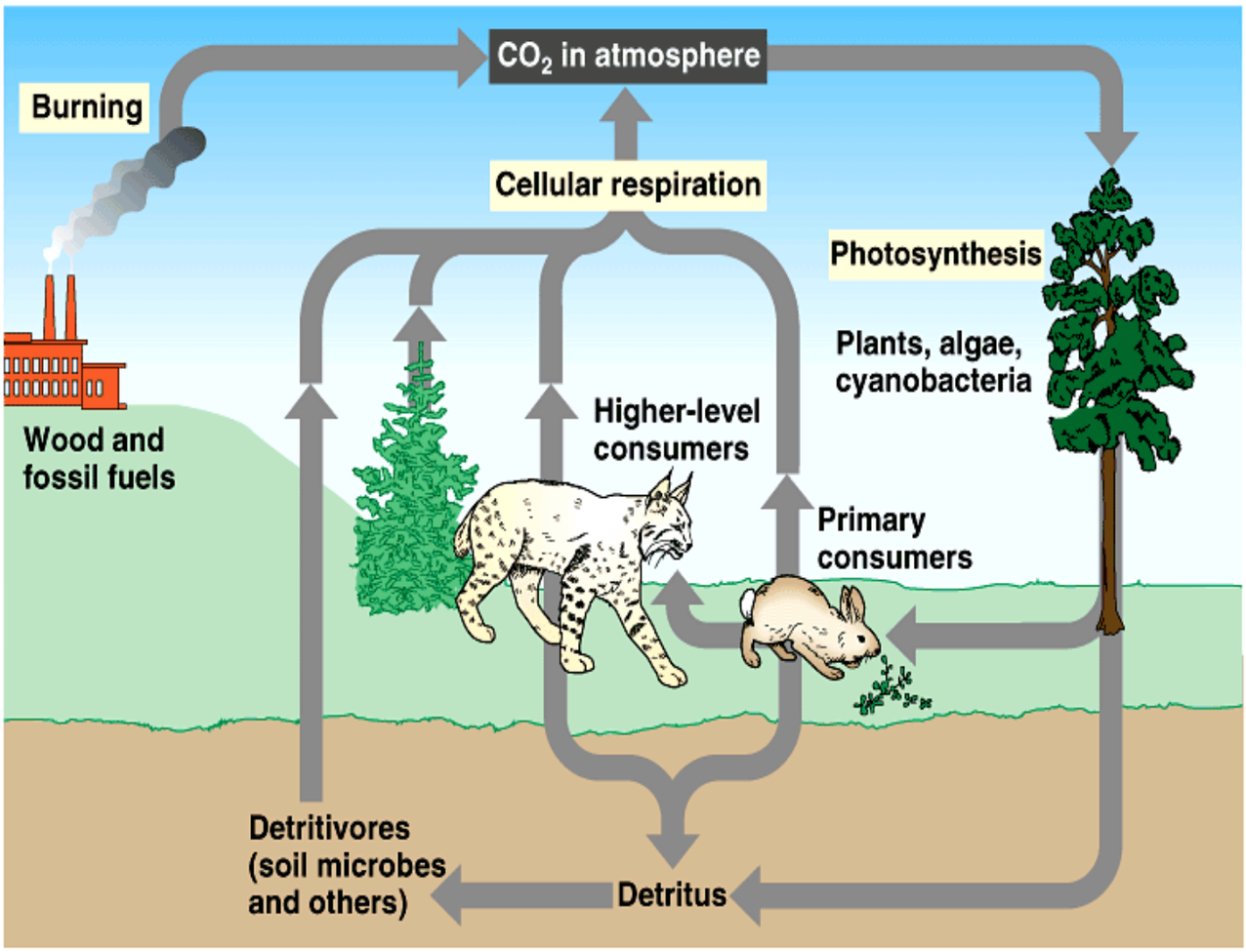
-inseparable

-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



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

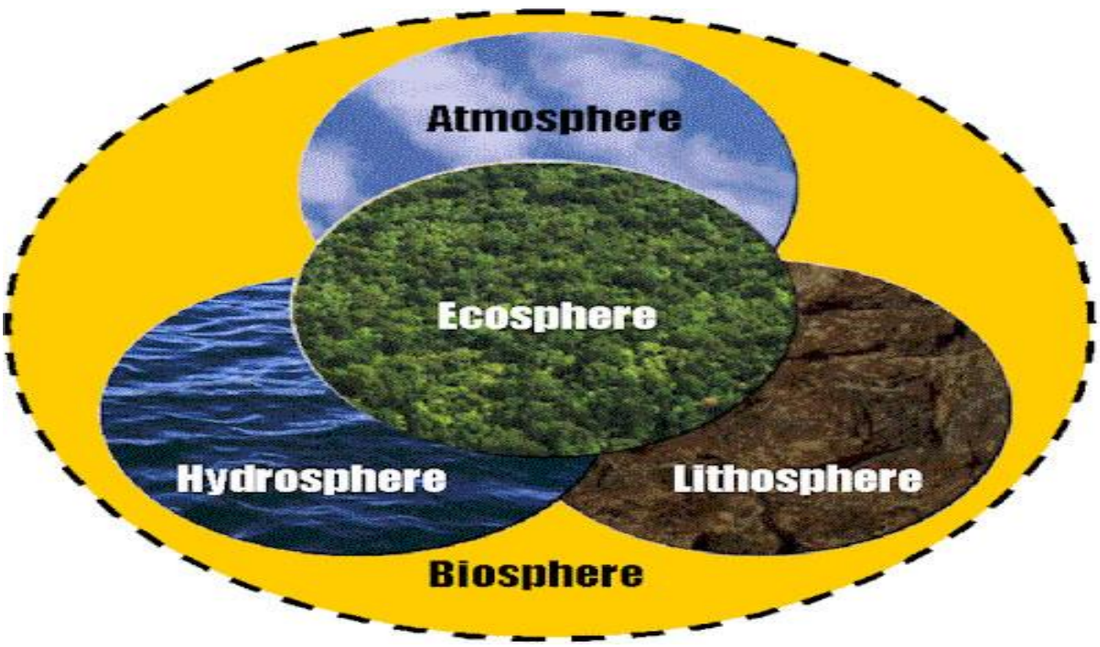
Hydrosphere-water

Atmosphere-air

whereas

Biosphere- life zone of the earth

Ecosphere = Biosphere + Lithosphere + Hydrosphere + Atmosphere)



Topic 11 Level of organization: Types of Ecosystem

Types of Ecosystem

Natural

i) **Terrestrial**

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

ii) Aquatic

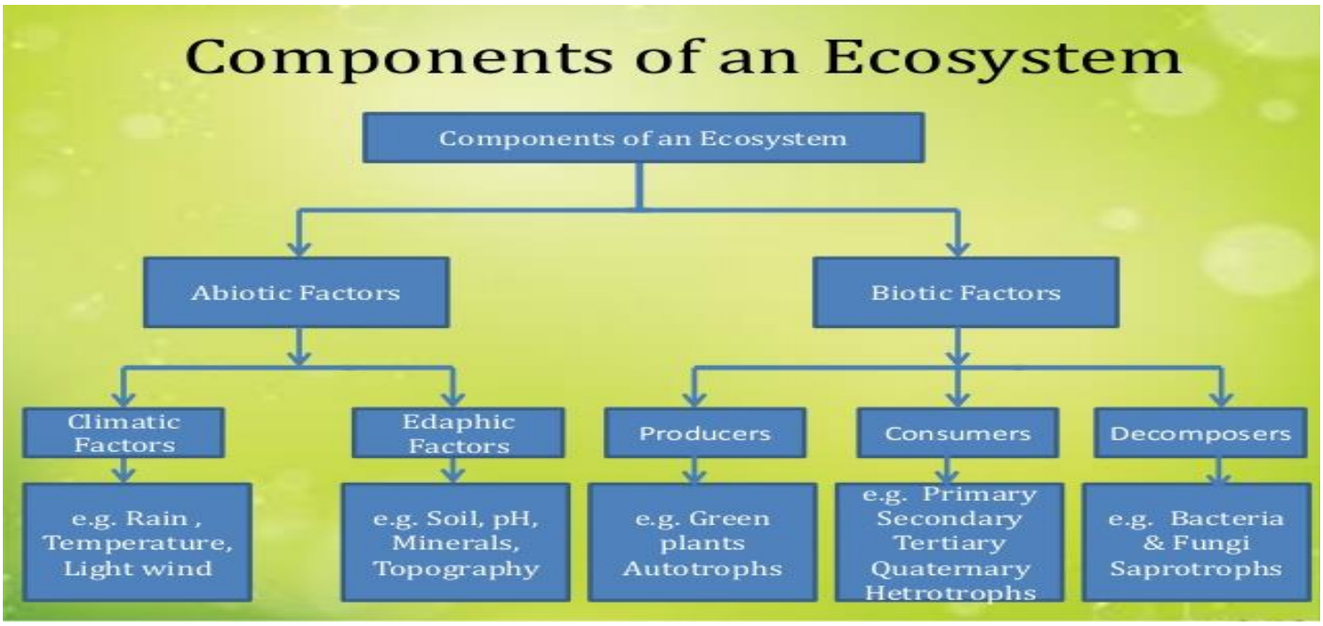
a.Lentic (Stagnant water) like lake, ponds etc.

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

Artificial

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

Topic 12 Components of 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

Topic 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

Topic 14 Components of Ecosystem-Abiotic

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

Topic 15 Components of Ecosystem-Abiotic

Atmosphere/Air

i. **Mixture of gases**

ii. **Layers of atmosphere**

iii. **Air pressure**

iv. **Role of atmosphere(air) for life on earth**

Topic 16 Components of Ecosystem-Abiotic

Temperature

i) Temperature is the function of light

ii) temp-affect body's metabolic rate

a) **Torpor**

b) **Hibernation**

c) **Winter sleep**

d) **Aestivation**

Module 17 Components of Ecosystem-Abiotic

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 soi**l-fertile-agricultural land

Module 18 Components of Ecosystem-Abiotic

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

Module 19 Components of Ecosystem-Abiotic

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

Module 20 Components of Ecosystem-Abiotic

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.

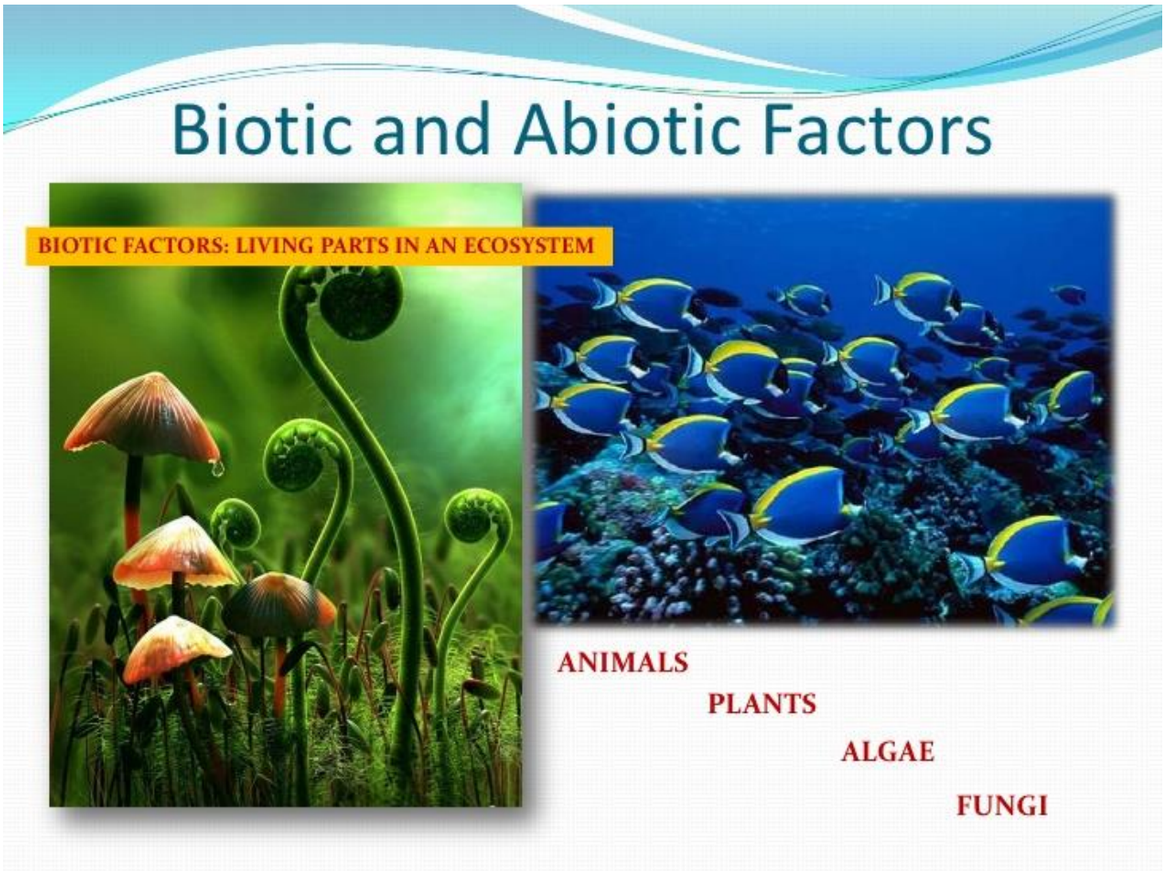
Module 21 Components of Ecosystem-Biotic

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



Module 22 Components of Ecosystem-Biotic

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

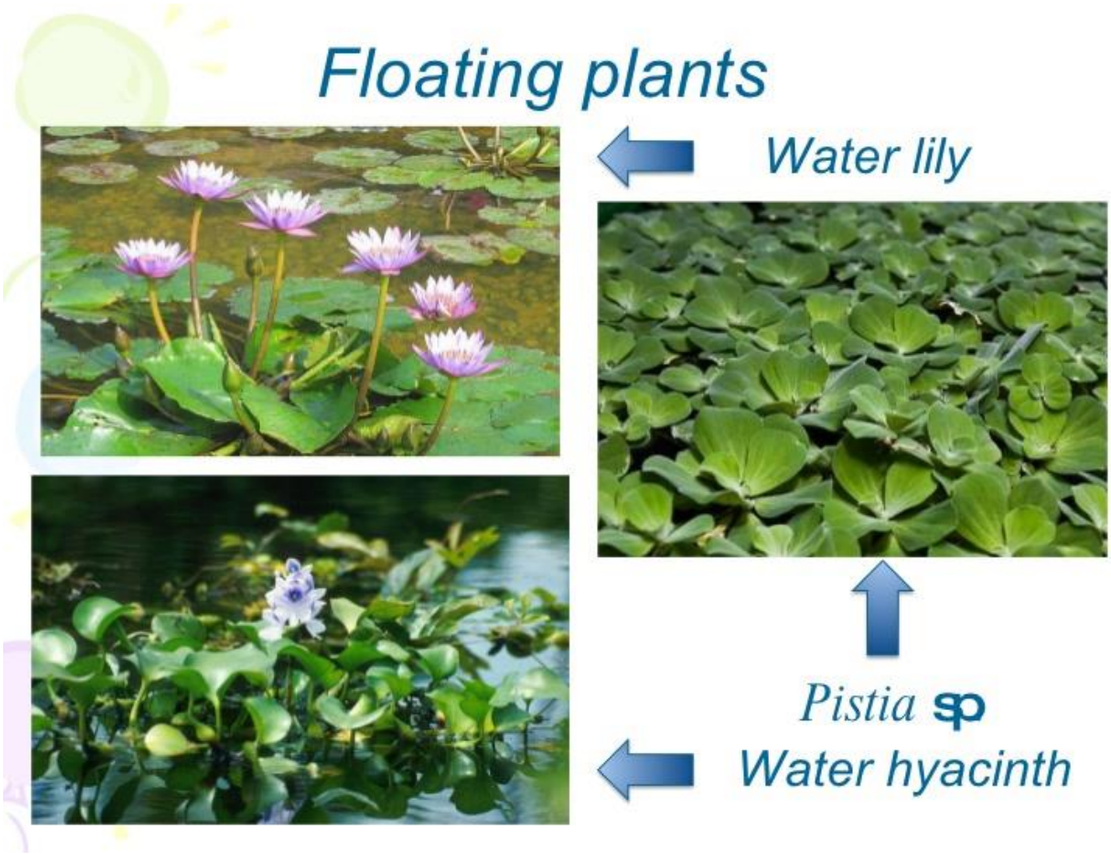
Producers or Autotrophs-

(Aquatic environment)

Two Types

Floating plants : called **phytoplankton** ("phyto"- plants,

"plankton" - floating.) for example, *Spirogyra*, *Ulothrix*, diatoms and *Volvox*.



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).

Module 23 Components of Ecosystem-Biotic

Consumers:

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

They can be further divided as

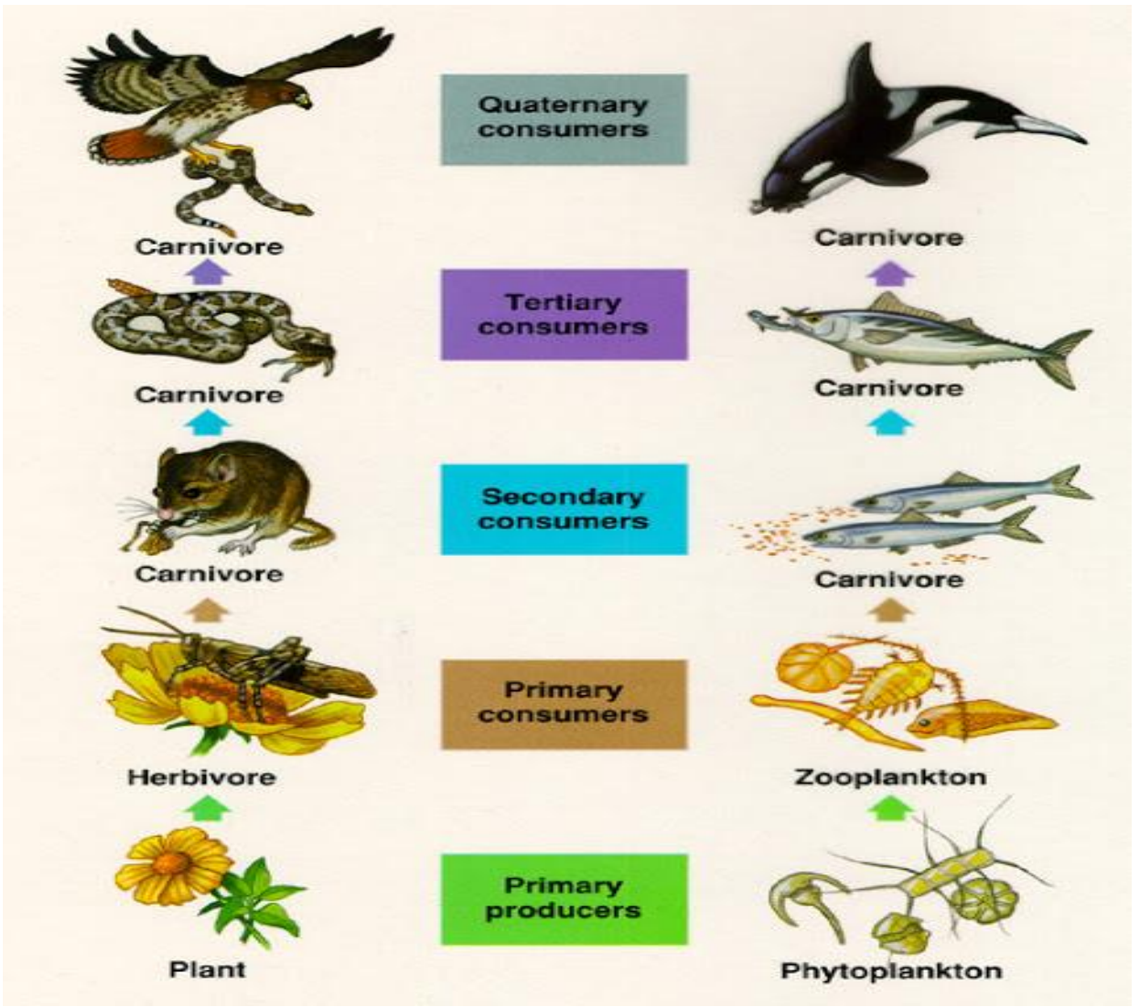
i. **Primary consumers**
ii. **Secondary consumers**
iii. **Tertiary consumers**

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

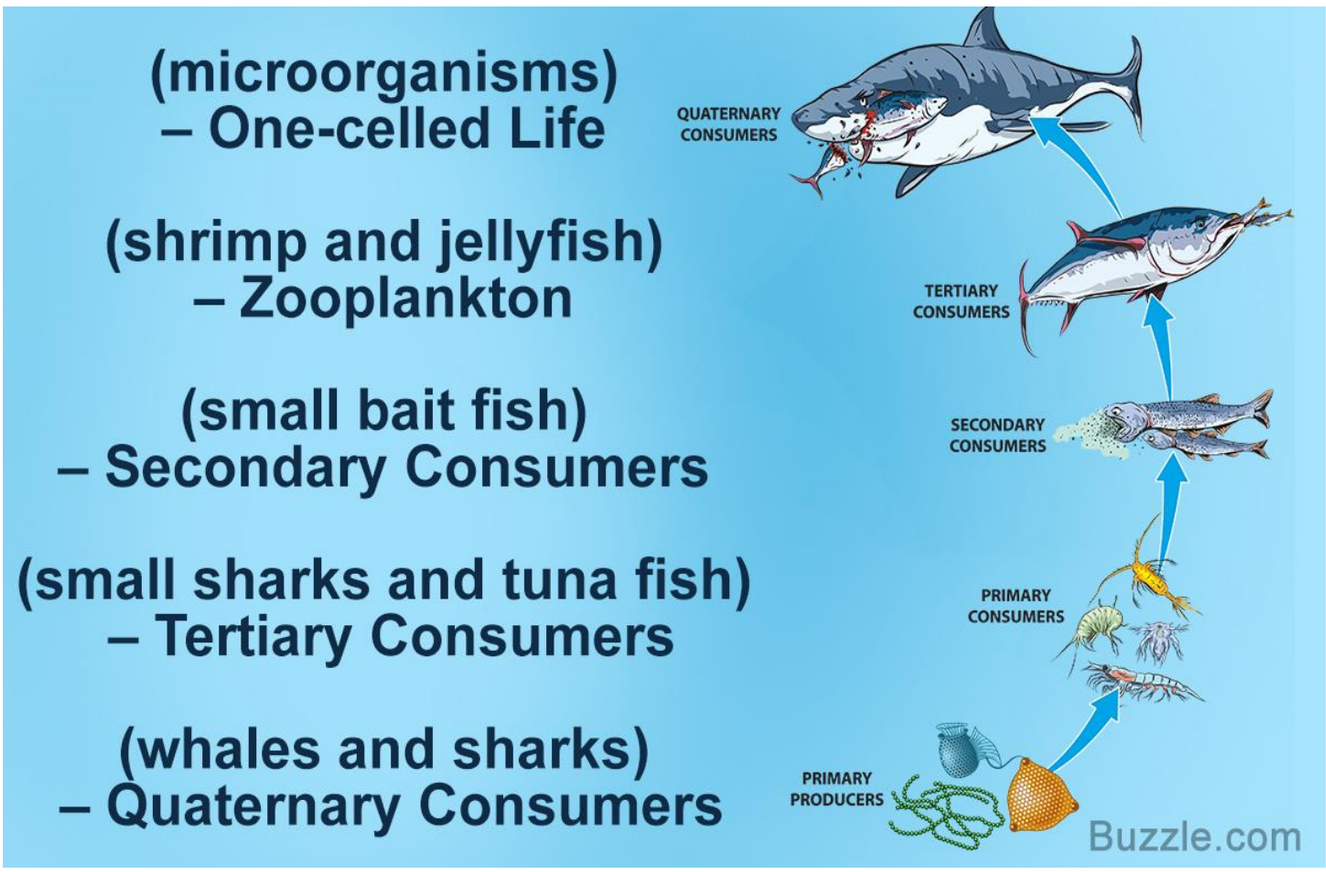
i. **Primary consumers**

as microconsumers,

zooplanktons and benthos

ii. Secondary consumers:

aquatic predaceous insects, game fish etc



Module 24 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' molluscals

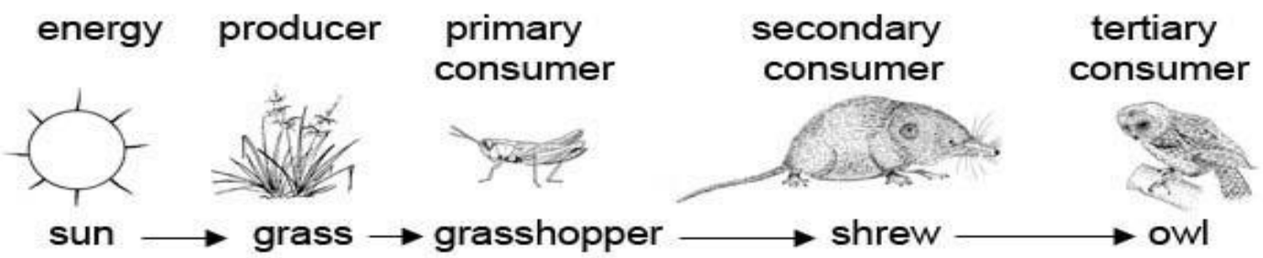
Module 25 Food Chains in Ecosystem

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"

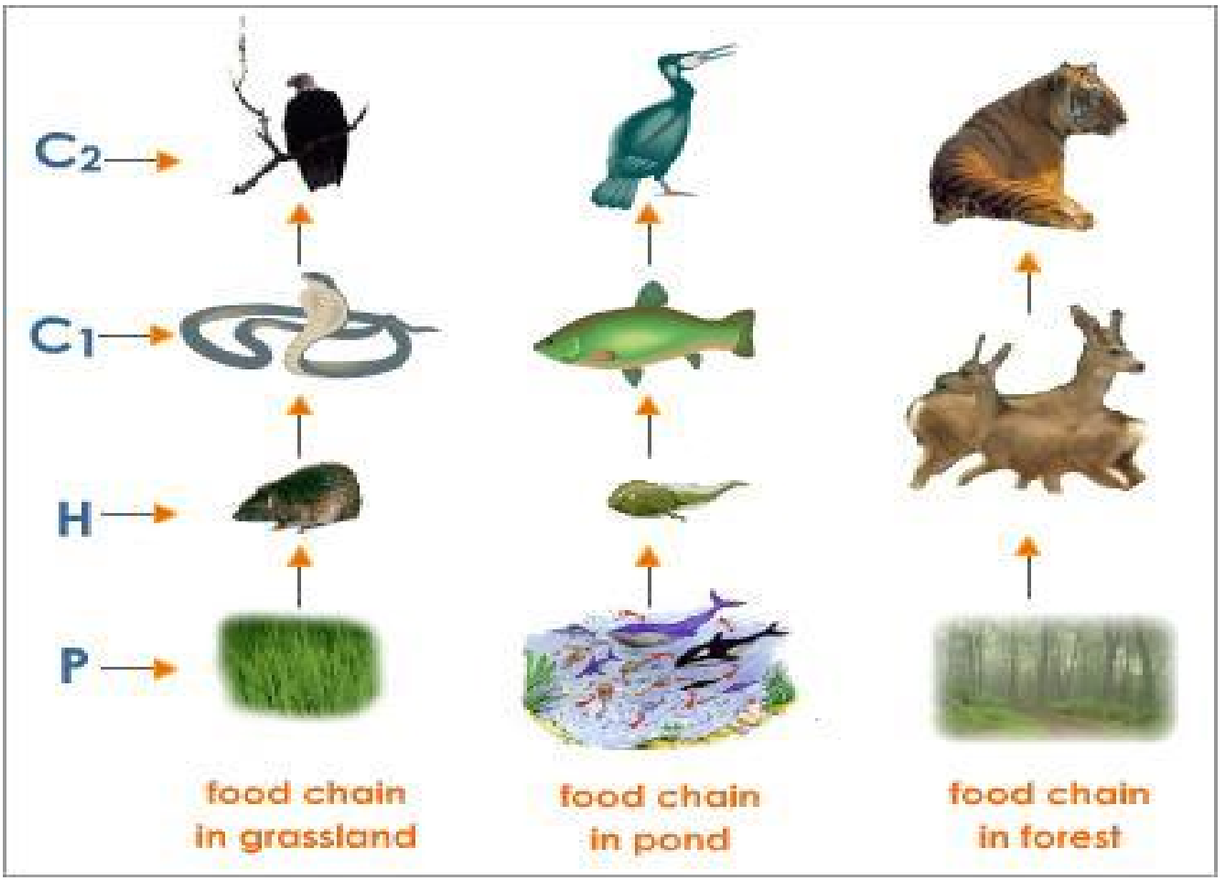
e.g.

Grasses → Grasshopper → Frogs → Snakes → Hawk/Eagle



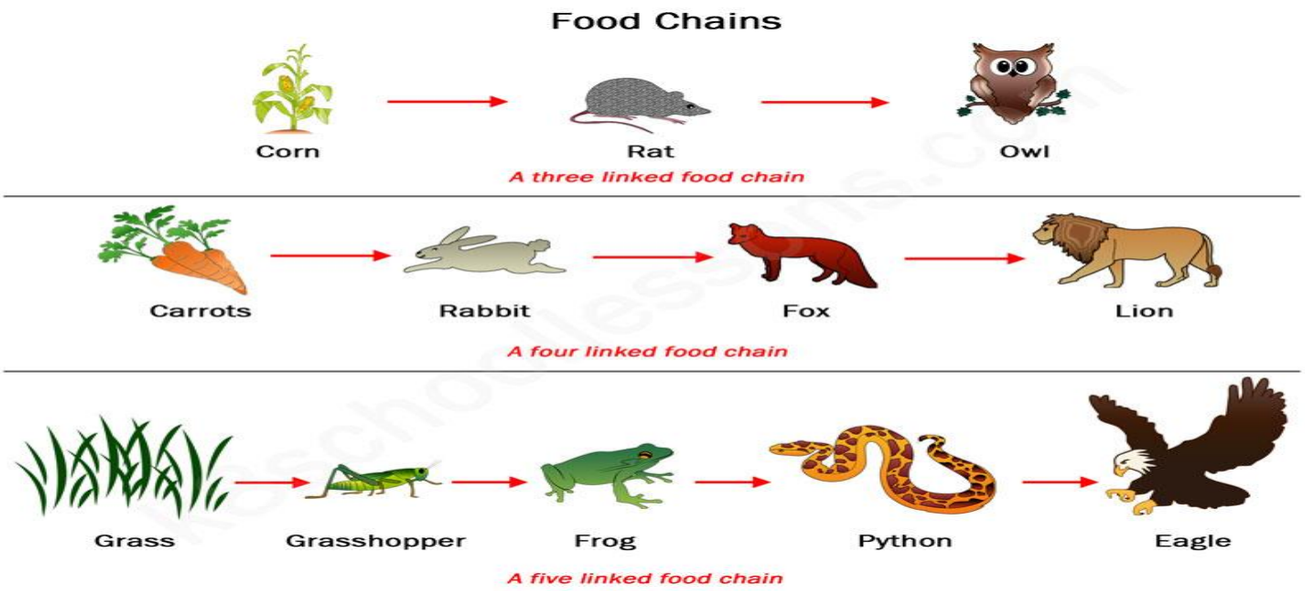
Food chain and trophic level

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.



Module 26 Food Chains in Ecosystem

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:

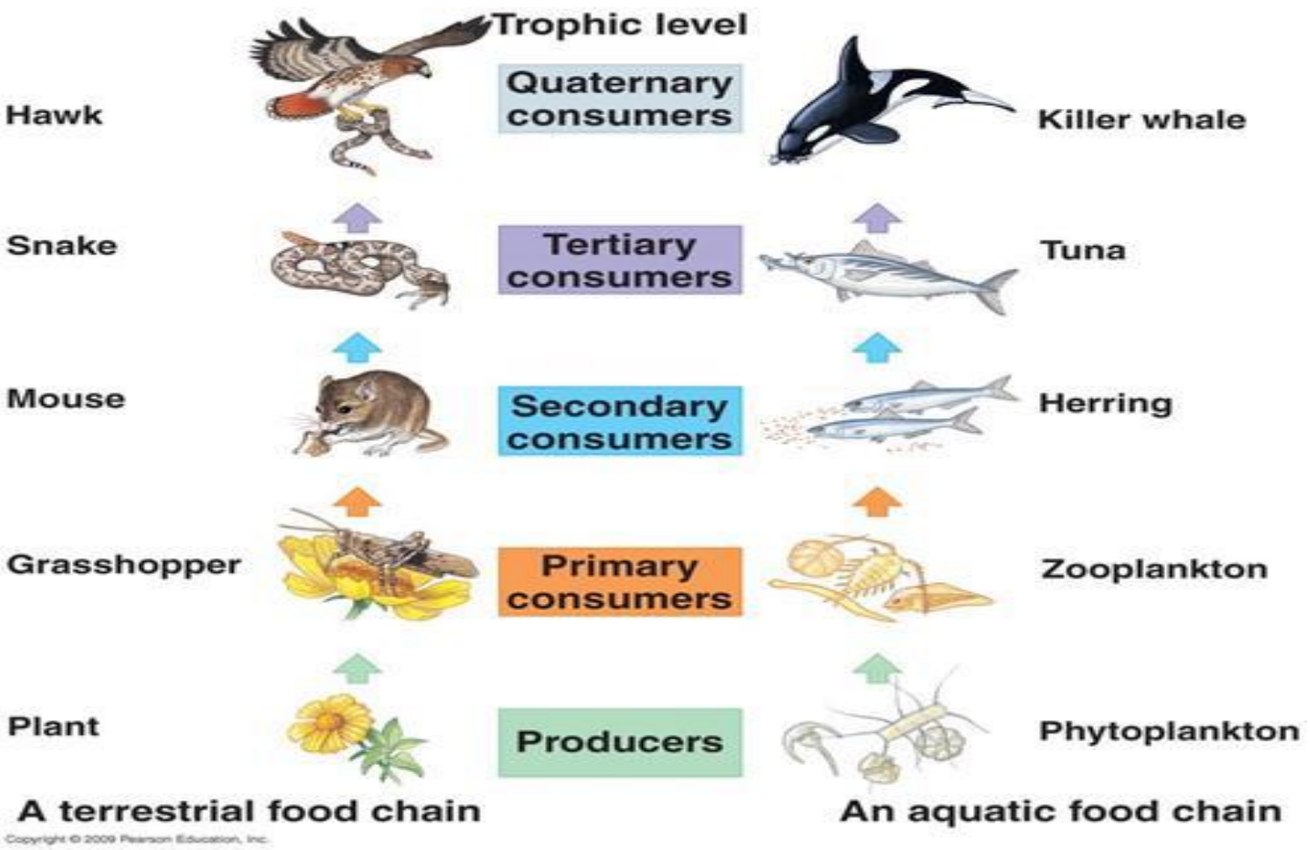
1. **(Producers) Autotrophs**

2. first trophic level

Gross Primary Productivity (GPP)

Net Primary, Productivity (NPP)

GPP = NPP + R 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 :

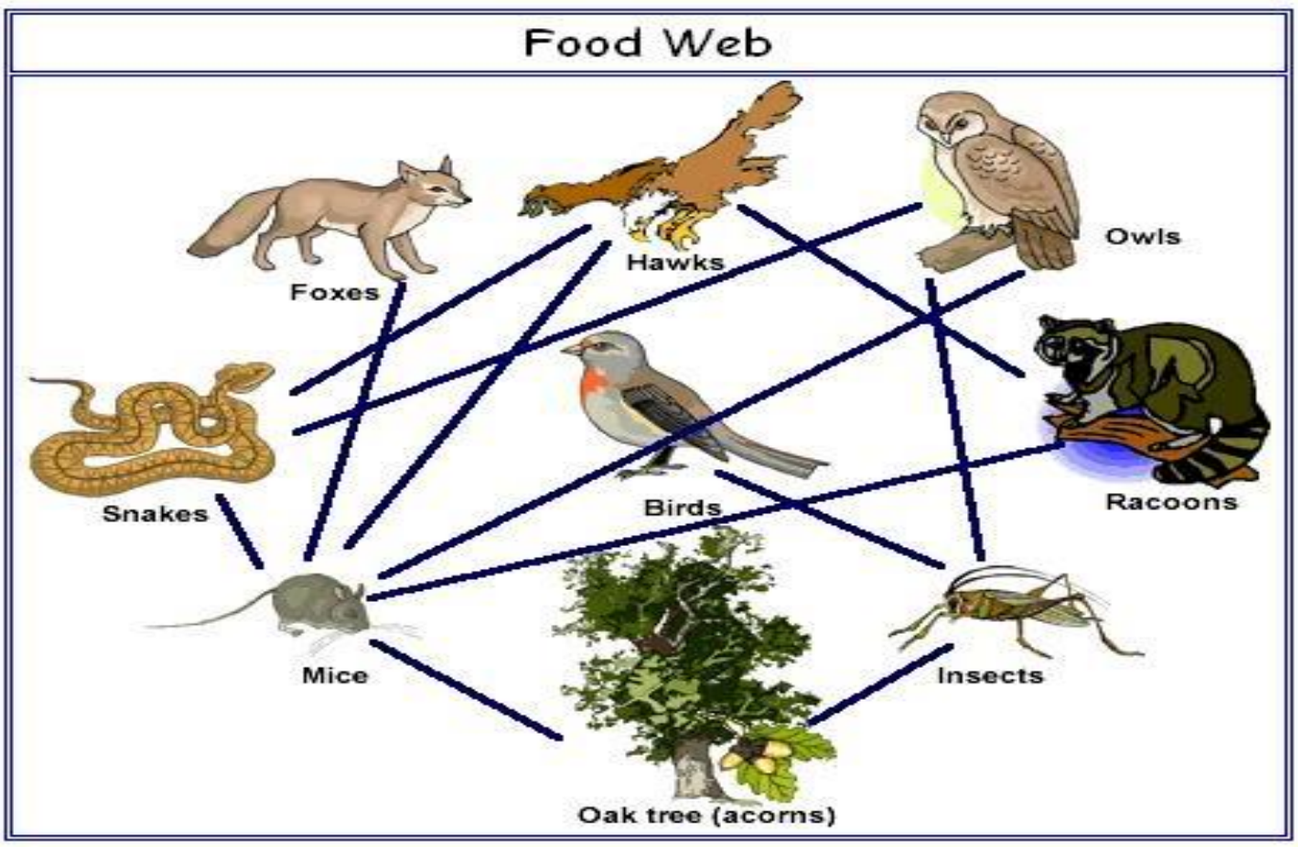
c) help in recycling the nutrients.

d) **Examples**: bacteria, fungi, mites, millipedes, earthworm, nematodes, slugs, crabs and mollusks

Module 27 Food Web in Ecosystem

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



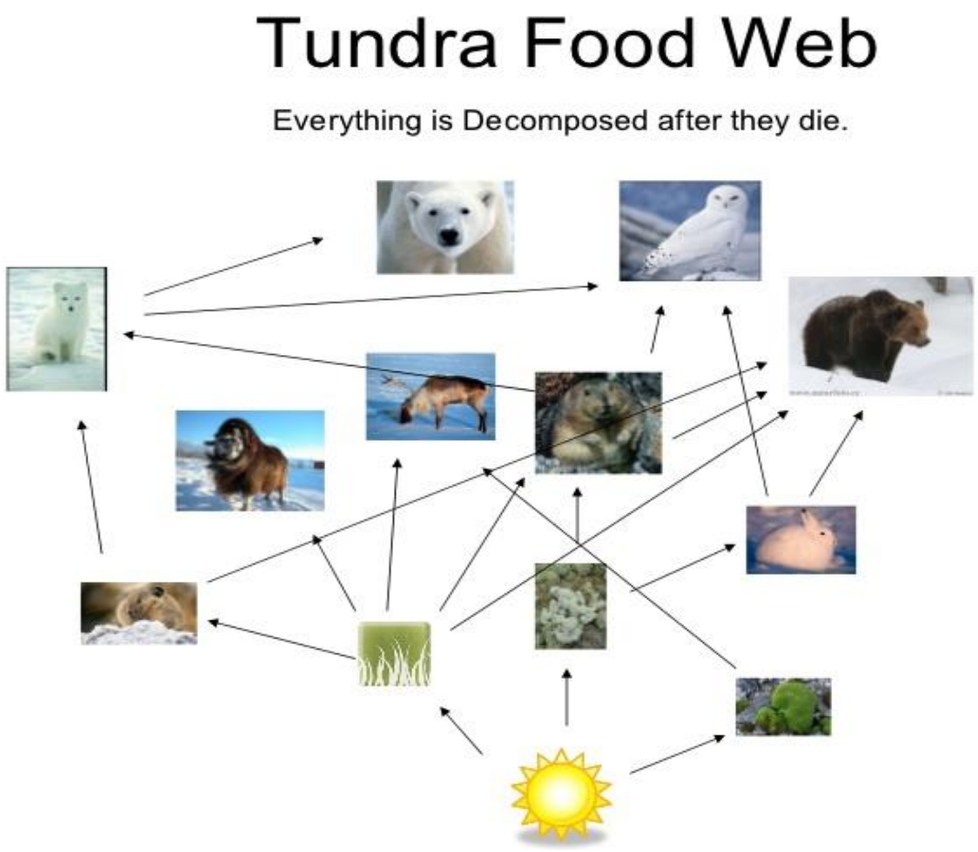
Food web

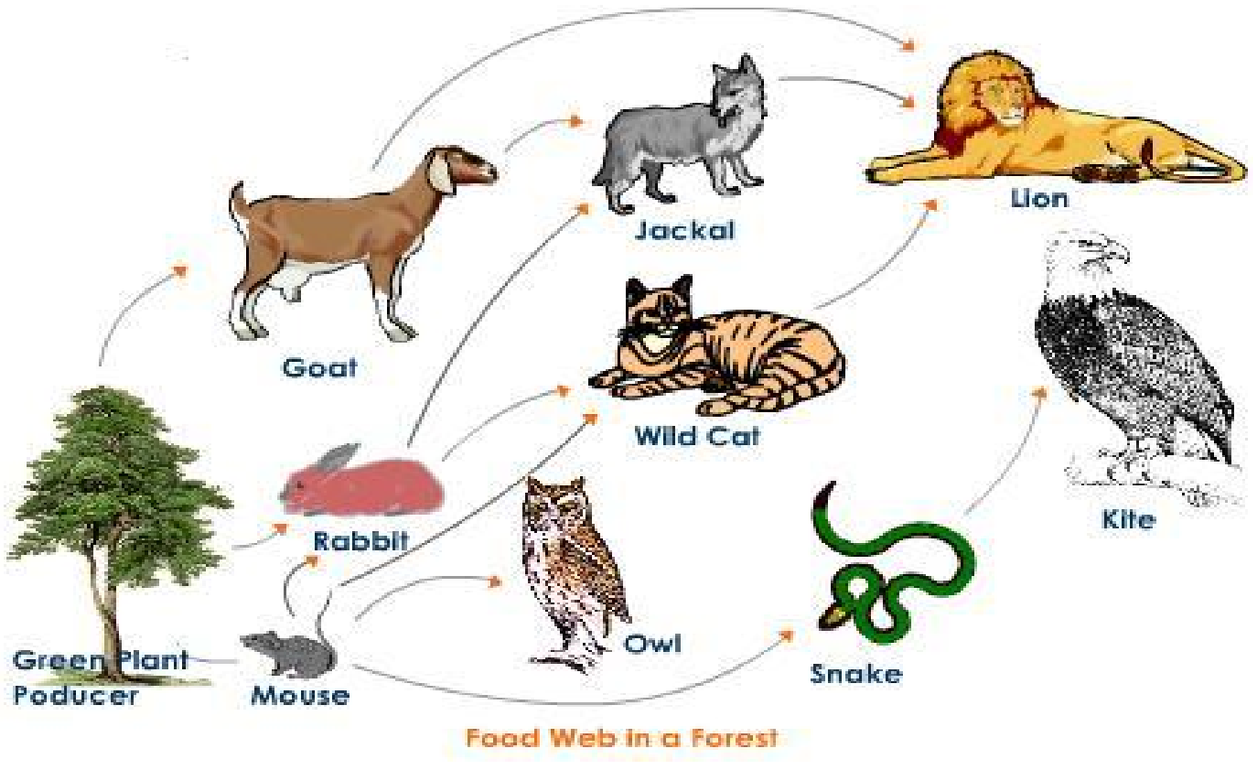
1. In a food web one trophic level may be connected to more than one food chain

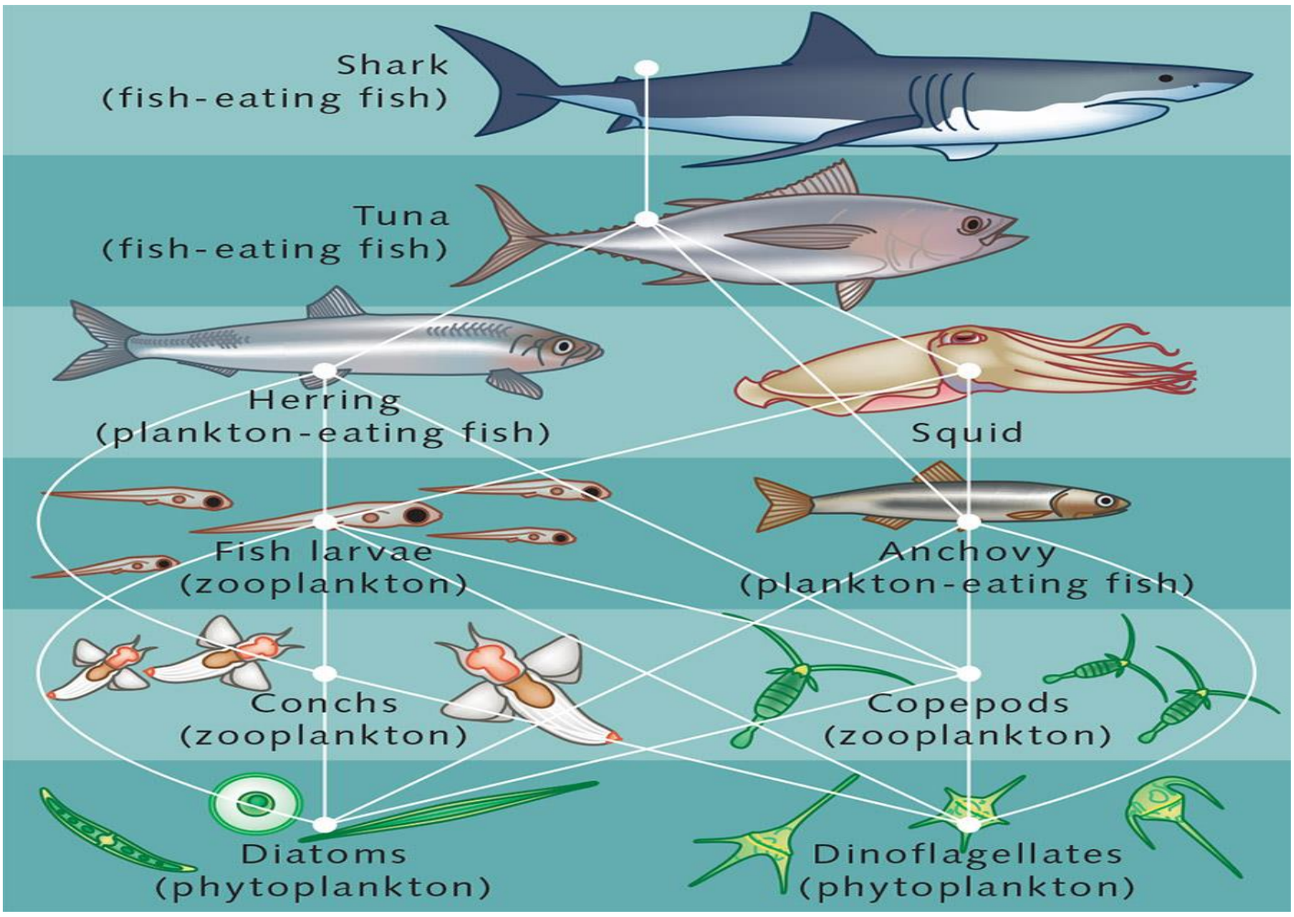
2. Food web is the geographical description of feeding relationship among species in an ecological community

Food web

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







Module 28 Energy in Ecological systems

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.

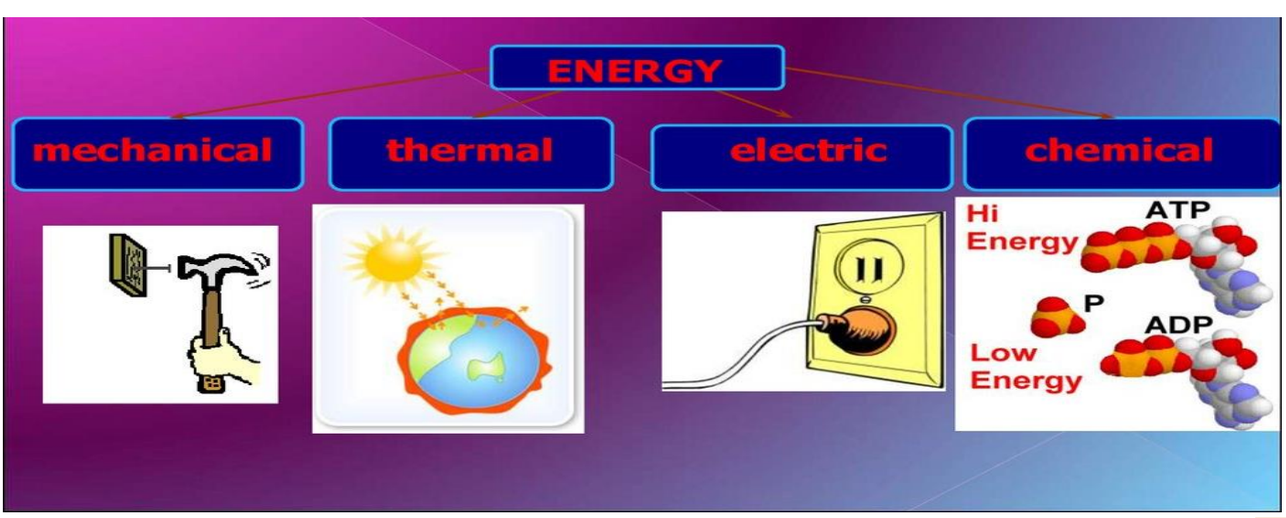
different forms of energy

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



Energy in Ecological systems

Module 29

2nd law of Thermodynamics Or

Law of Entropy

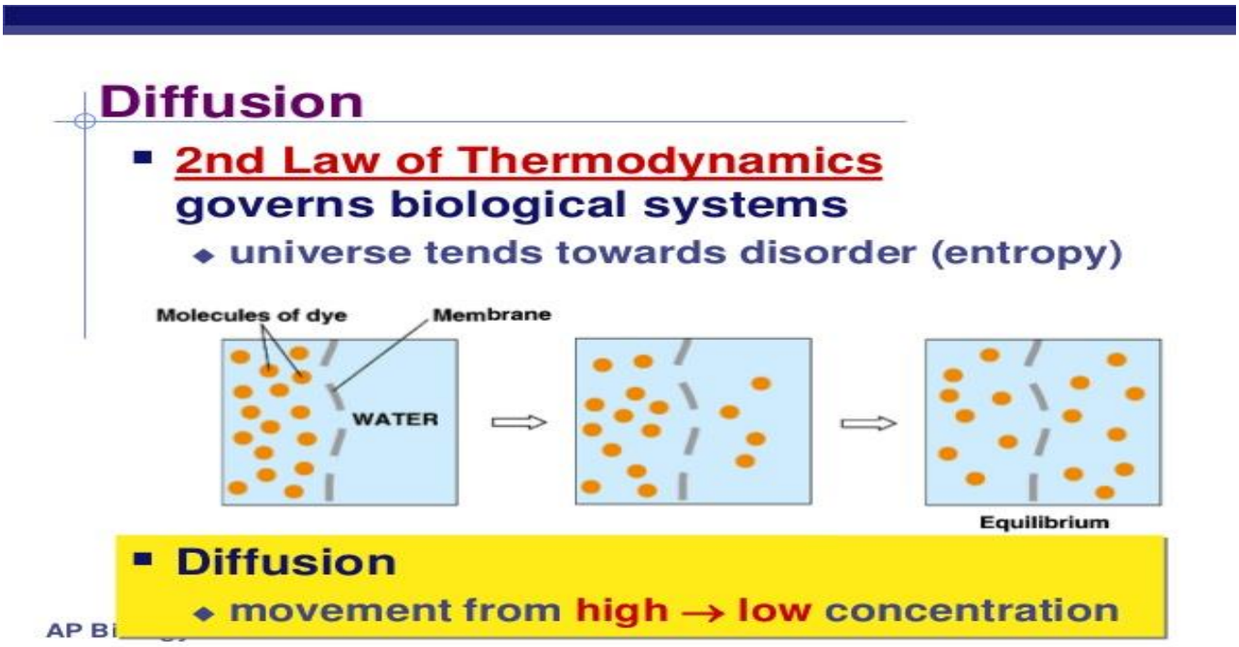
Its about the *quality* of energy

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.

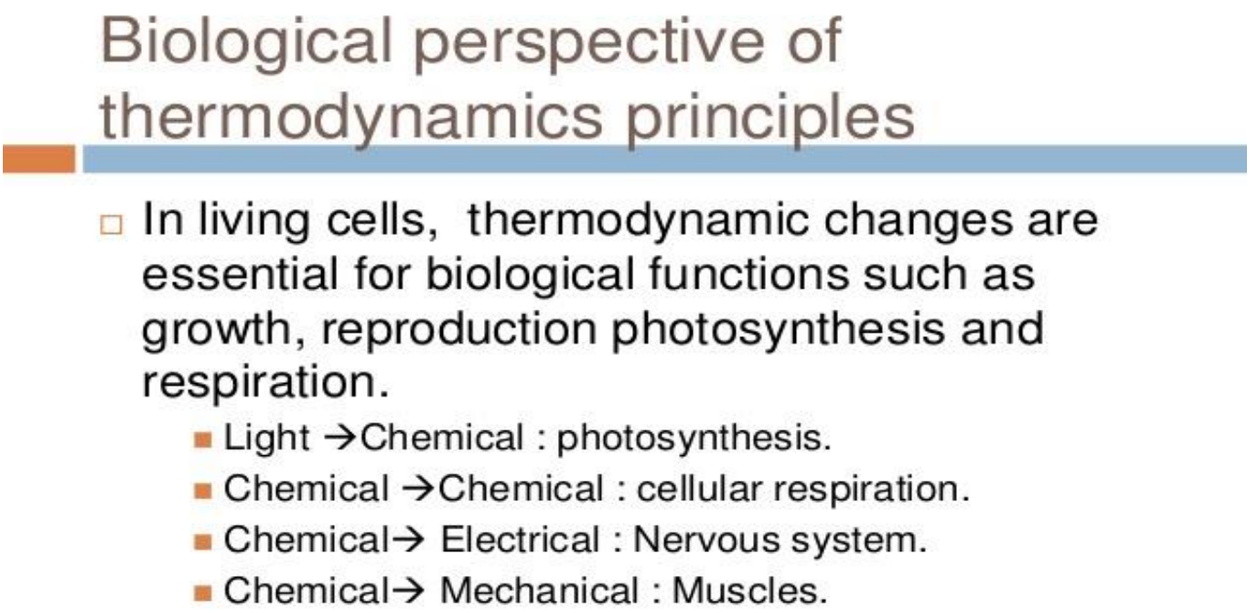
It asserts that a natural process runs only in one sense, and is not reversible

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



Biological perspective of thermodynamics principles

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



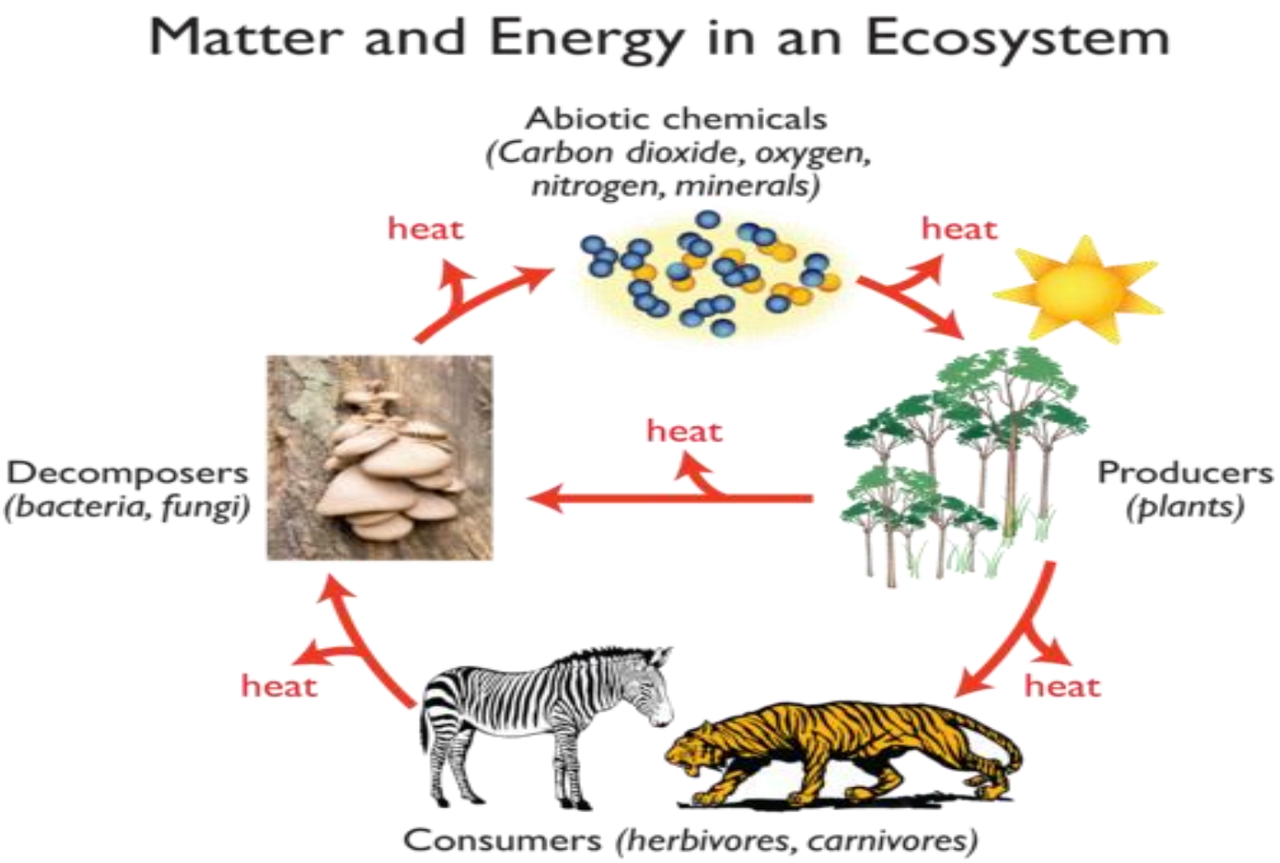
Biological perspective of thermodynamics principles

Light-chemical: Photosynthesis

Chemical-chemical: cellular respiration

Chemical-Electrical: Nervous system

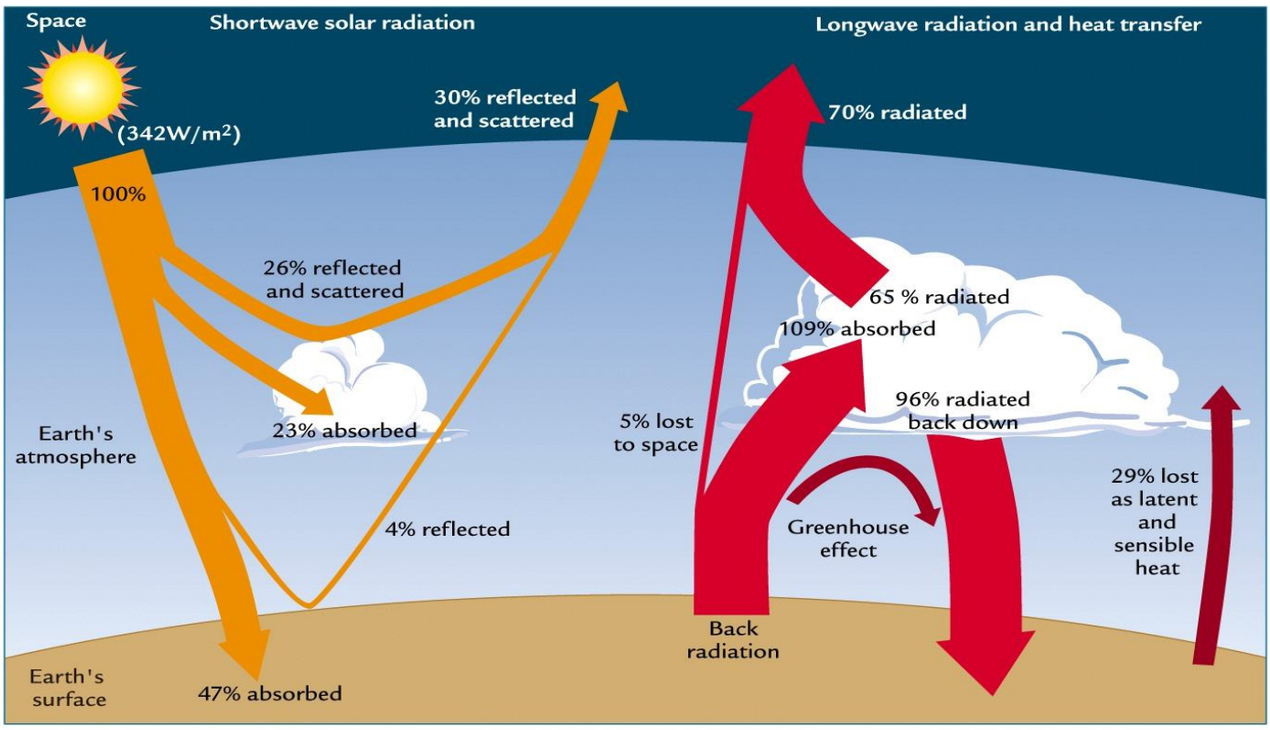
Chemical- Mechanical: Muscles



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

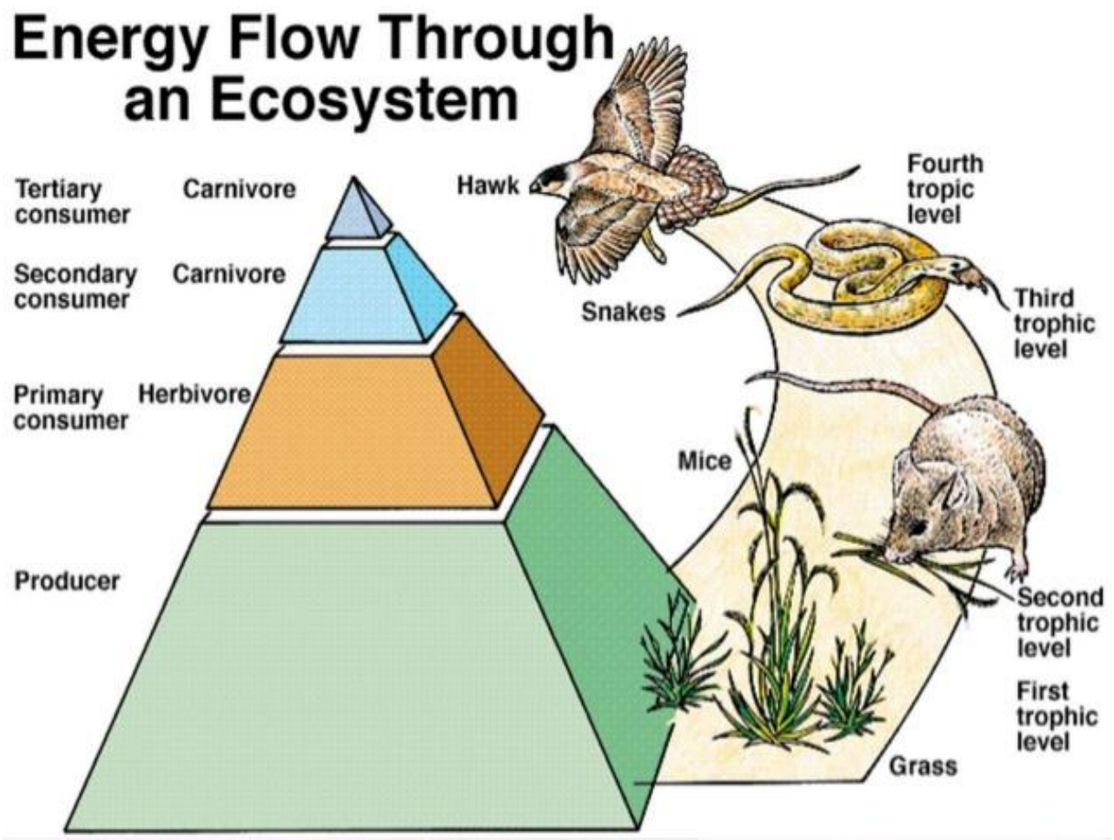
3. infrared rays-45%- longer wavelength-absorbed and reradiated as heat in a complex manner by atmosphere, clouds, and various natural and man – made objects and surfaces

Flow of energy in Ecosystem

Important factor as describe

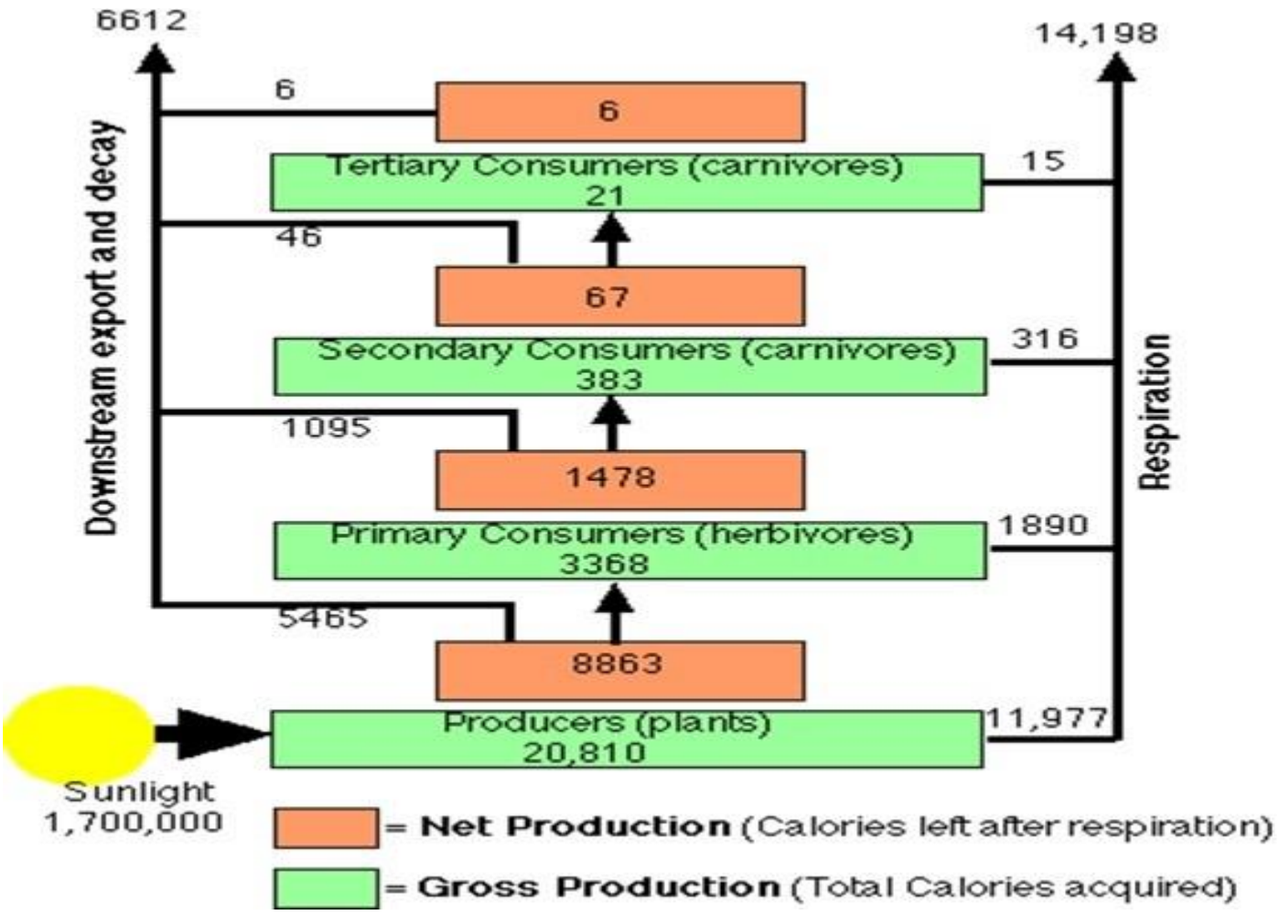
Types and number of organism would live in ecosystem

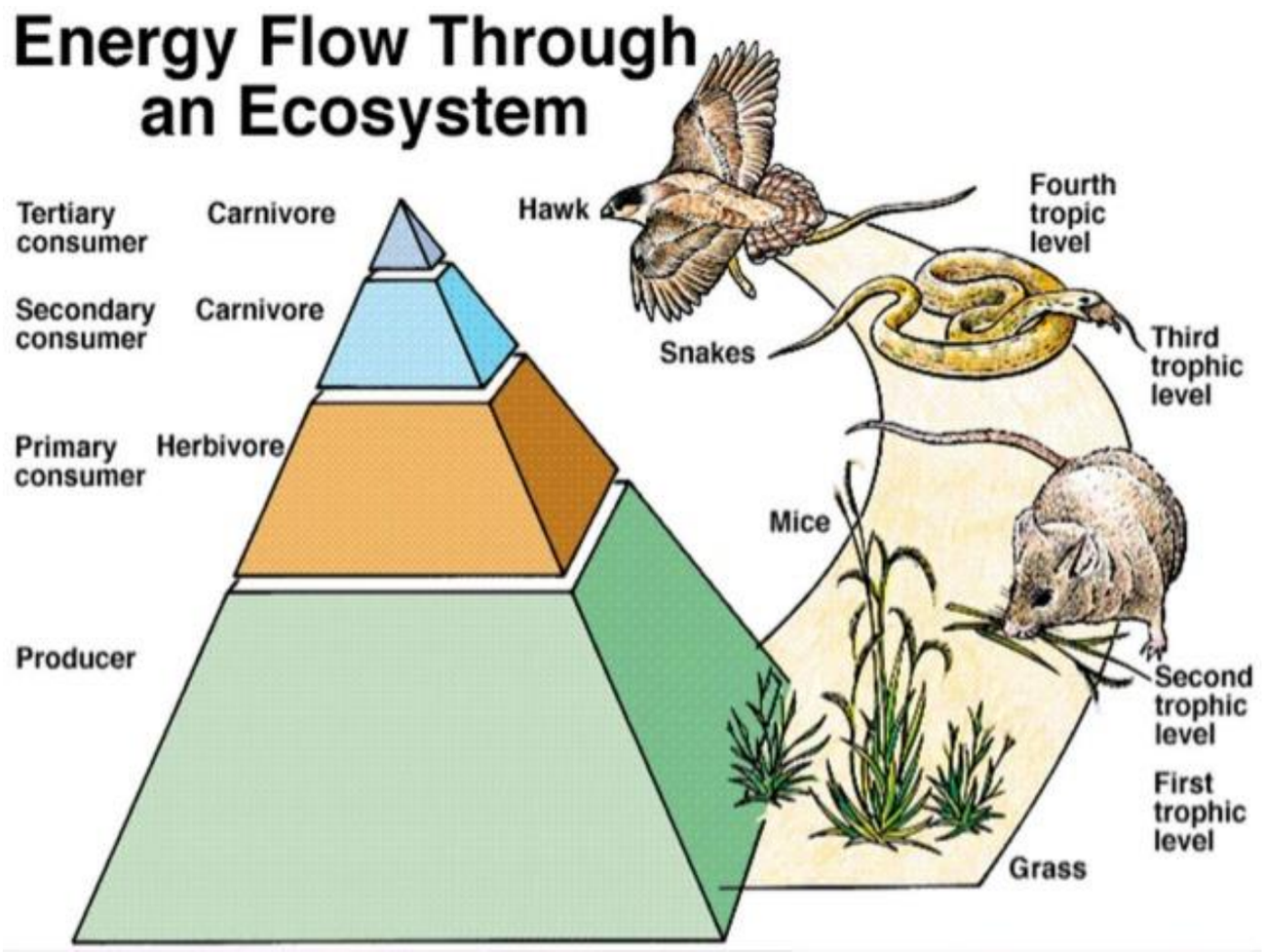
Ecological Pyramids- relative amount of energy, biomass, number of organisms at each level in ecosystem



Flow of energy in Ecosystem

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





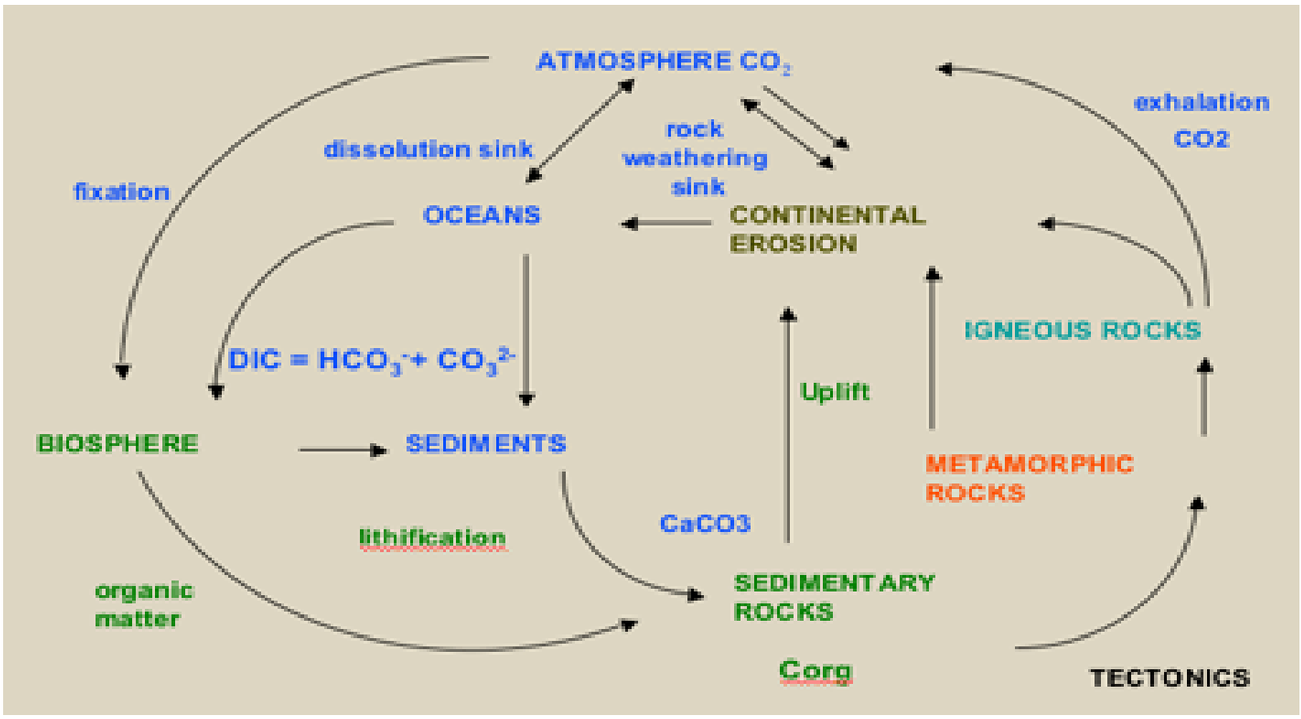
Module 30 Biogeochemical cycles

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

Module 31 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

Lecture 32 Nitrogen (N2) Cycle

Importance of Nitrogen

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

a) Atmosphere

as reservoir -78%-

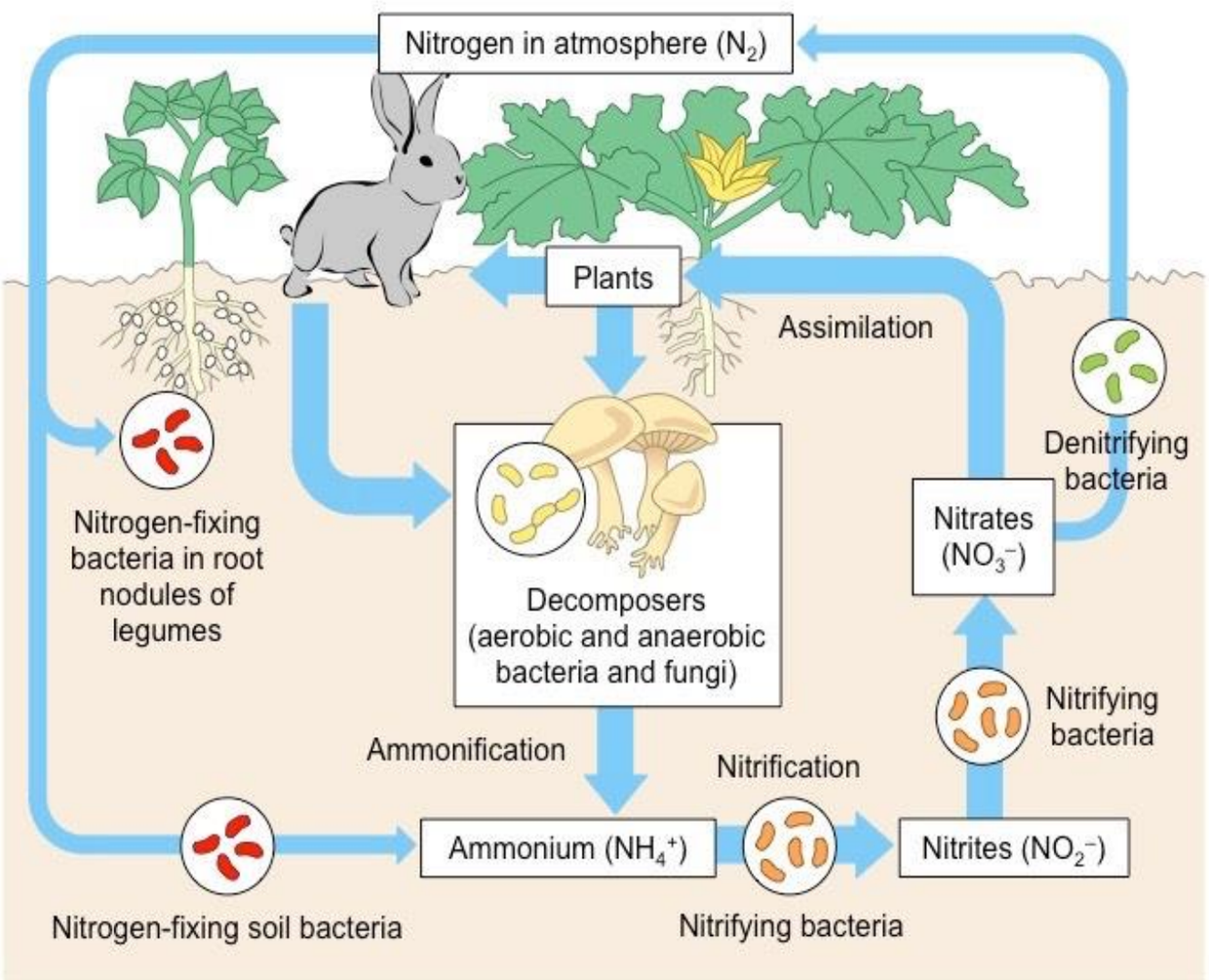
safety valve

N_2 Cycle Steps

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

None-Biological Fixation

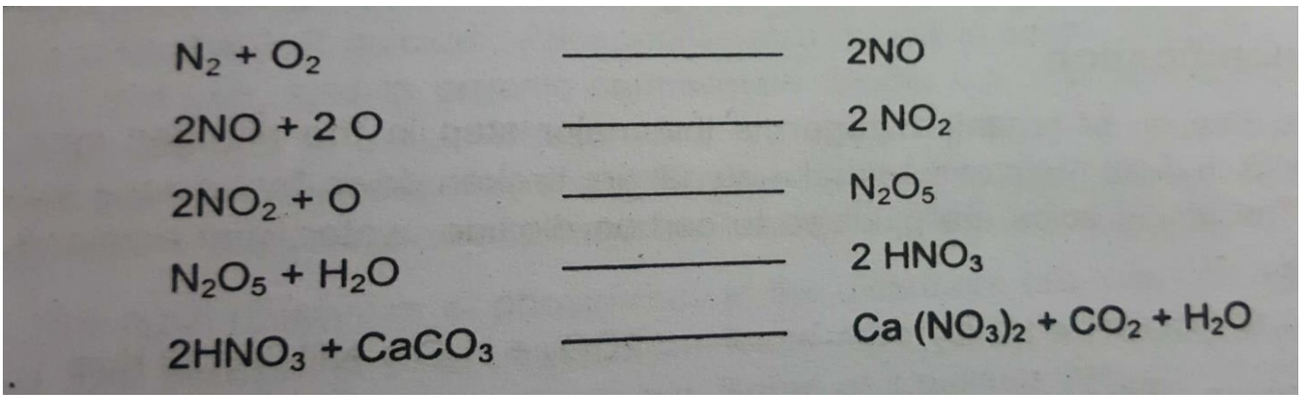
Biological Fixation



Lecture 33 Biogeochemical Cycles-Nitrogen (N_2) Cycle

Non Biological Nitrogen Fixation

1. Atmospheric fixation: A natural phenomenon where the energy of lightning splitting up of the gaseous nitrogen, combing 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.

Lecture 34 Biogeochemical Cycles-Nitrogen (N_2) Cycle

Biological Nitrogen Fixation

Steps

a) 90% fixed nitrogen to earth (100-200 kg/ha)

b) ammonia (NH3) or ammonium ion or nitrites or nitrates basic useable form by plants

c) Legume nodules plants-10g glucose-fix 1g

d) Free living microbes fixers-100g glucose- 1g

Biological Nitrogen Fixation

Steps

a) Ammonification

b) Nitrification

c) Assimilation

d) Denitrification

3**. Biological fixation:**

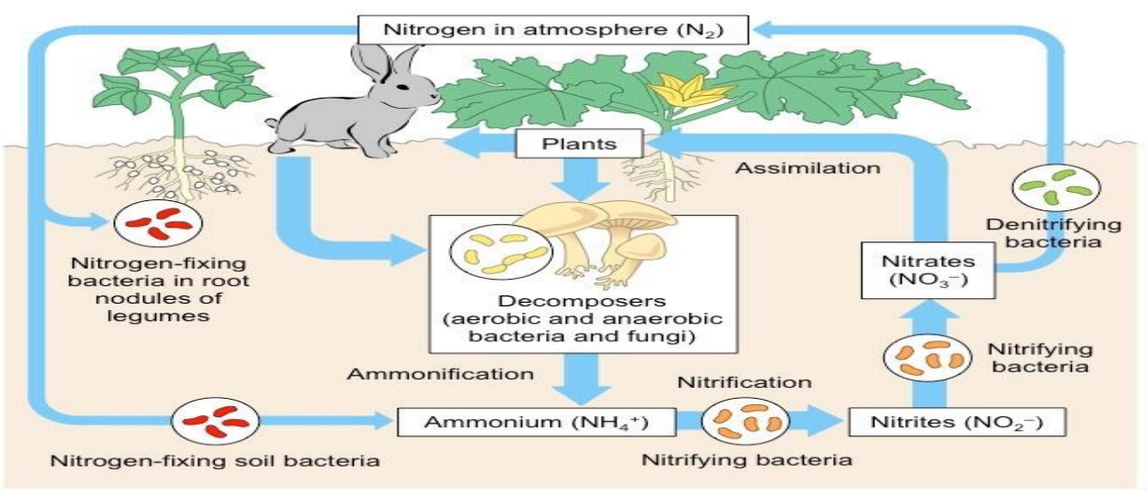
a) Mutualistic bacteria-beneficial association with

b) Leguminous (agricultural system)

c) Root nodules in none-leguminous plants

d) Free living nitrogen fixing bacteria-Soil

e) Cyanobacteria- Ocean ecosystem

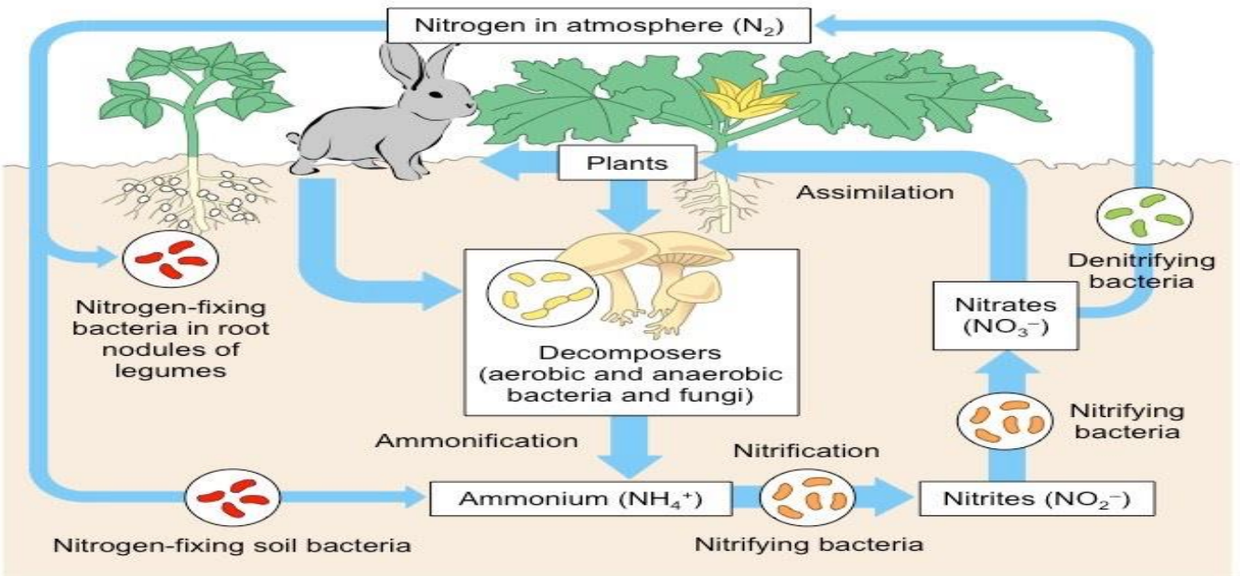


Lecture 35 Biogeochemical Cycles-Nitrogen (N_2) Cycle

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 Rhizosphers- 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

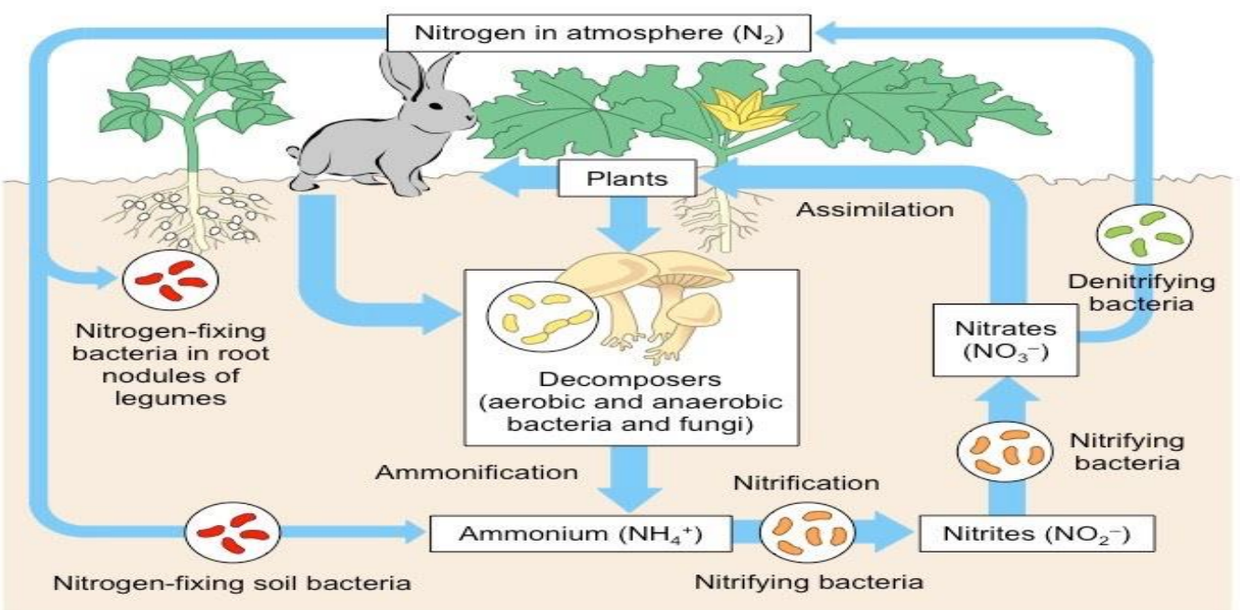
Lecture 36 Biogeochemical Cycles-Nitrogen (N_2) Cycle

3. **Biological fixation:**

Free living bacteria- 15 known genera fix gaseous nitrogen-*Azobacter* (aerobic), *Clostridum*-(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



Lecture 37 Biogeochemical Cycles-Nitrogen (N_2) Cycle

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.

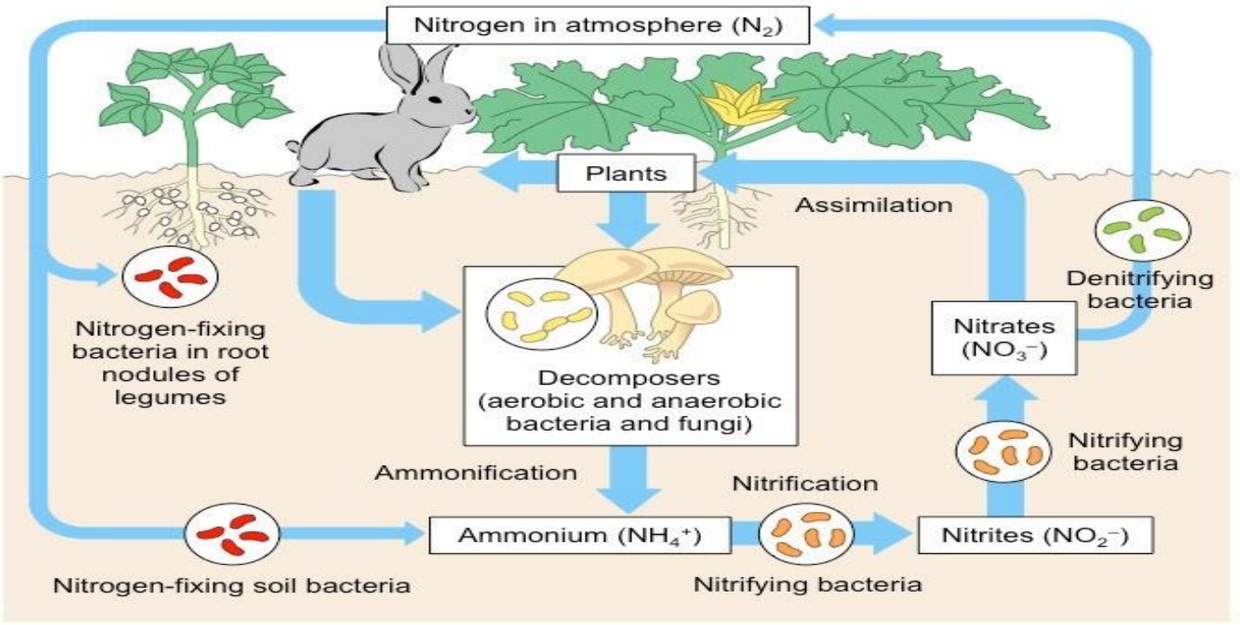
Nitrification-ammonia is oxidized into nitrate

Nitrosomonas bacterium in soil

$$2NH_4 + 3O_2 \quad 2NO_{-2} + 4H^+ + 2H_2O$$

nitrites are converted into nitrates by *Nitrobacter*

$$2NO_{-2} + O_2 \quad 2NO_{-3}$$



Lecture 38 Biogeochemical Cycles-Nitrogen (N_2) Cycle

Assimilation

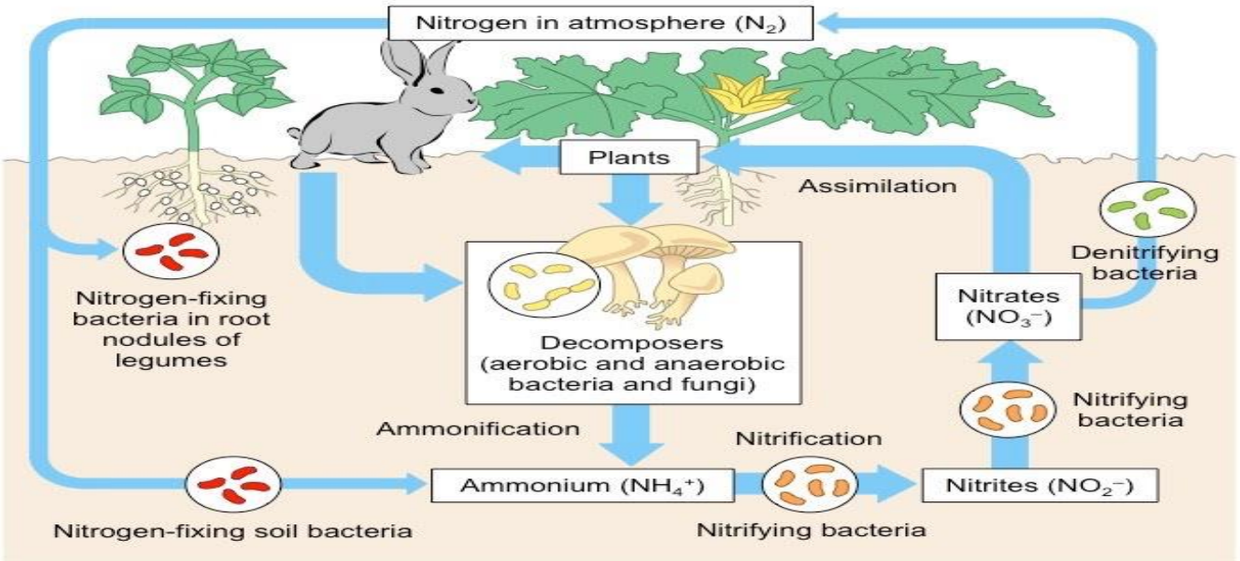
Primary producers- nitrite ions, nitrate ions or ammonium ions- through roots- plant protein

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*



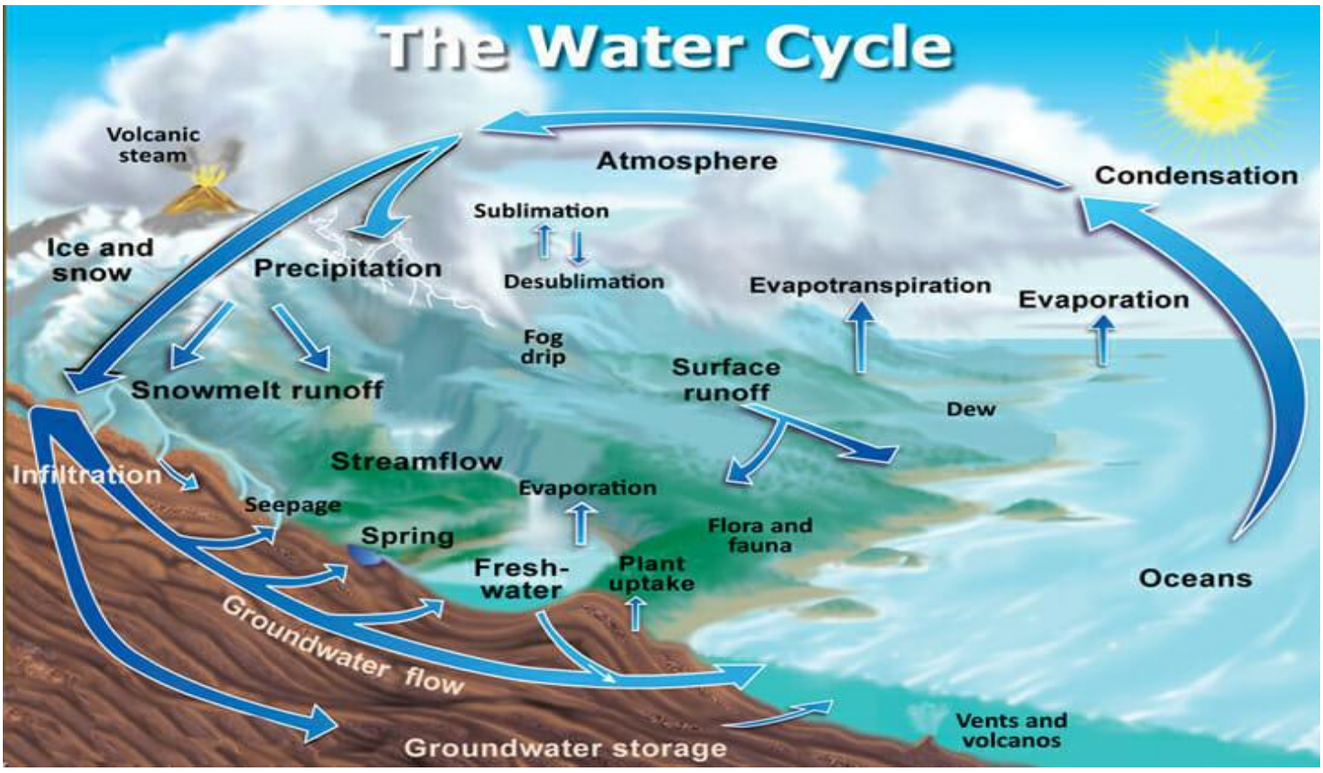
Lecture 39 Biogeochemical Cycles-Hydrological Cycle

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

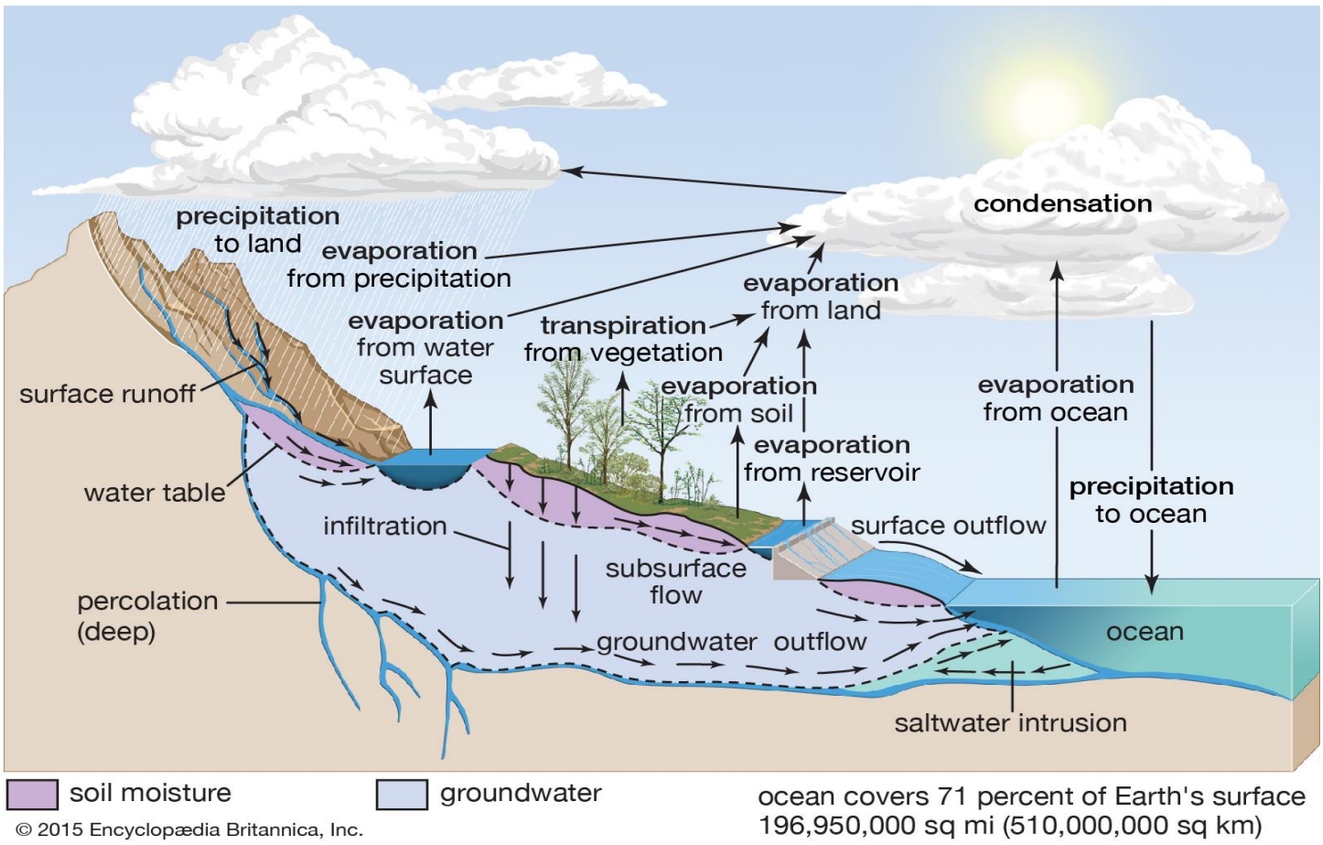


Facts of hydrological cycle

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

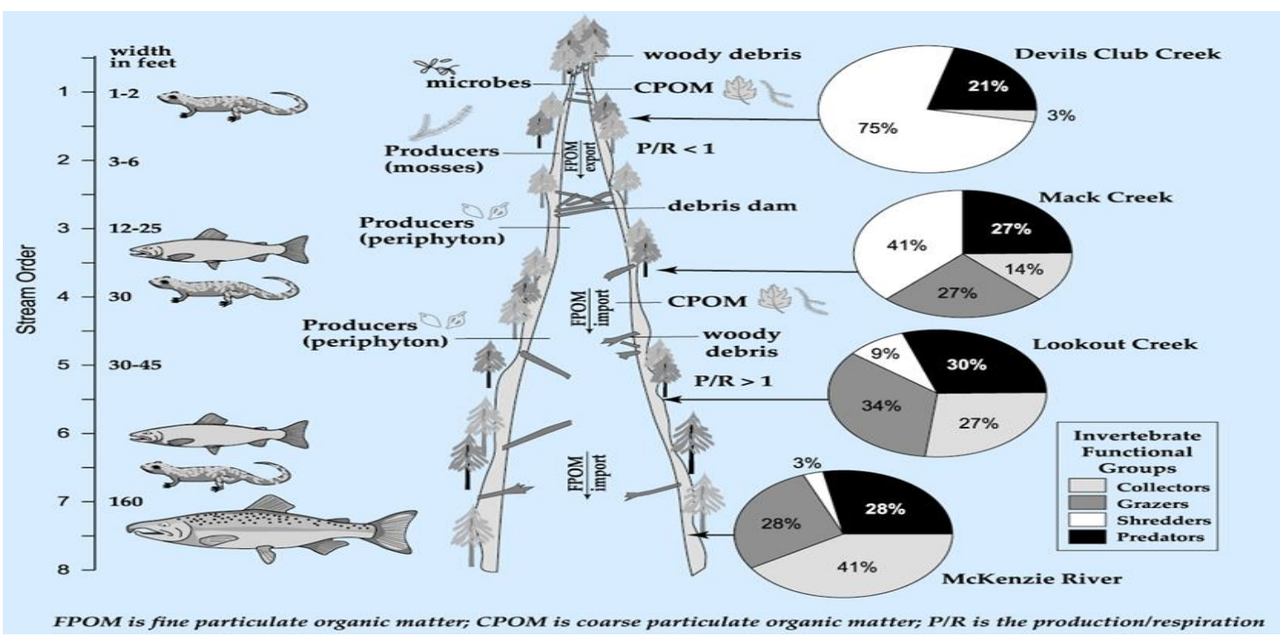
3. Down hill loop releases energy, used for electric power generation and used by ecosystem

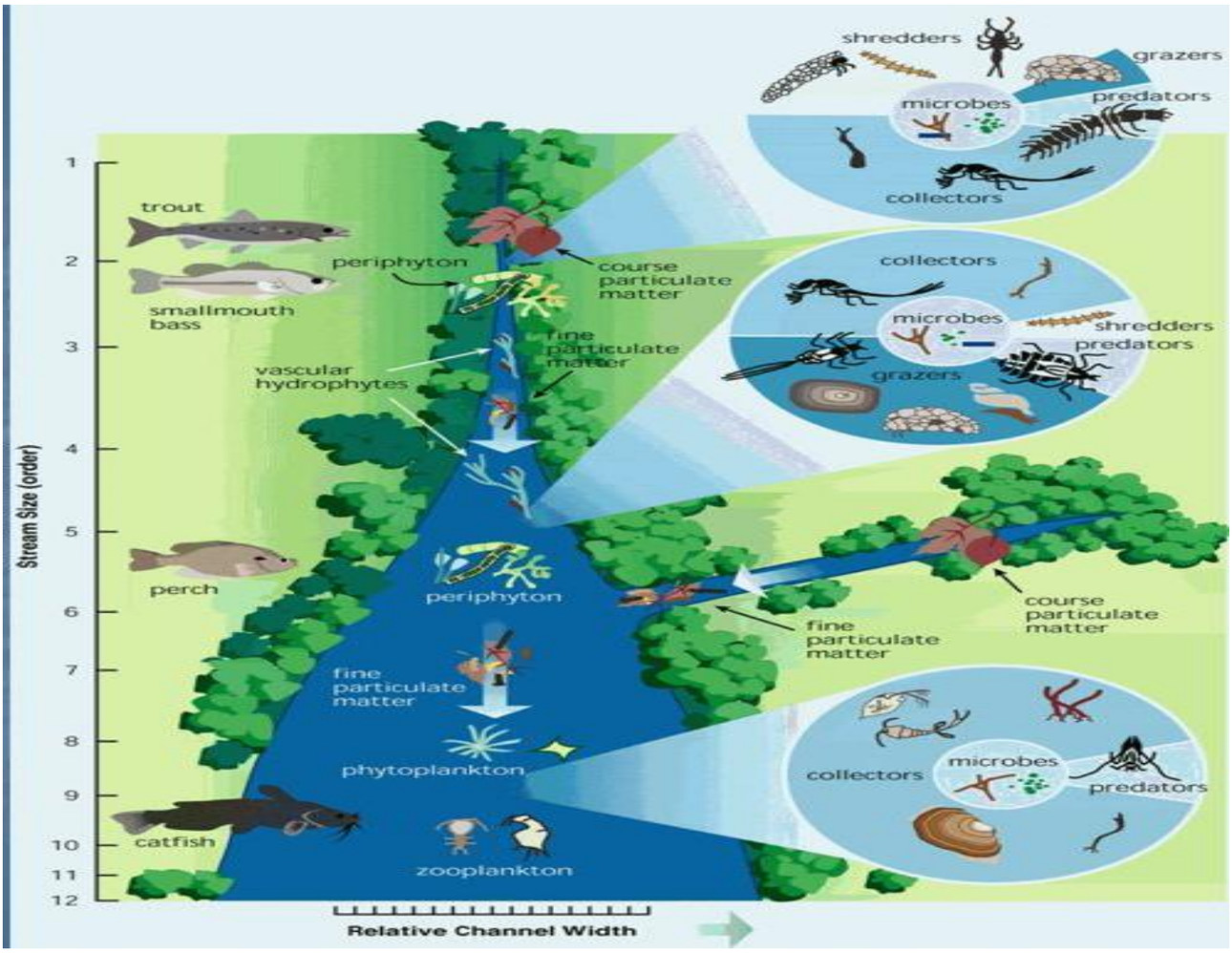
4. Aquifers- under ground water-largest global water reservoir-porous underground strata mostly limestone, sand, gravel, clay that hold water like elongated tank

Lecture 40 Biogeochemical Cycles-Hydrological 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



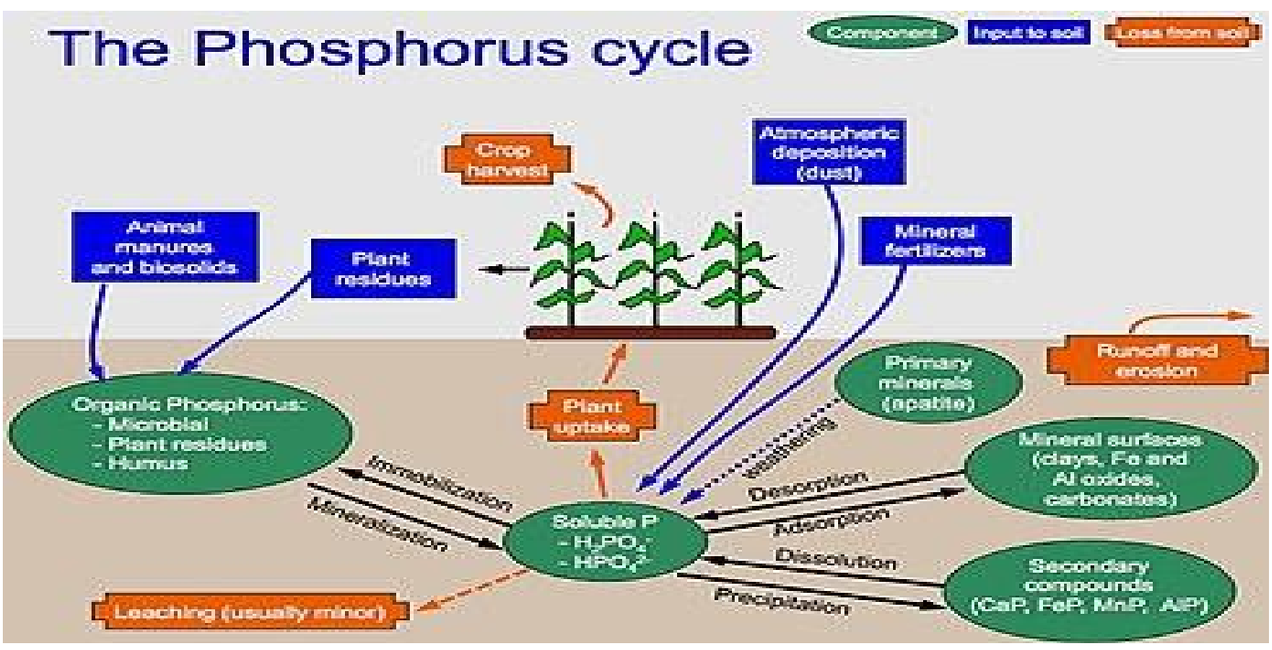


Lecture 41 Biogeochemical Cycles-Phosphorous Cycle

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 (PO4) returns to sea
6. Animal consume plants-phosphorous
7. Death and decay (decomposition), excreta of animals, bones and teeth -Phosphorous return to nature



Lecture 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 bading to green house effect and global warming.

Lecture 43 Population Ecology-Definition

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

Lecture 44 Population Ecology- 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

Quadrate 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

Lecture 45 Population Natality

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

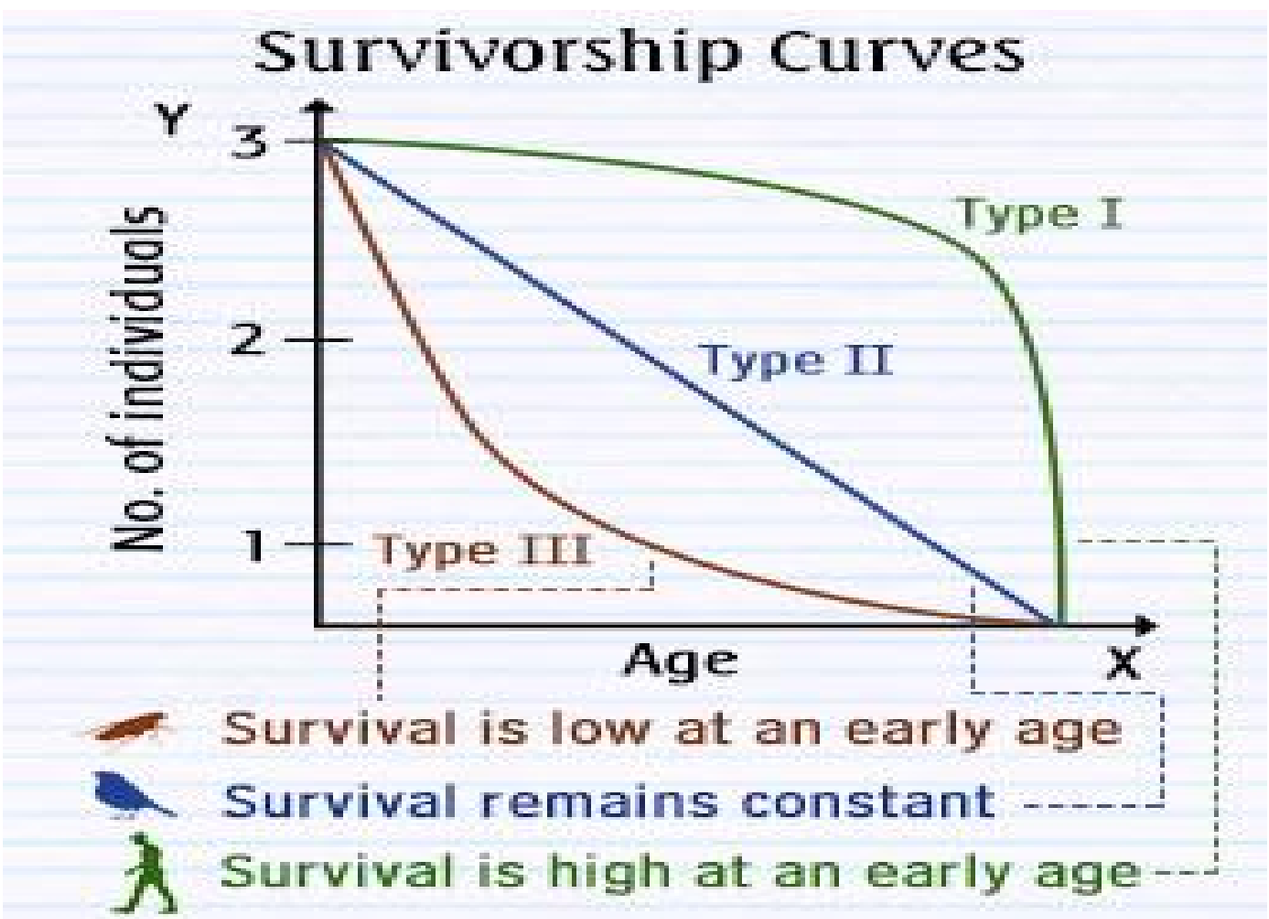
Minimum Mortality- constant for a population- represents the minimum loss under ideal or non-limiting conditions

Lecture 46 Survivorship curve

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



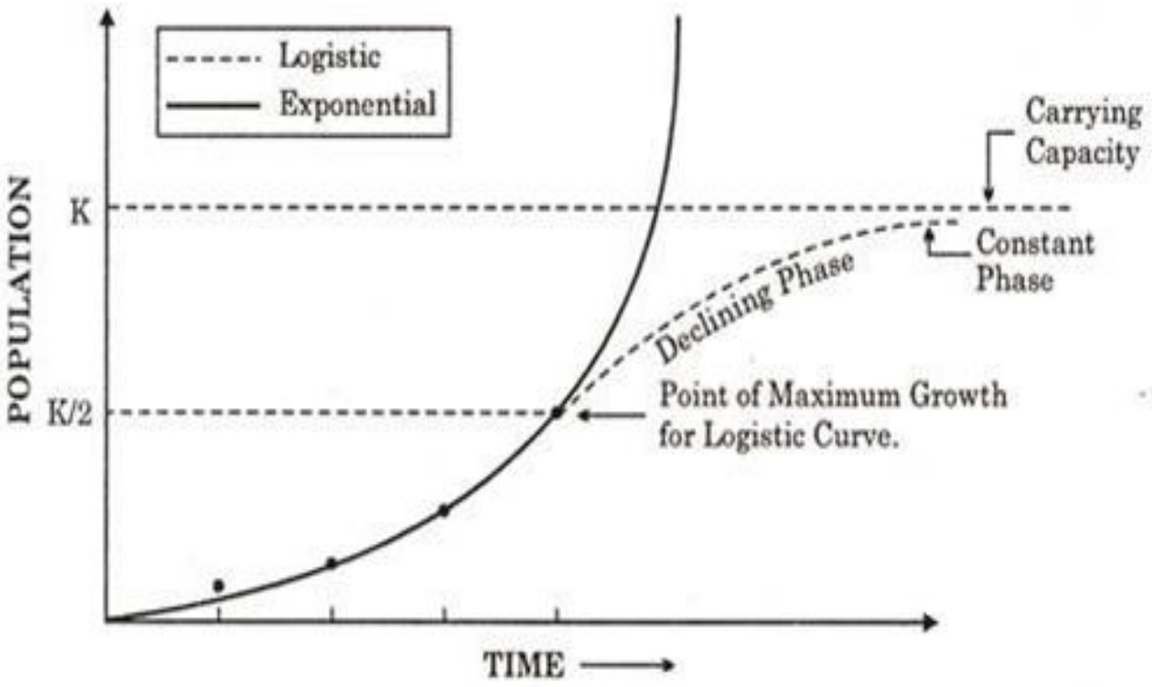
Population Ecology-carrying capacity

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

Growth curves can be

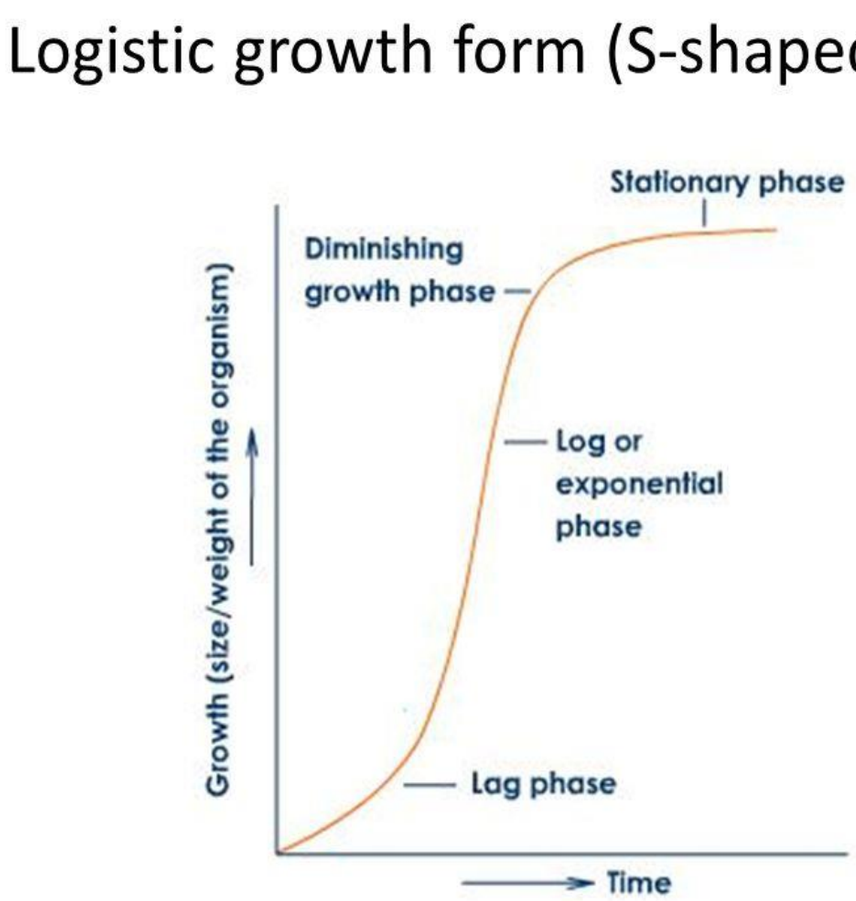
J-shaped

S (sigmoid) shaped



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

Population Ecology-Survivorship curve



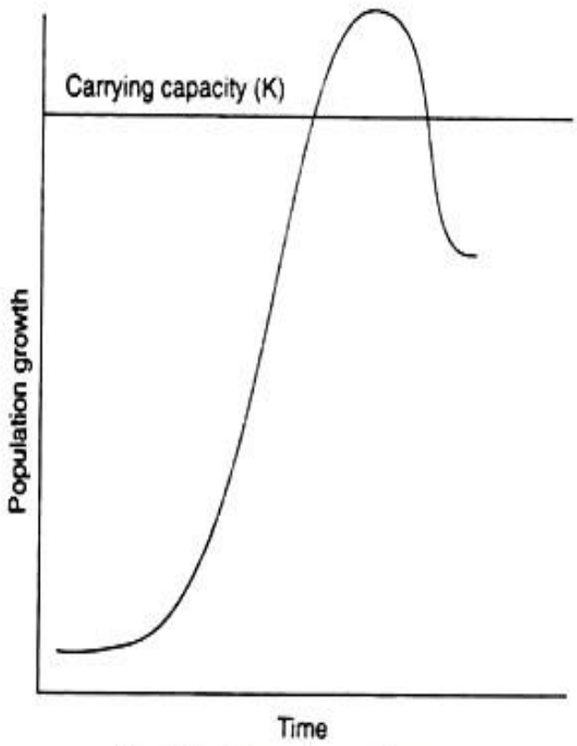
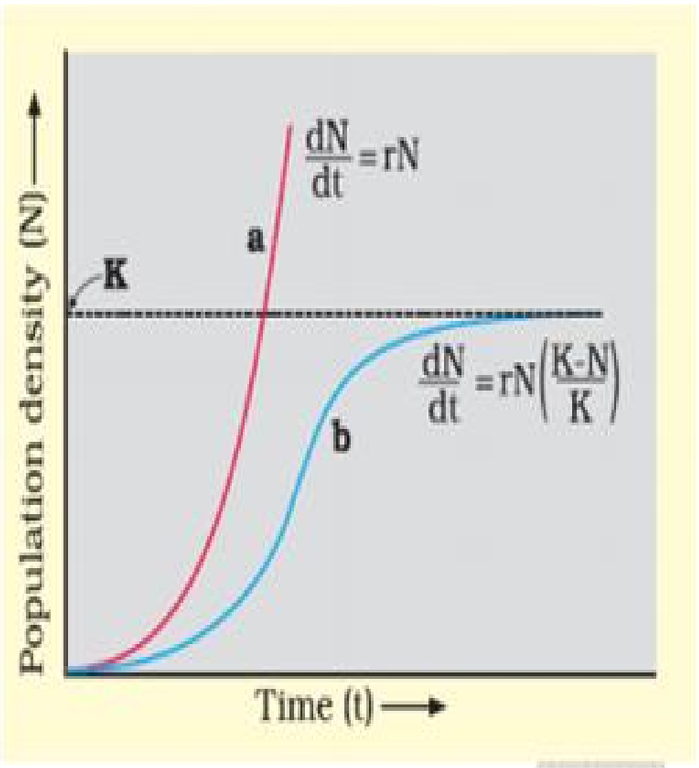
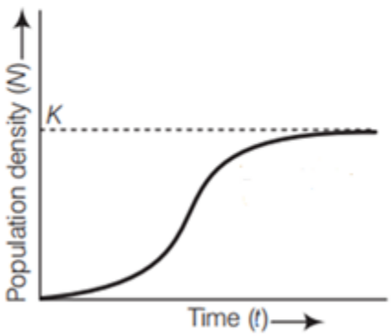
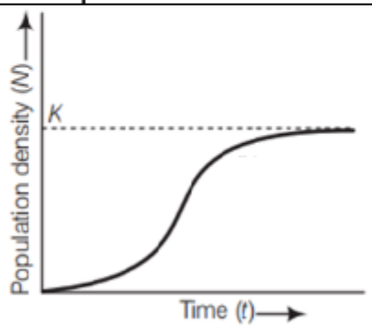


Fig. 4.43 : J-shaped growth curve



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

Lecture 47 Community Ecology-Definition

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

Lecture 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**(+/-).

Lecture 49 Community Ecology-Competition

Competition (-/- interaction),

- where one or both inhibit the population of the other

1. Direct Competition for same recourse

- 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.

Lecture 50 Predation& Herbivory Open

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

Lecture 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

Lecture 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

Lecture 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

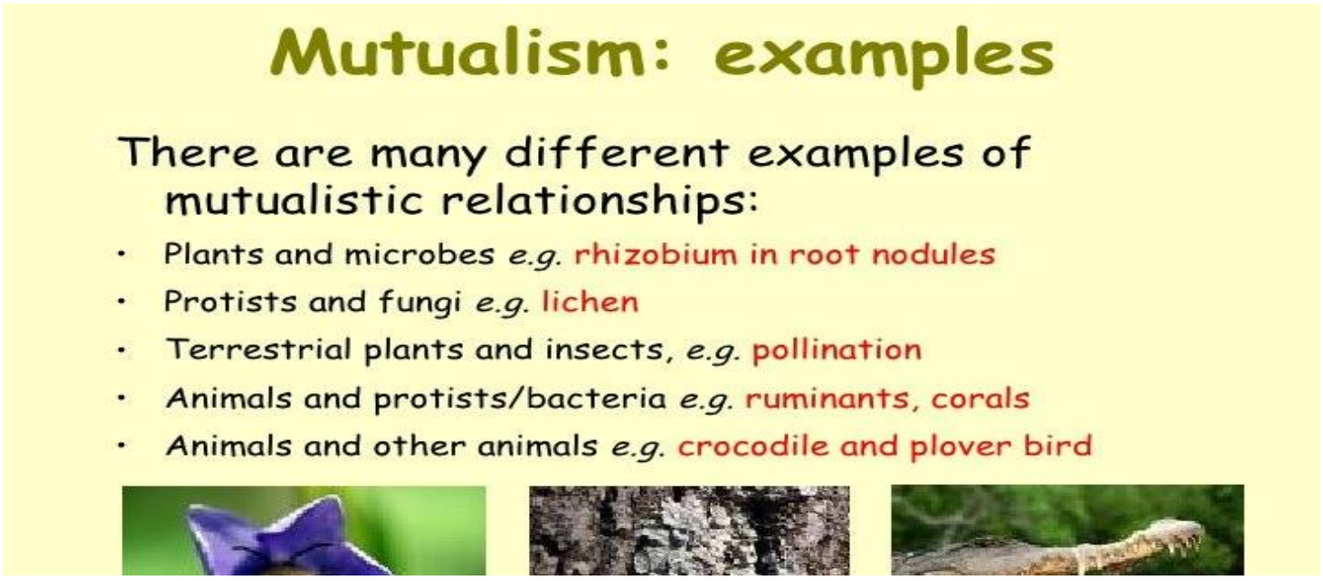
Commensalism: example- grazing cattle and cattle egrets. As the cattle graze in the grass, they stir up the insects living there, allowing the cattle egret a tasty meal. The cattle egrets get a meal, but the cattle receive nothing in return from the long-necked birds, nor are they harmed by the relationship.

Lecture 54 Community Ecology-Mutualism

Mutualism: (+/+) interaction

- two species have a long-term interaction that is beneficial to both of them

- **Example-**
- Lichens **and** Mycorrhizae



Lecture 55 Amensalism

Amensalism: (-/0,Interaction)

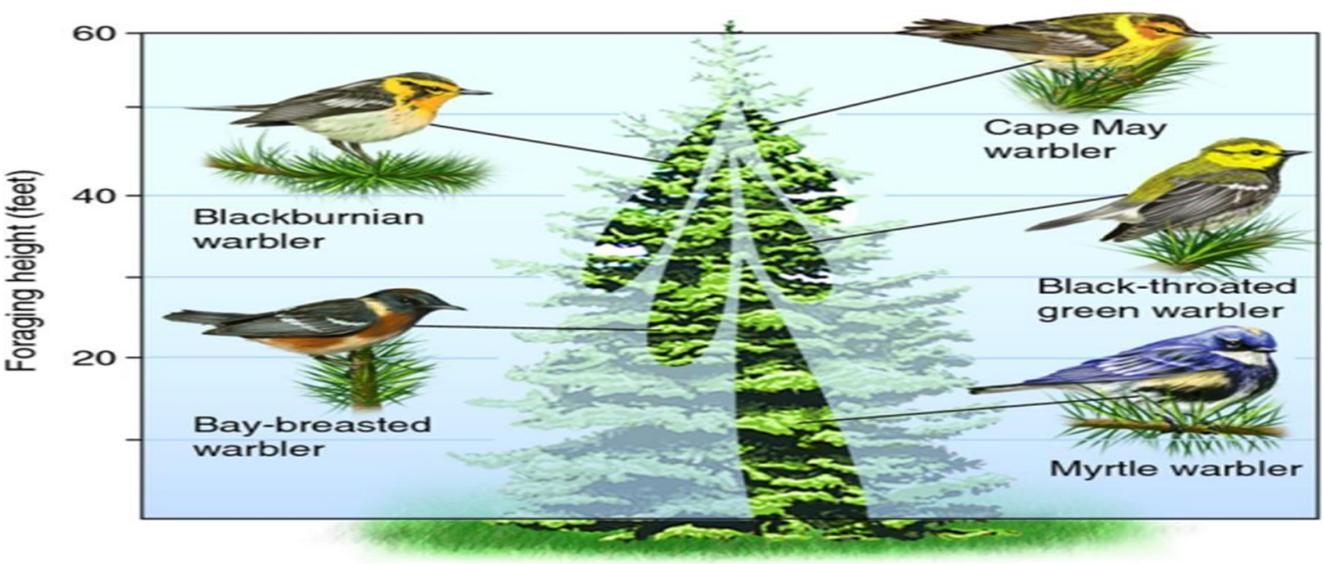
It describes an interaction in which the presence of one species has a negative effect on another, but the first species is unaffected.

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

Lecture 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 its plays in its habitat.



Lecture 57 Community Ecology- Succession

Succession

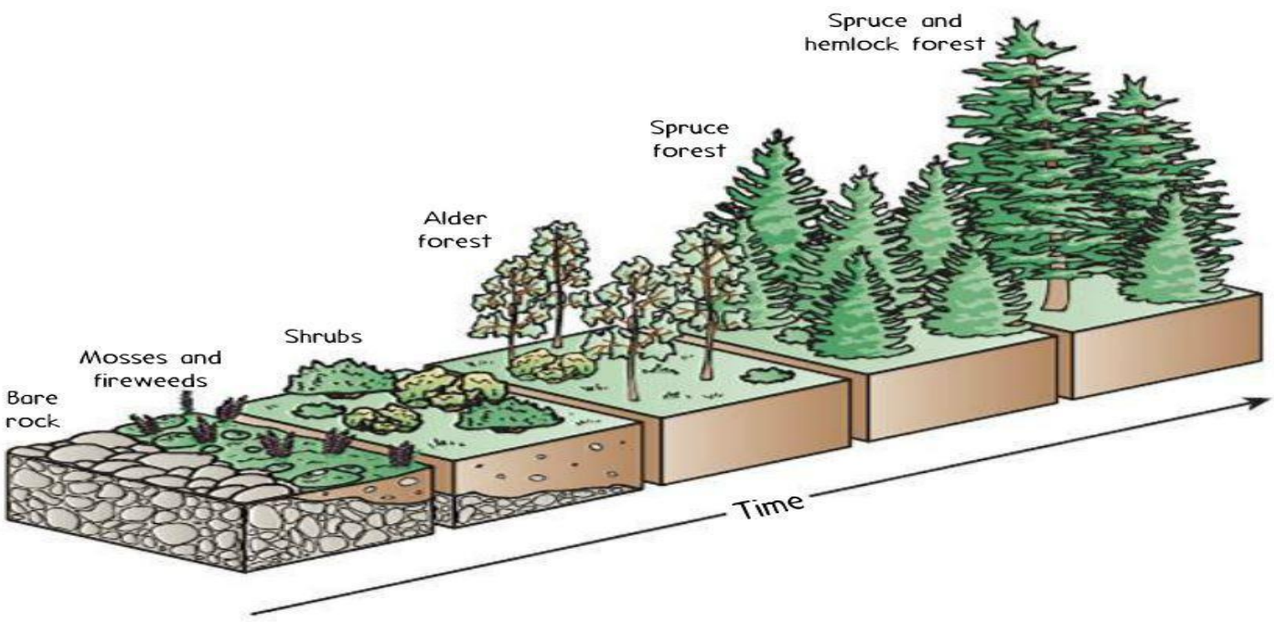
Succession • The process by which communities of plant and animal species in an area are replaced by another over a period of time is known as ecological succession

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

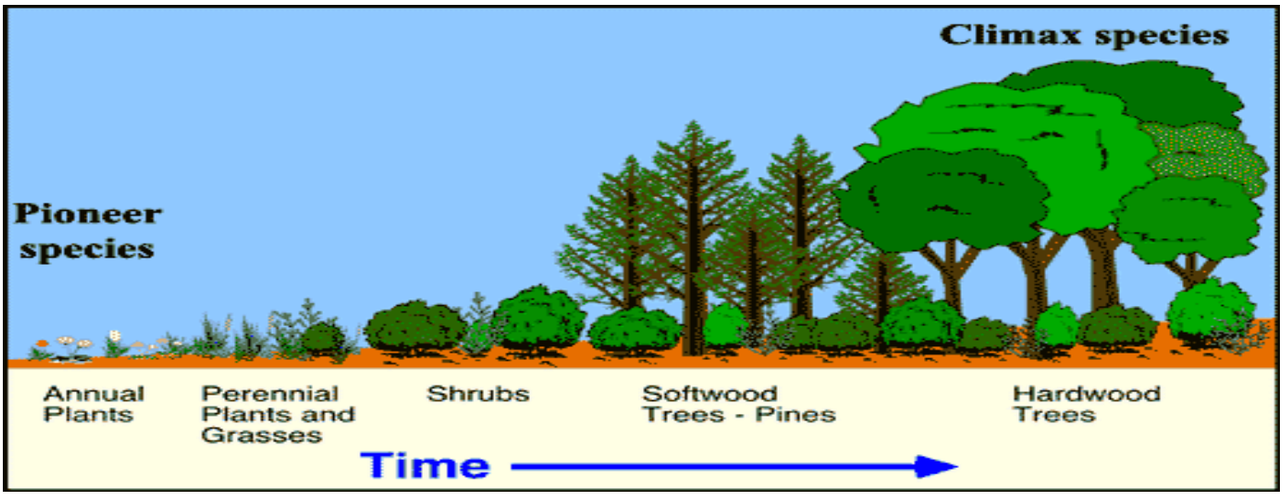
Seral stage

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

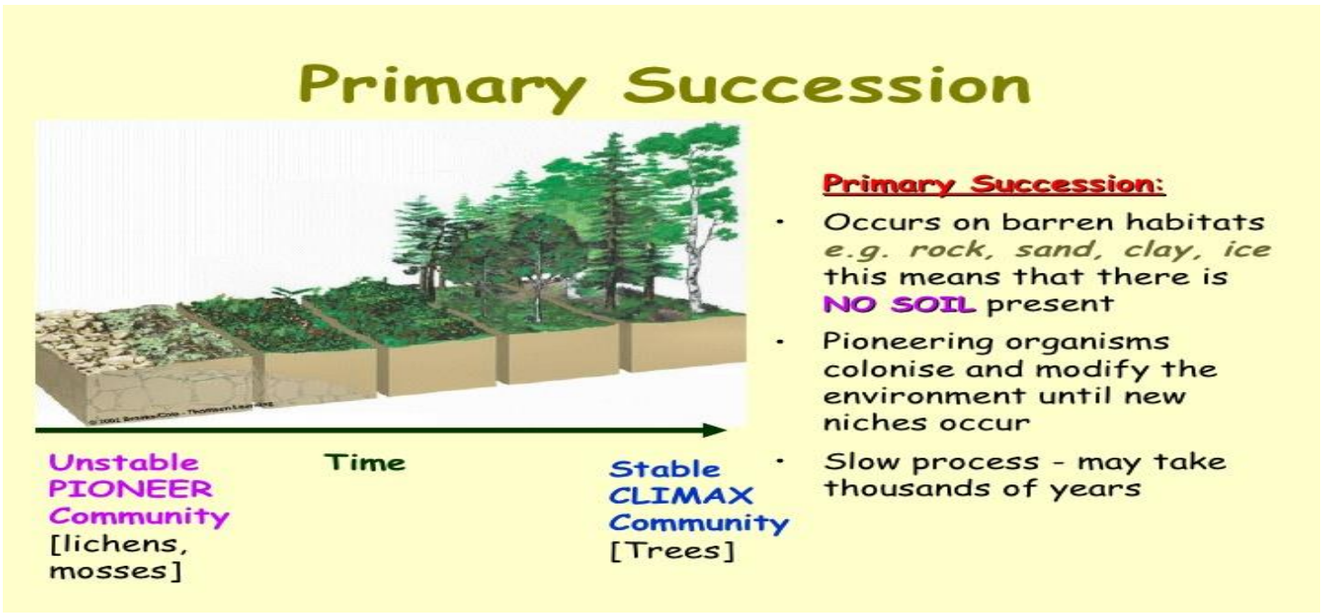


Seral stage

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

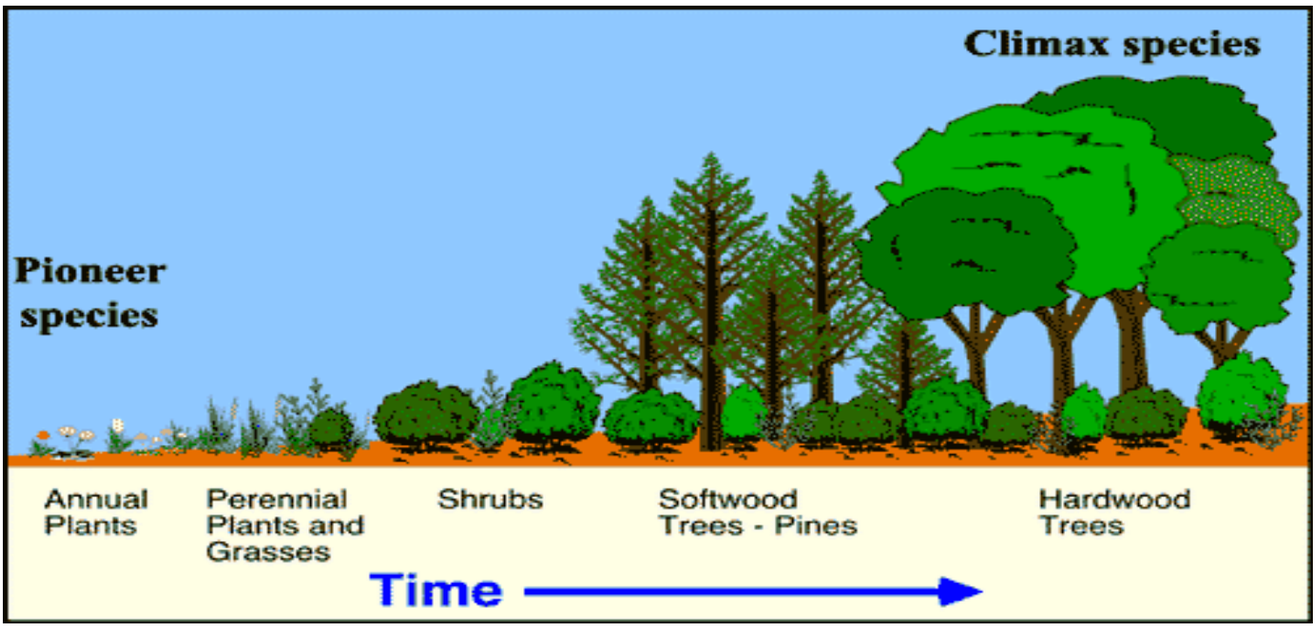
Each successional stage is called a **seral stage,**

and the entire successional sequence is a **sere**



Lecture 58 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

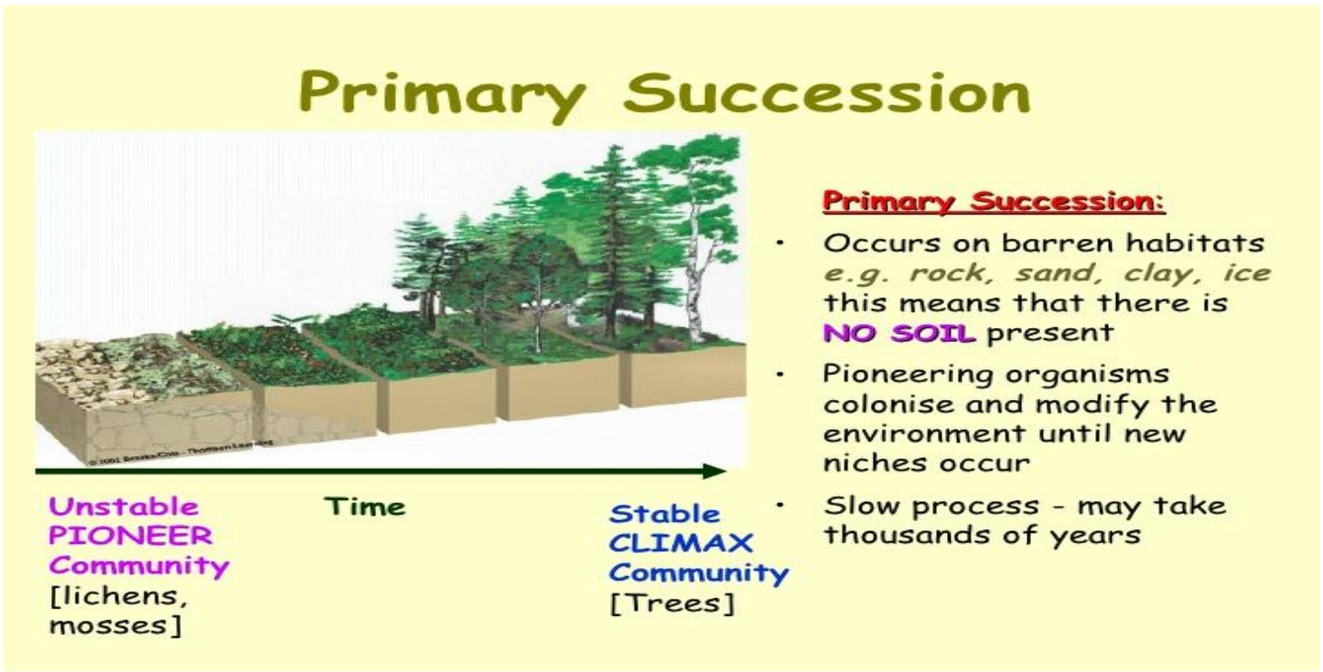


Two types:

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)



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

Lecture 59 World 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.

Lecture 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

Lecture 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) T**undra 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

Lecture 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

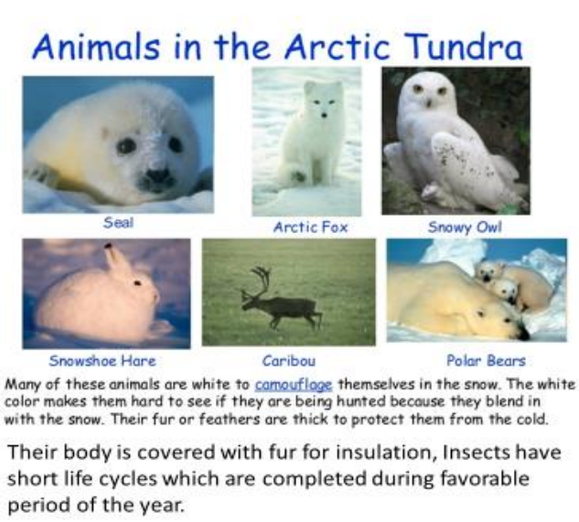
Tundra Climate

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



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

Lecture 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

Lecturer 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.

Lecture 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.

Lecture 66 Temperate Decidous 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, **Winte**r 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 heath**, **chest nuts, pitch pine, cyprus**. Invertebrate fauna comprises green **oak**

moth, bark beetle, green flies, aphids, sapflies, moths and butterflies.

Lecture 67 Temperate Deciduous Forests 2

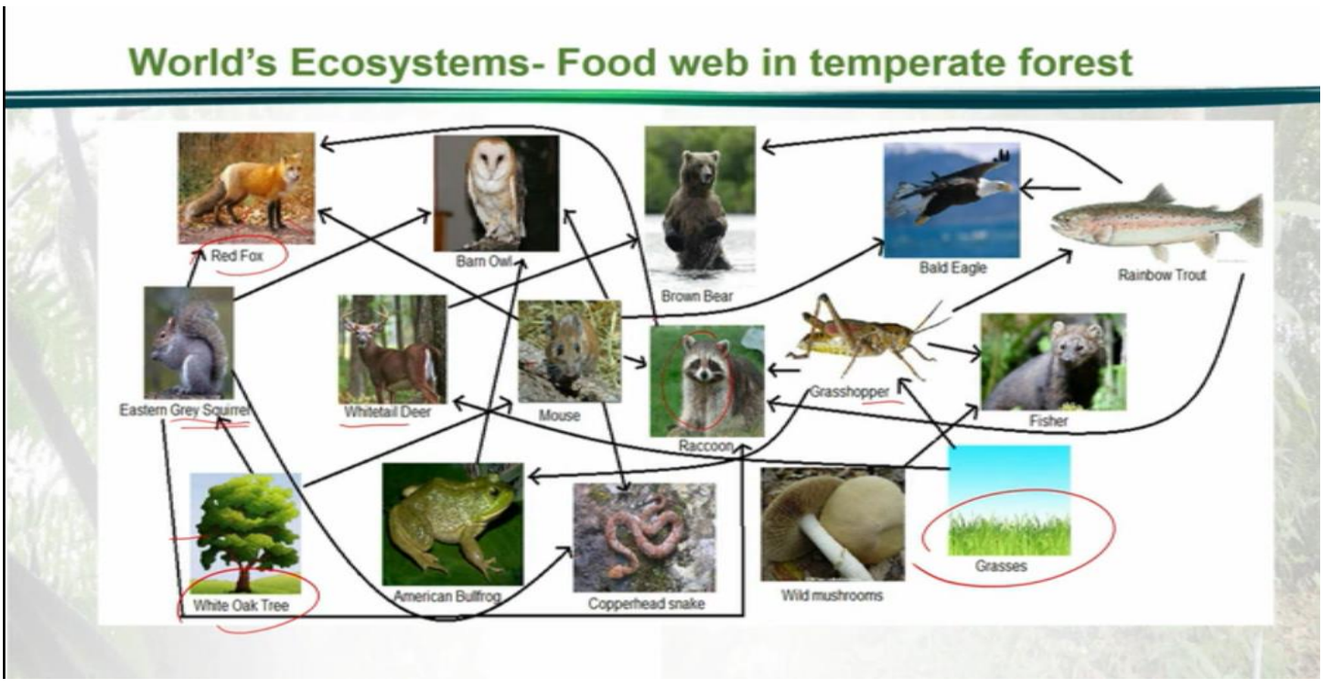
Flora and fauna : Prominent

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.

Lecture 68 Food Web of Temperate forest



Lecture 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**.

Lecture 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.

Lecture 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.

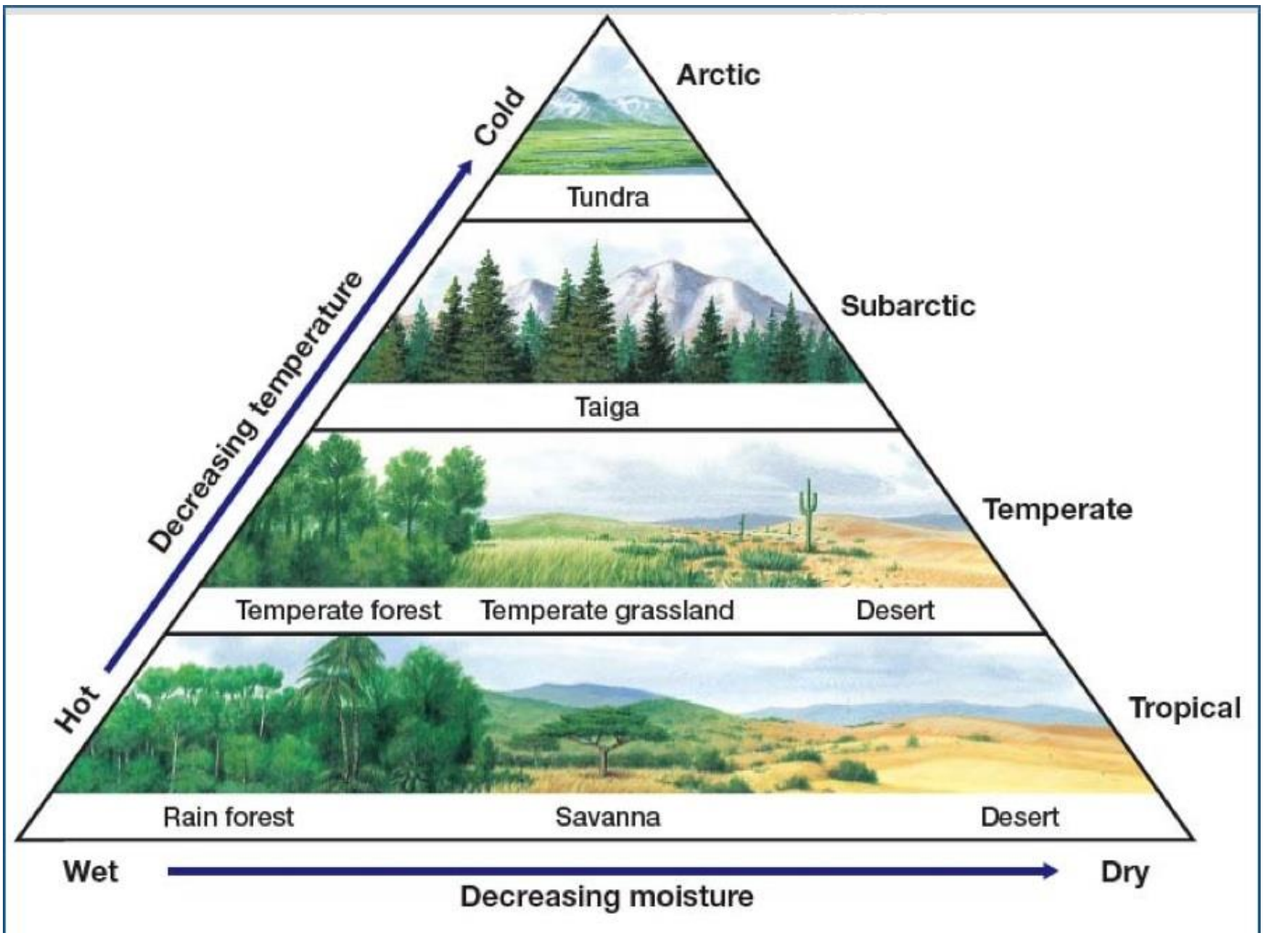
Lecture 72 World's Ecosystems-Grassland Ecosystem

Grasslands:

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

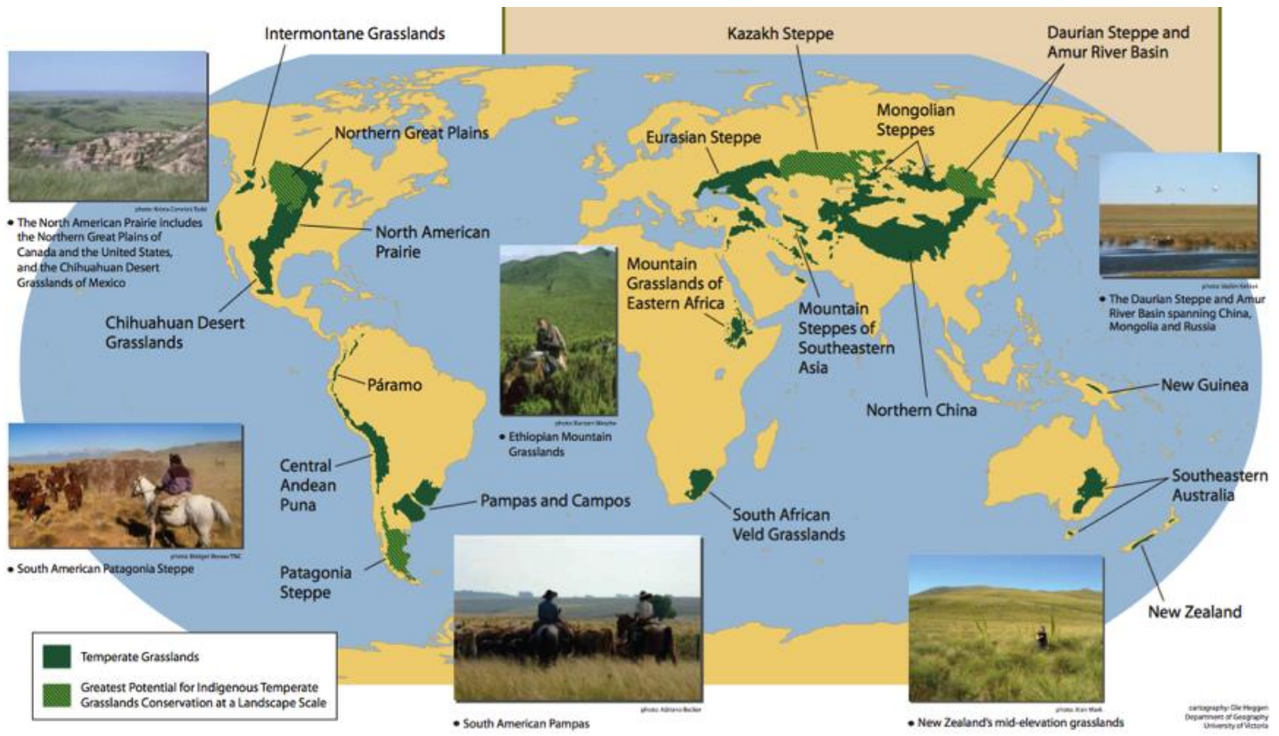
Grasslands Distribution : They occur in both tropical and temperate regions where environmental conditions are better than that of the desert but rainfall is not enough to support the growth of trees

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



Lecture 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.**



Lecture 74 Tropical grasslands

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

African Savannah grassland

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, tipachak- 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

Feather grass

Steppes

Wild horse on the steppe of Kyrgyzstan, Central Asia

Antelopes

Lecture 76 World's Ecosystems-Desert Ecosystem

- **Deserts Distribution :** Deserts are waterless barren regions of the earth.

- They occupy about 1/7th 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

Lecture 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

Lecture 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

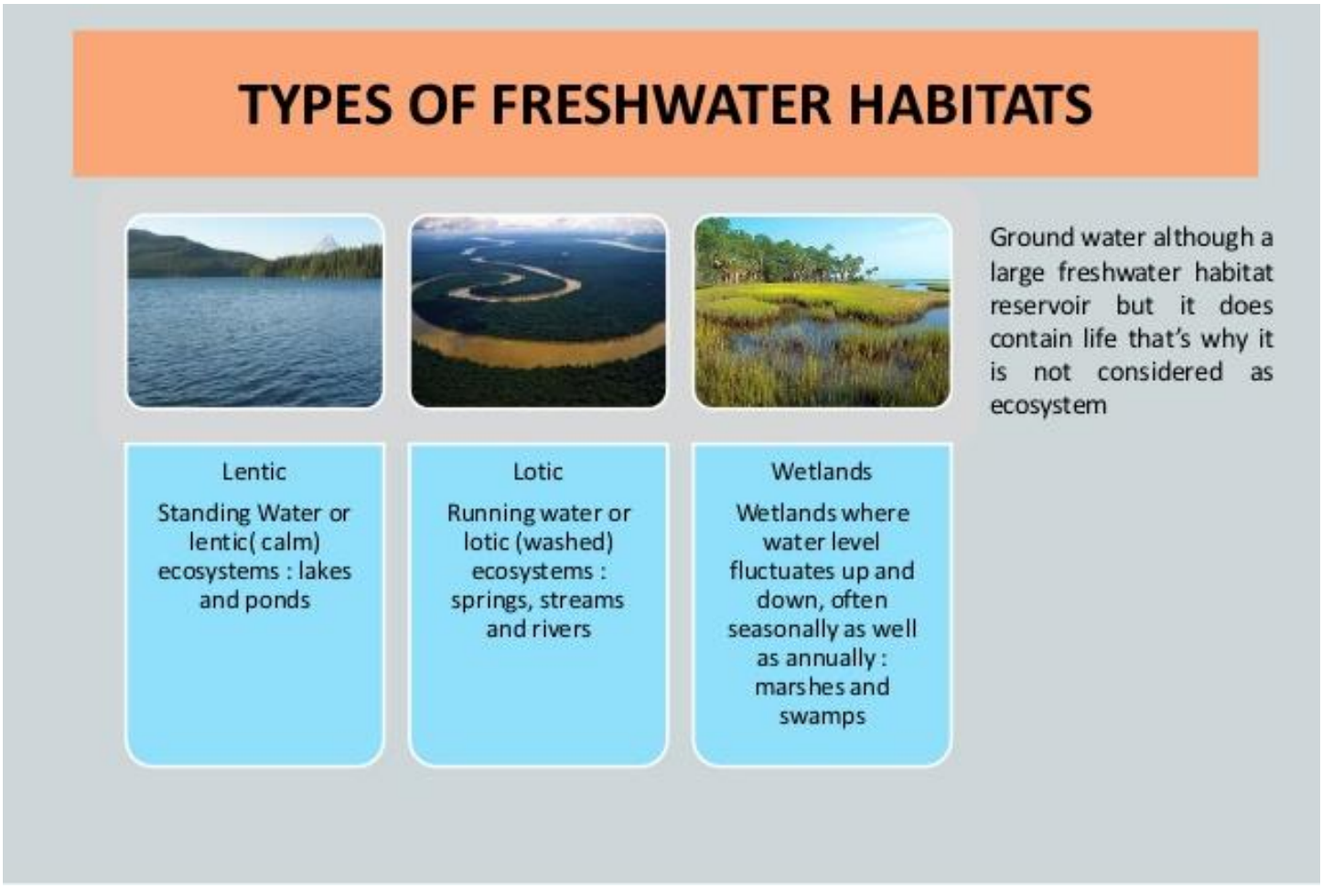
are classified on the basis of salinity into following two types:

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**



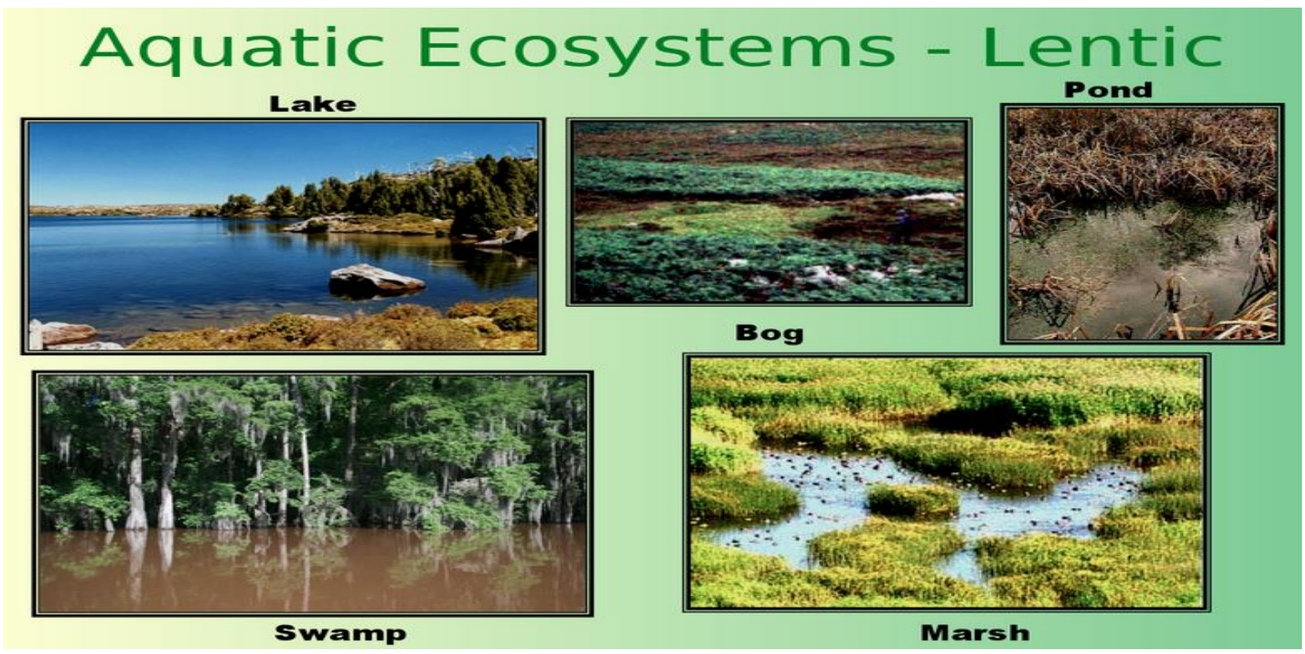
Lecture 79 Types of aquatic ecosystem

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



Lecture 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.

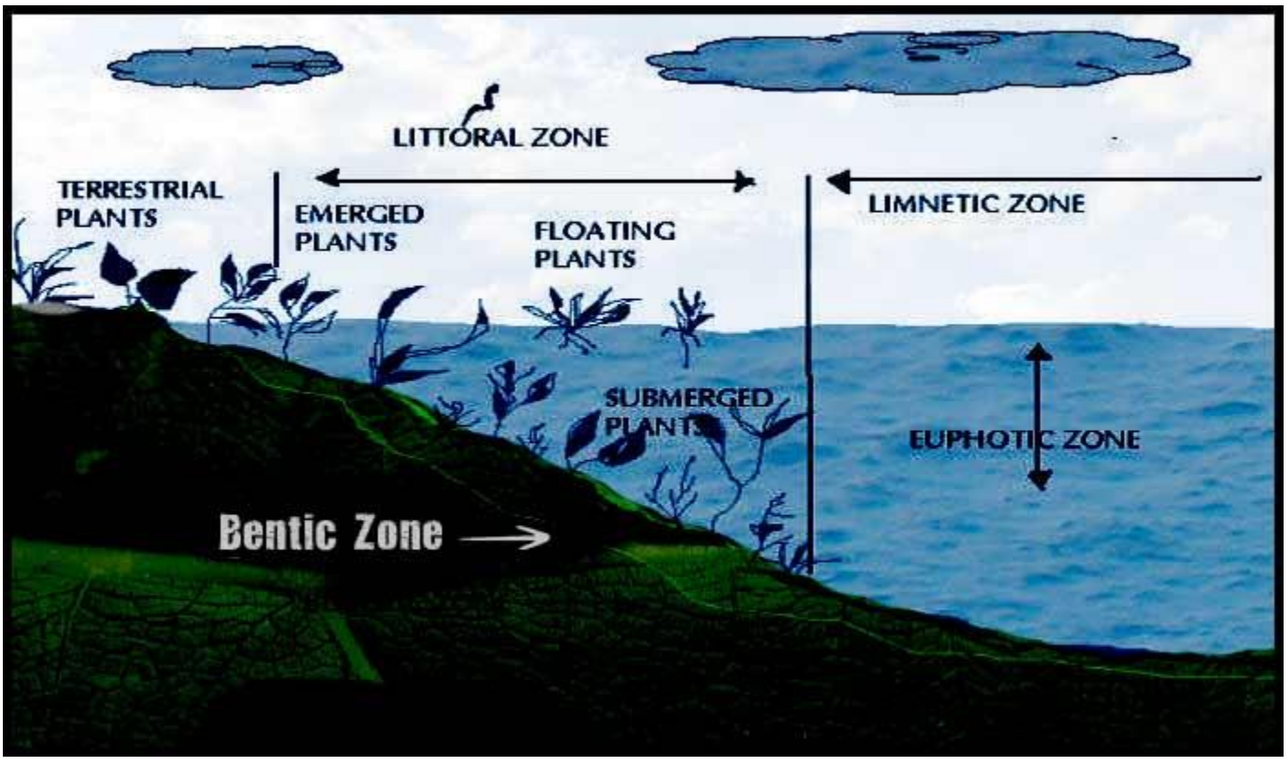
(iv) Birds such as herons, water fowls and ducks occurs in and around water.

Fresh Water Ecosystem

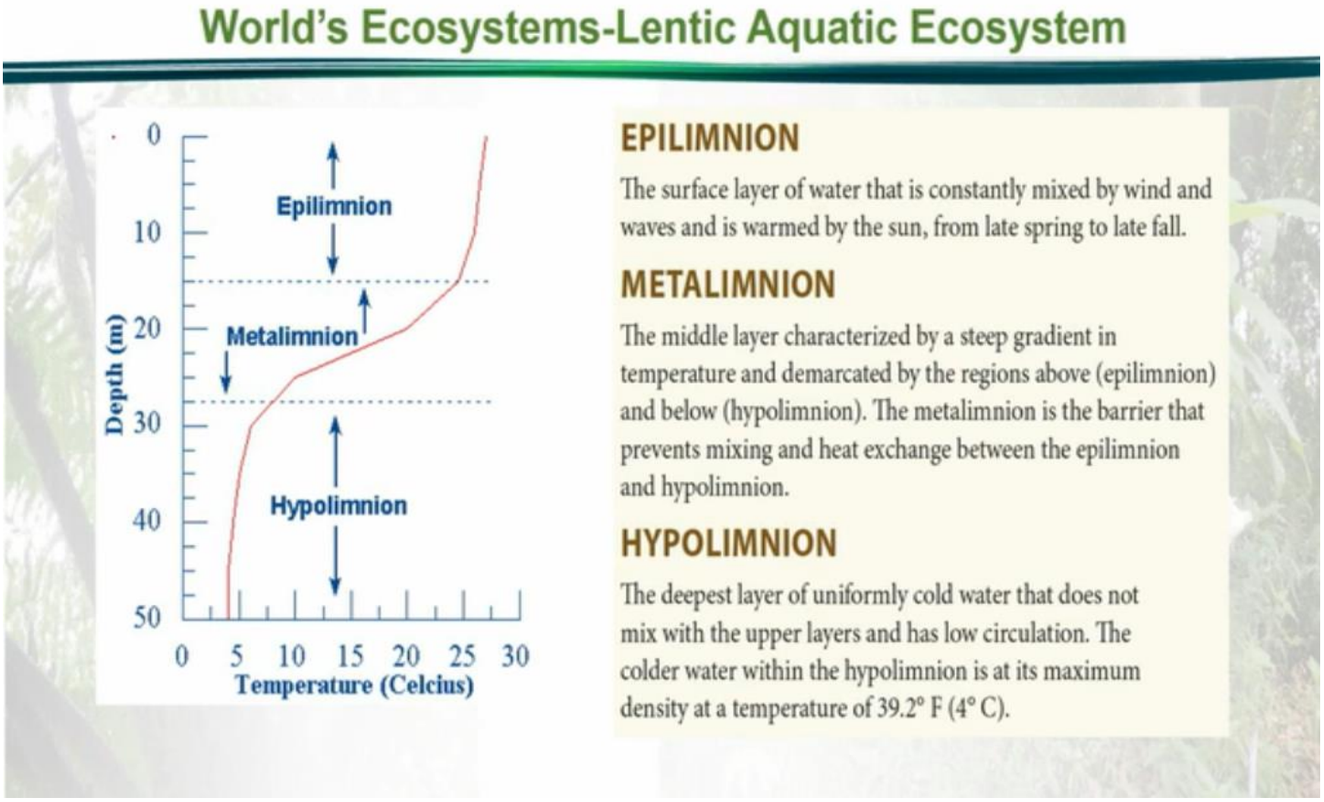
The common animals in ponds and lakes include

(i) Zooplankton (freely floating microscopic animals) such a protozoans and crustaceans

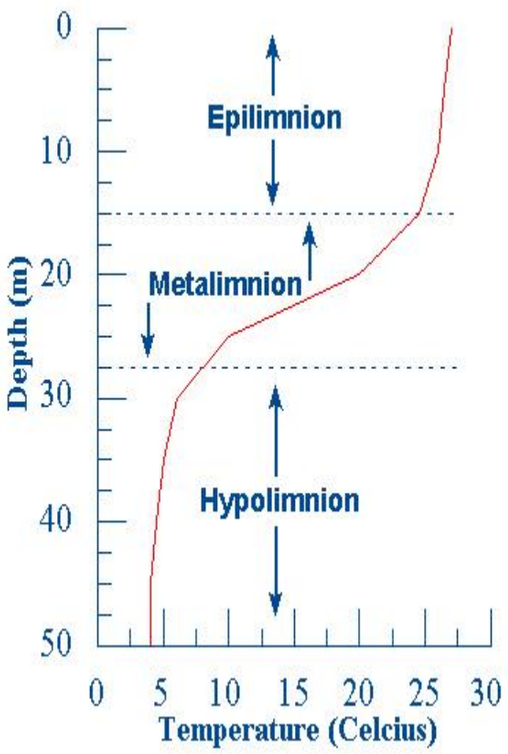
(ii) Actively swimming fishes, frogs, tortoises (Nekton).

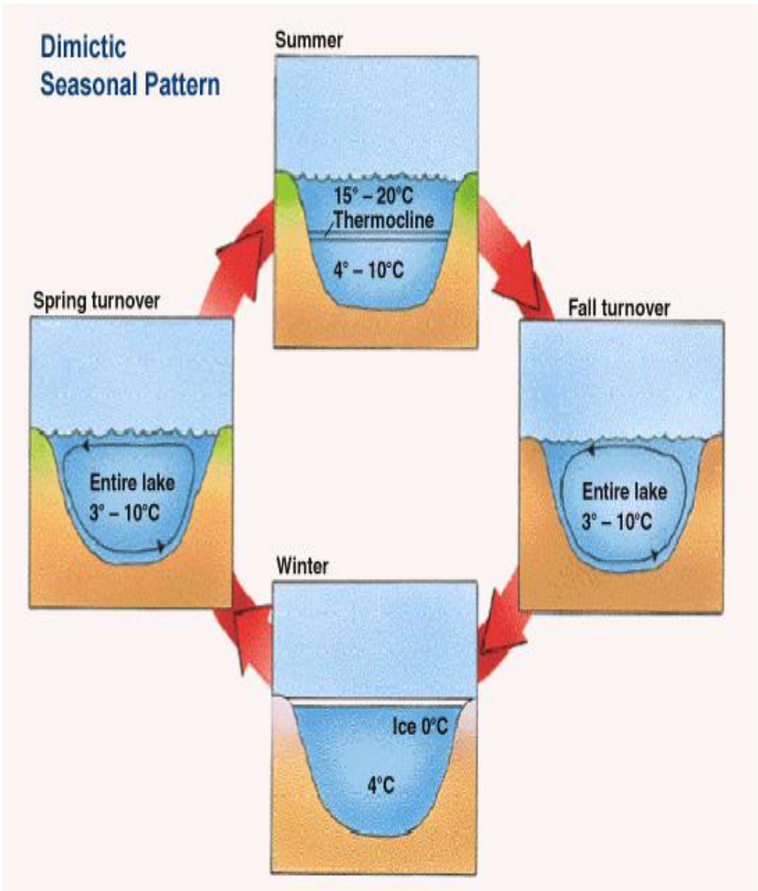


Lecture 81 Thermal stratification in lakes



Thermal stratification in summer in lakes





Lecture 82 Lotic freshwater Ecosystem

Lotic freshwater Ecosystem

(Rivers, Streams, Springs)

a) Perennial or seasonal Species adaptive to live in condition of constant flow Variation is determined by

b) Shape of stream, riverbed

c) Stream or river gradient

Lotic freshwater Ecosystem

d) Quantity of water

e) Velocity of current (faster moving water has more dissolved oxygen, support diversity)

f) Light

Lecture 83 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

Lecture 84

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

Lecture 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

Lecture 86 Marine Ecosystem Temperature, Pressure & Light

Marine Ecosystem

Temperature : The range of temperature variation is much less in sea than on the

land although near the surface it is considerable from –2°C in antarctic ocean to 27°C in the warmer waters of pacific ocean. In the deeper layers temp. is

constant at about 2°C.

Marine Ecosystem

Light : The light reaches up-to a certain depth only. Deeper regions are permanently

dark.

Marine Ecosystem

Pressure : Pressure increases with depth in oceans. It is 1 atmosphere near the surface and 1000 atmosphere at greatest depth.

Lecture 87 Marine Ecosystem Tides

Marine Ecosystem

Tides : The gravitational pulls of the sun and the moon cause tides in oceans. At the time of full moon and new moon tides are high and are called **spring tides**.

At quarter moon the tides are exceptionally low and are known as low tide or **neap tides**

Lecture 88 Marine Ecosystem Flora and fauna

Marine Ecosystem

Flora and fauna : Life in the oceans is limited but its biodiversity is very high as compared to terrestrial ecosystems. Almost every major group of animals occur somewhere or the other in the sea. except for insects and vascular plant are completely absent

Lecture 89 Geography of Pakistan

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

Lecture 90 Pakistan Geography-Forests

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. 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 geradiana* (Chilgoza), *Indigofera gerardiana, Sorbaria tomentosa, Sambucus ebulus*

Lecture 91 Dry temperate Coniferous Forest Fauna

4. 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

Royle's Pika

long tailed field mouse

yellow throated marten

small Kashmir flying squirrel

Lecture 92 Himalayan Moist Temperate Forest

5. Himalayan Moist Temperate Forest

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

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

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

Lecture 93 Sub-tropical Pine Forest

6. 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

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

Lecture 94 Tropical Deciduous Forest

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

Lecture 95 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 polycarpos, Pinus wallichiana, P.geradiana*

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

Lecture 96