Virtual University of Pakistan

Federal Government University

UPDATED 2021 TOPIC 1 TO 179

World-Class Education at Your Doorstep

MSC-ZOOLOGY

ZOO507-Principles-of-Animal-Ecology

HANDOUTS TOPIC NO 1 TO 179

MUHAMMAD IMRAN

Principles of animal Ecology

Lecture No. 1 Introduction

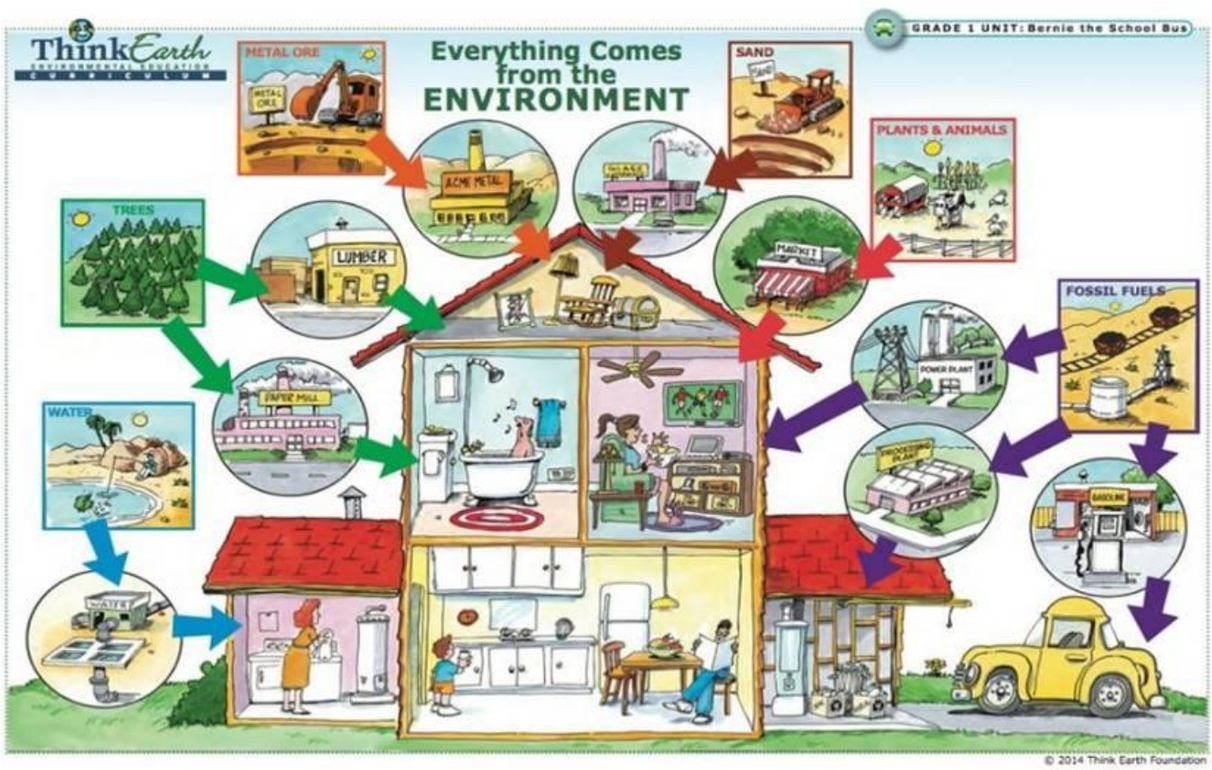
Agenda

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

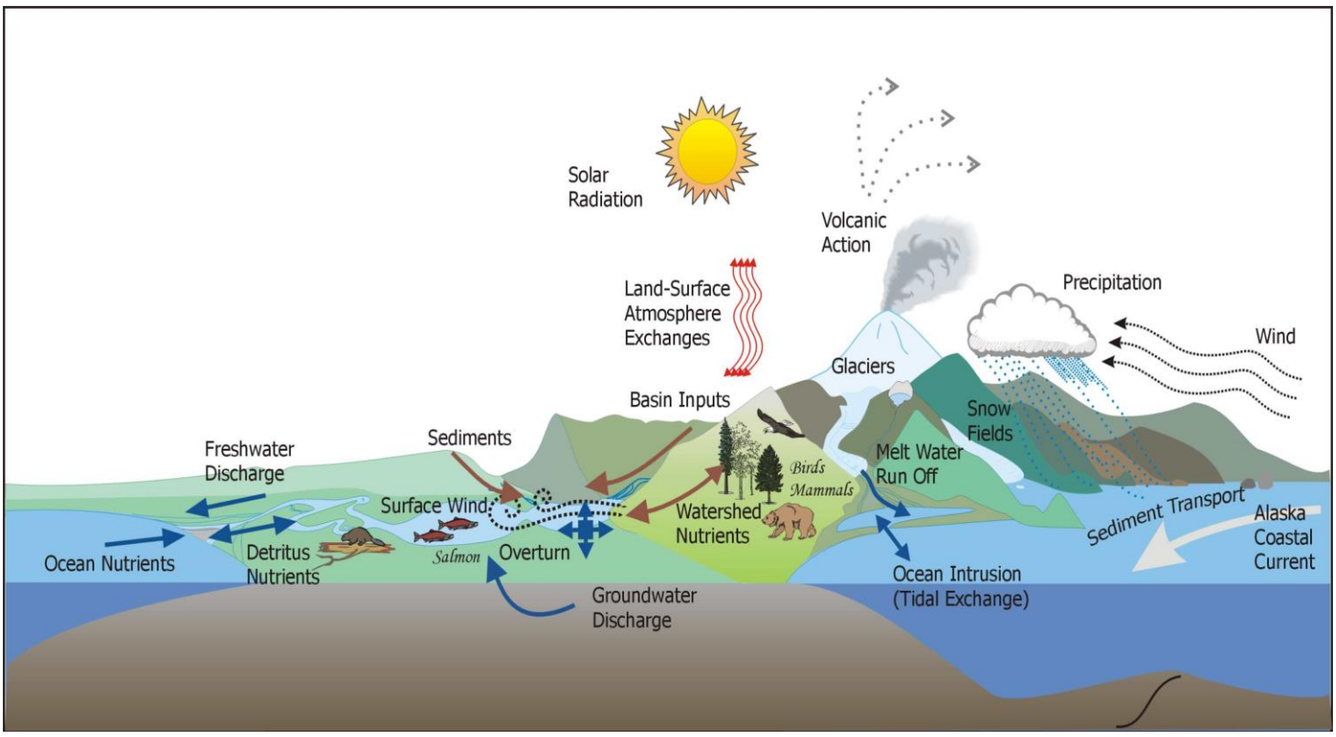
Topic 3 Ecology and Environment: Importance

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

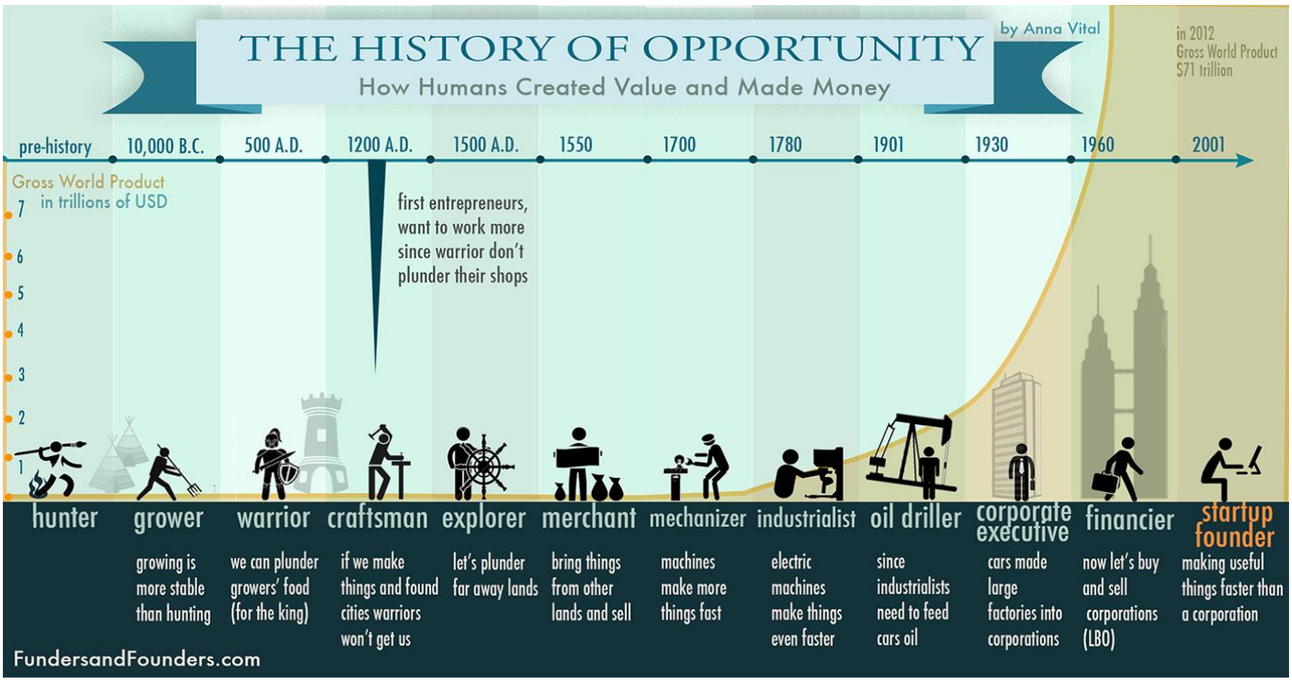
Relevance to man kind

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—

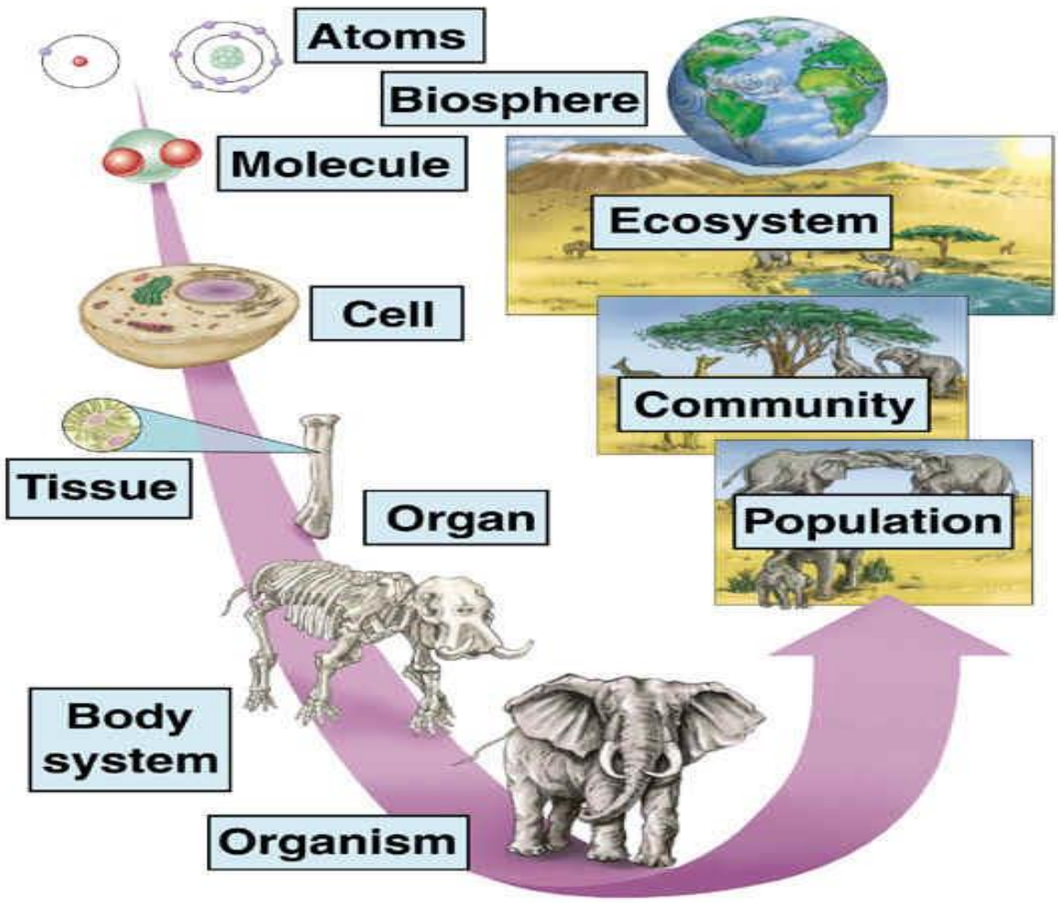
a) **organismal**, organisms interactions with their environments

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

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

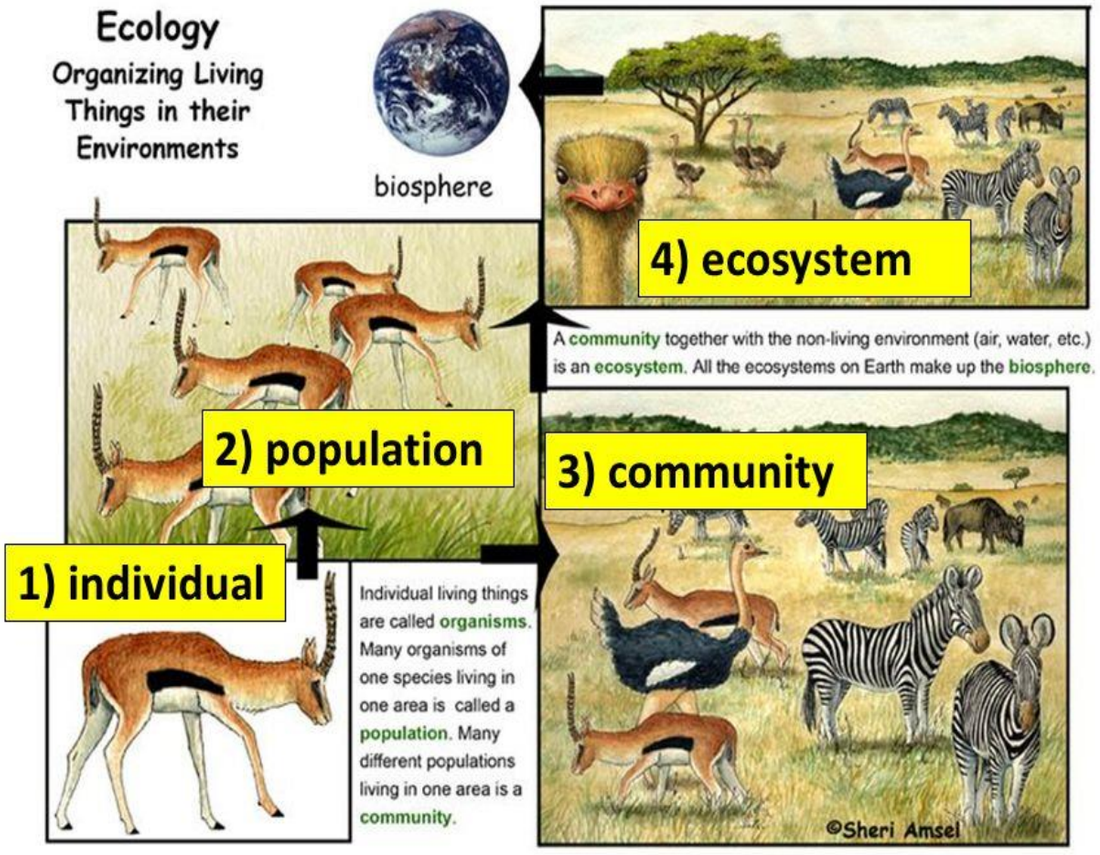
d) **Ecosystem**, examine the living species (the biotic components) of the ecosystem and the nonliving portions (abiotic components), such as air, water, and soil, of the environment.

Raven/Berg, Environment, 3/e
Figure 4.1



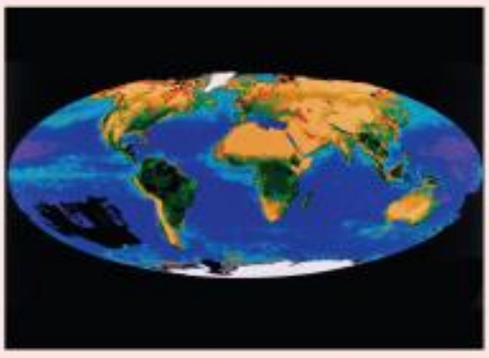
Harcourt, Inc.

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

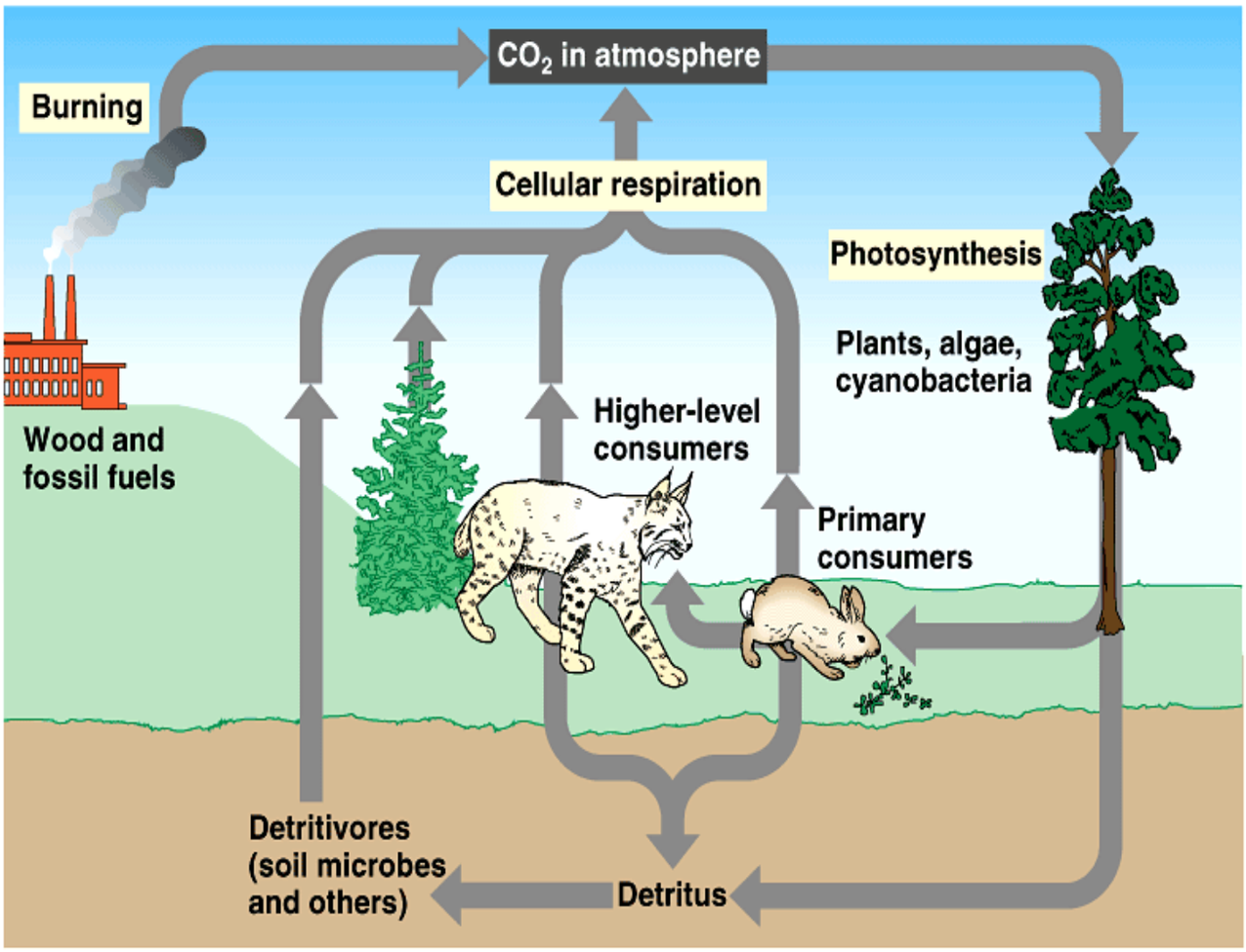
-inseparable

-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

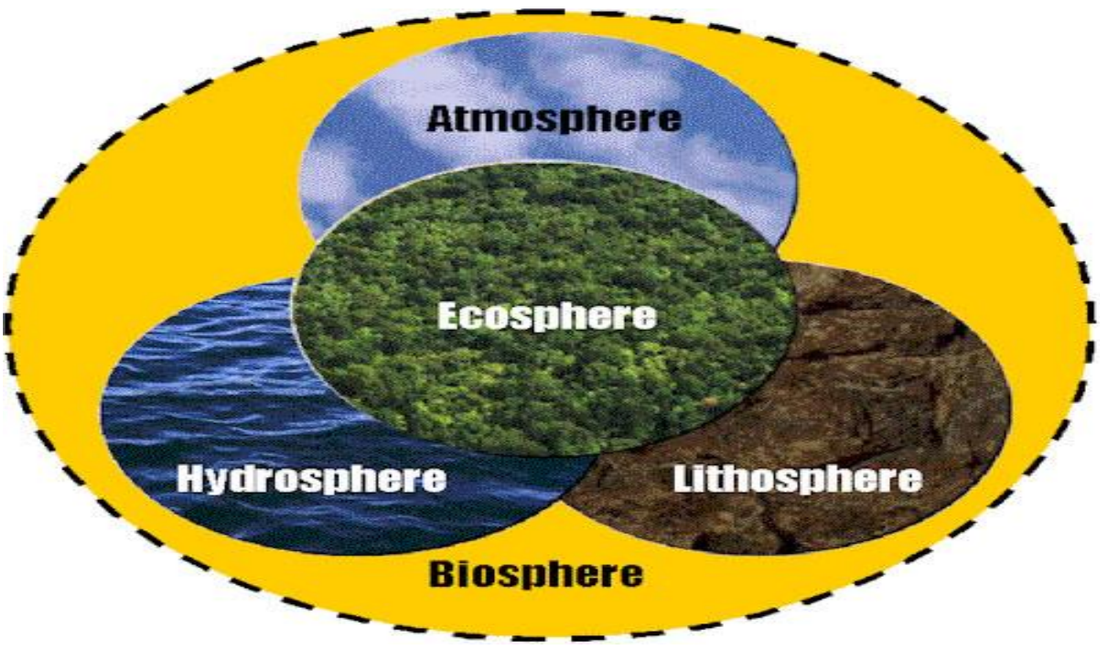
Hydrosphere-water

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

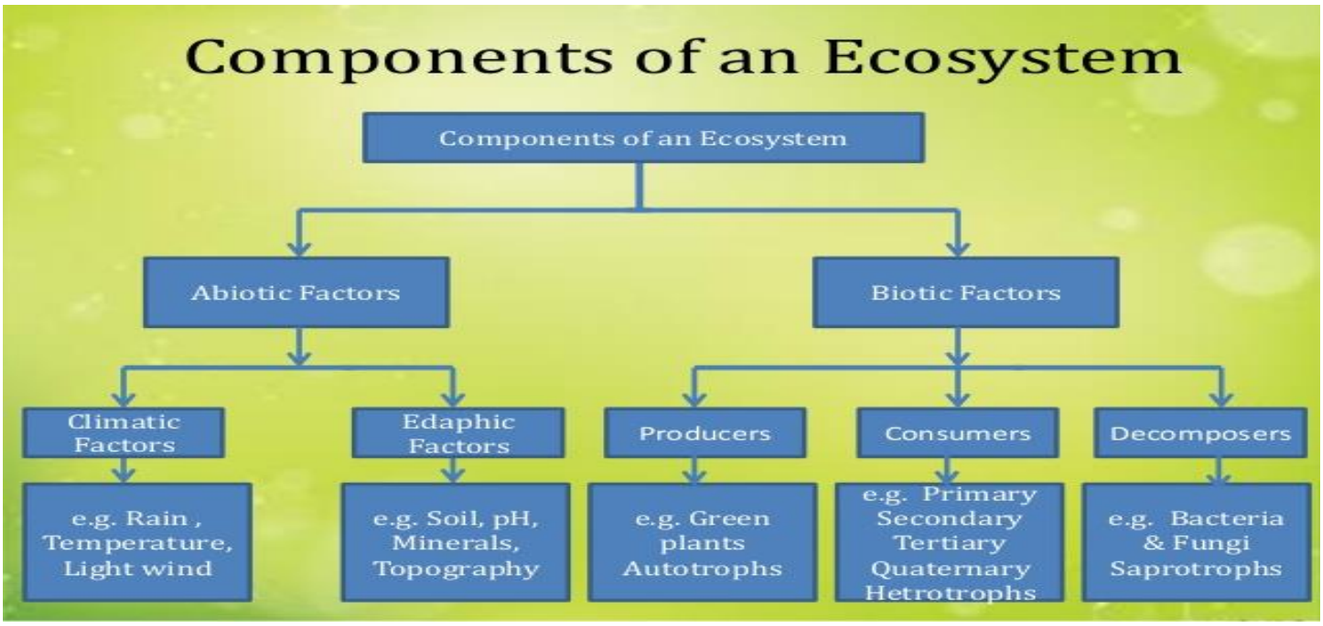
a.Lentic (Stagnant water) like lake, ponds etc.

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.

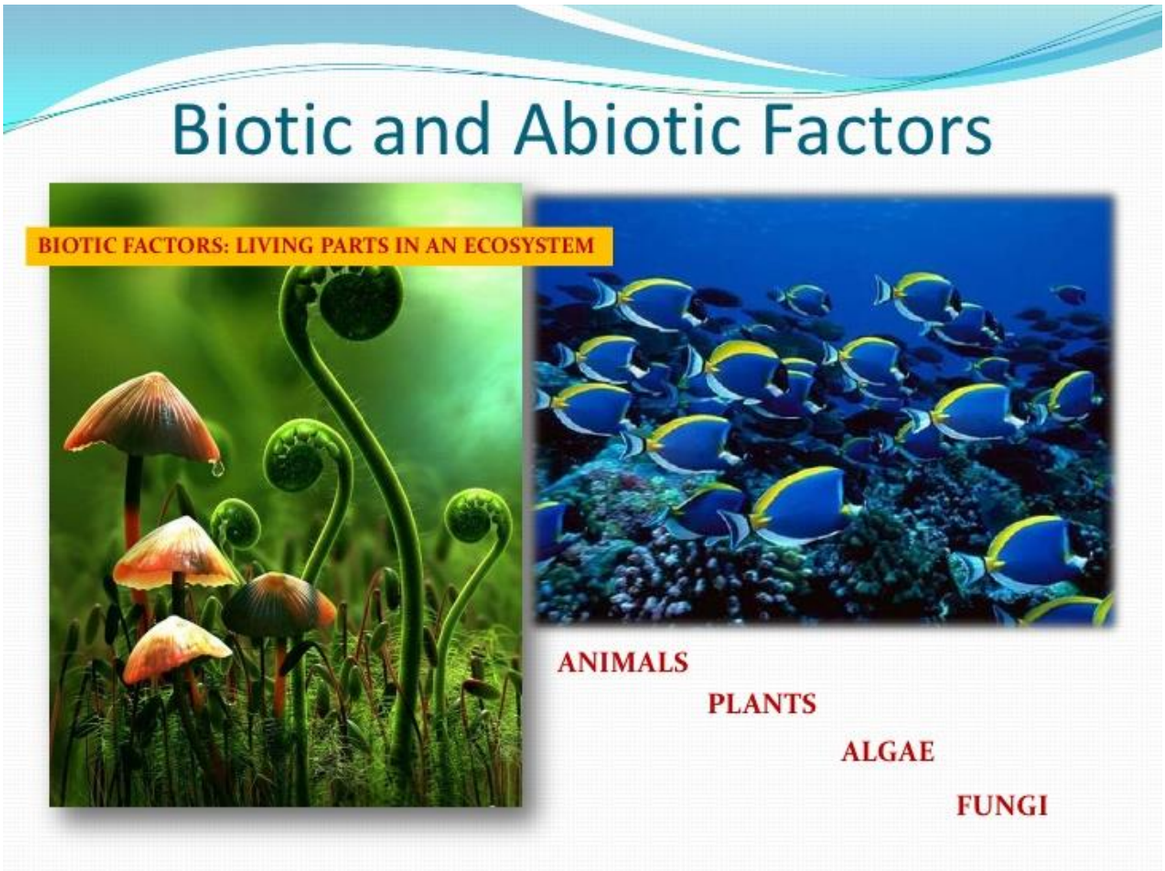
Module 21 Components of Ecosystem-Biotic

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

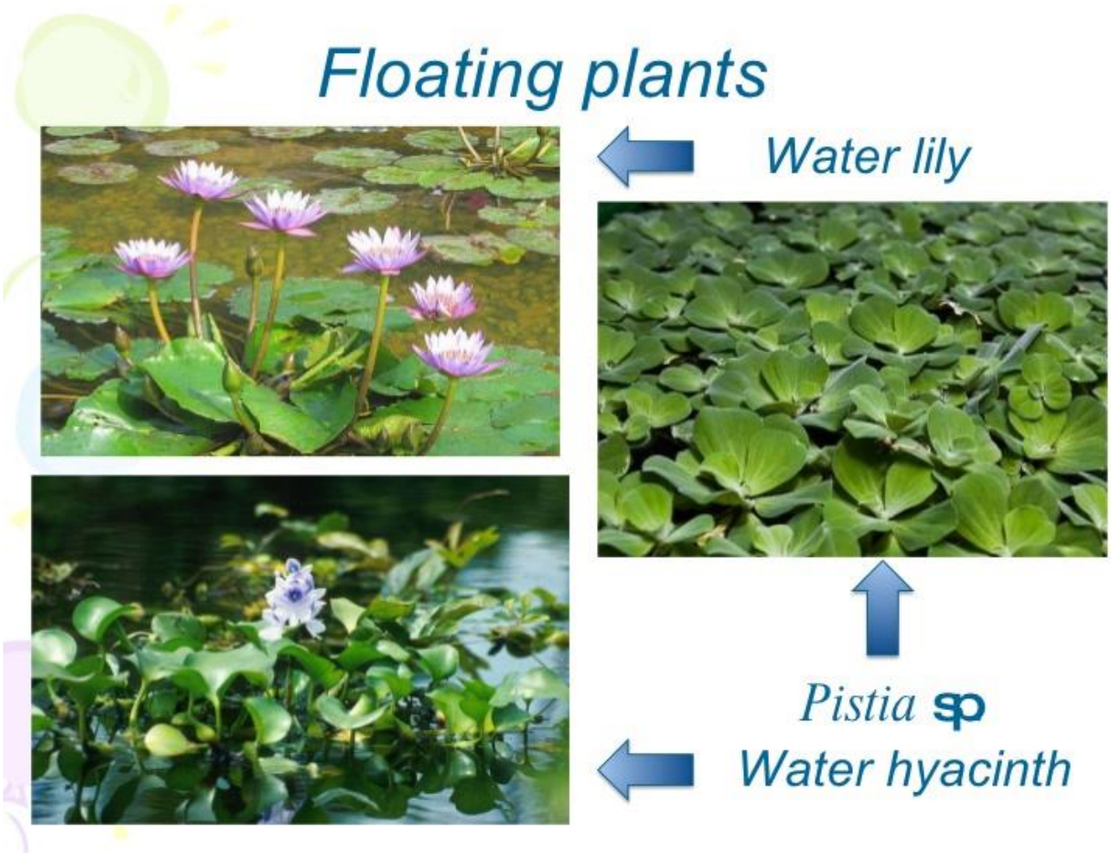
Producers or Autotrophs-

(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

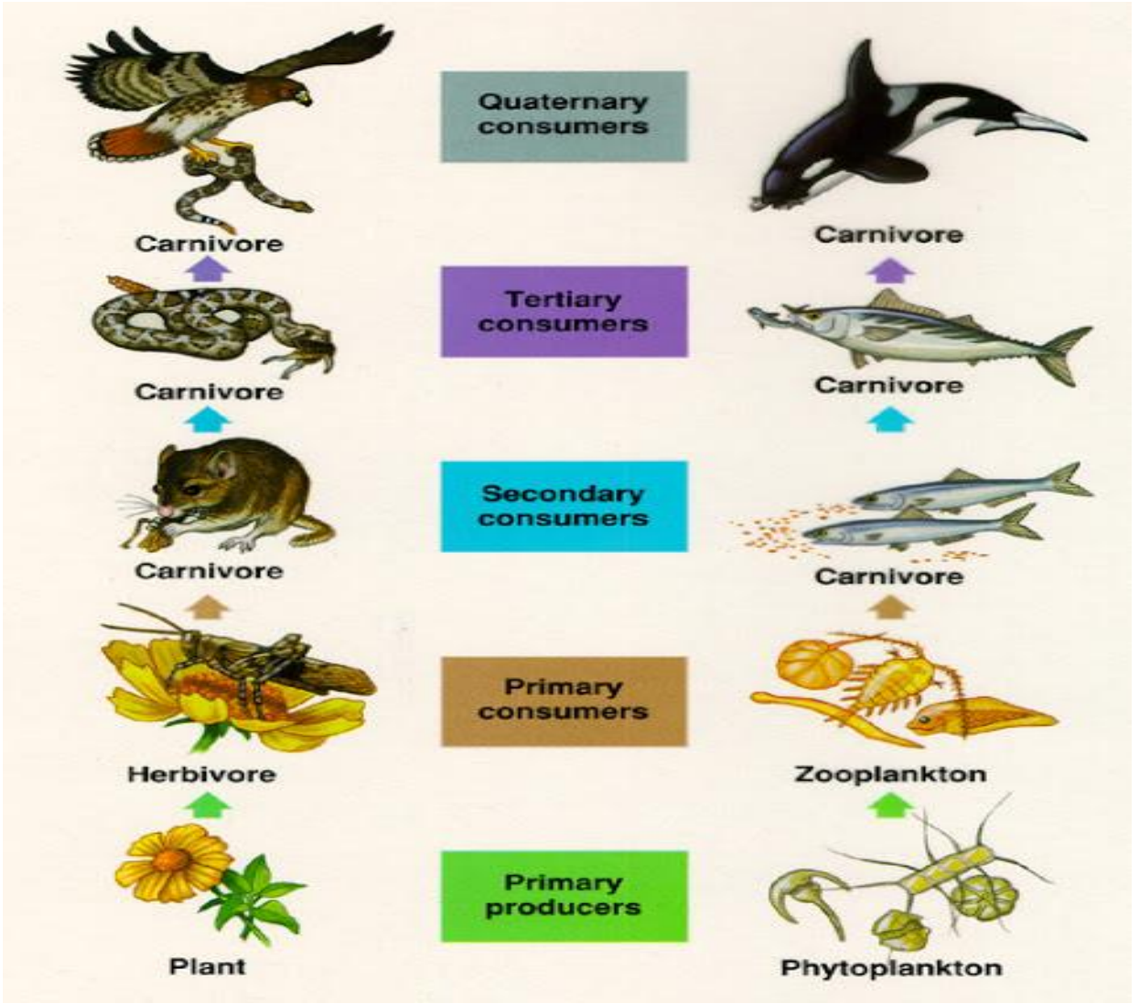
i. **Primary consumers**
ii. **Secondary consumers**
iii. **Tertiary consumers**

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

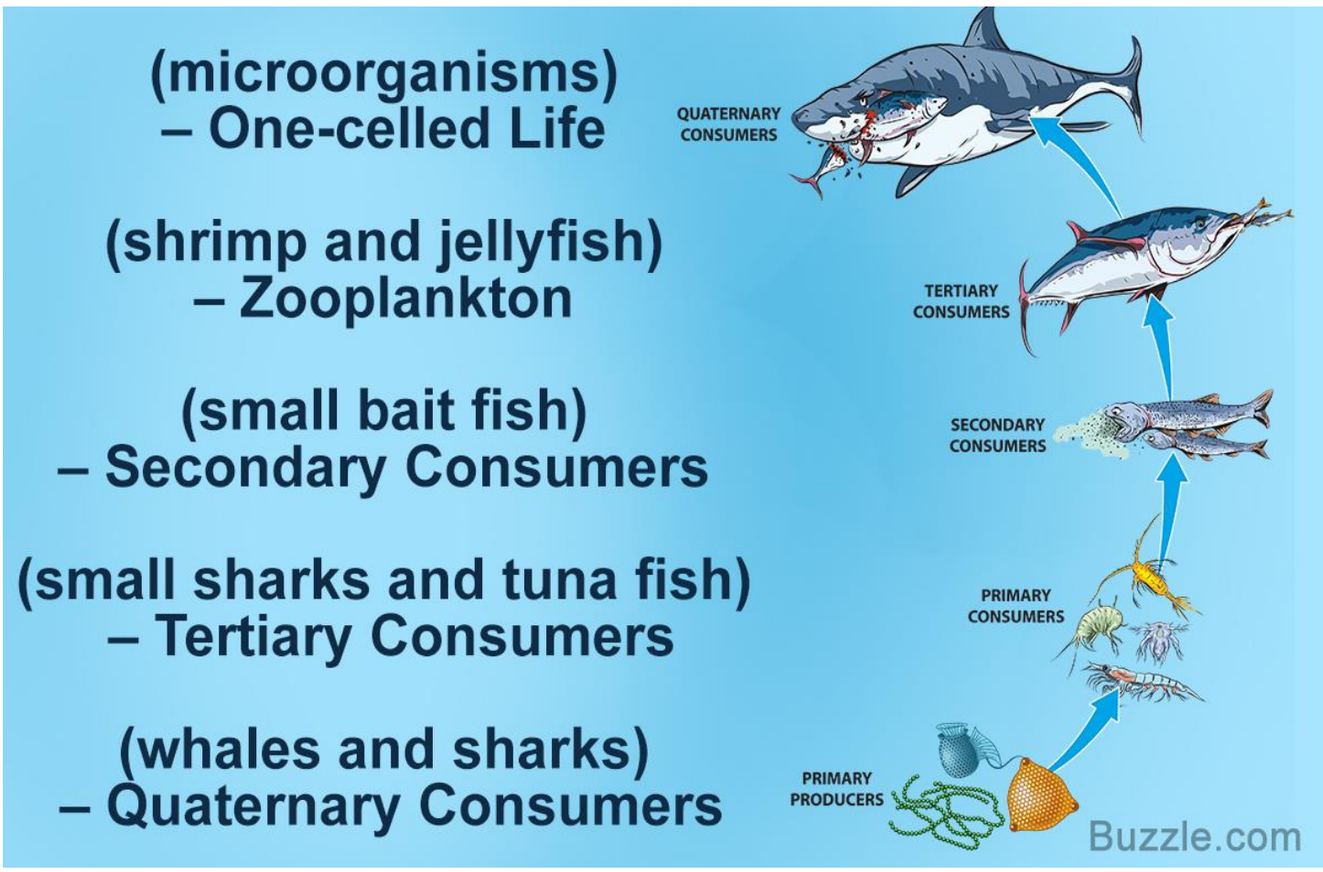
i. **Primary consumers**

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

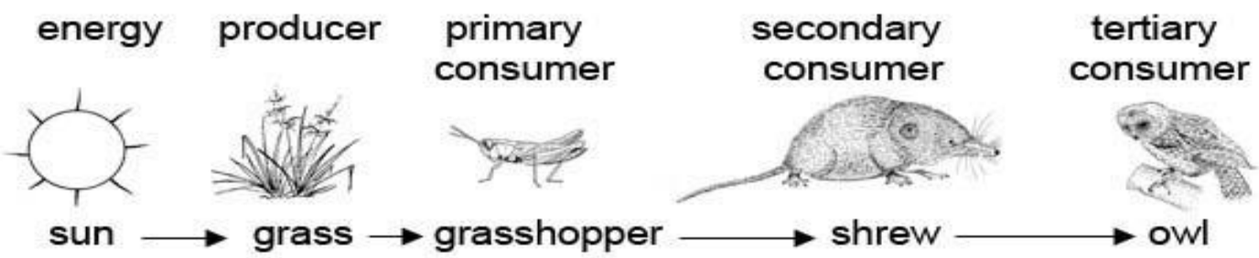
Module 25 Food Chains in Ecosystem

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"

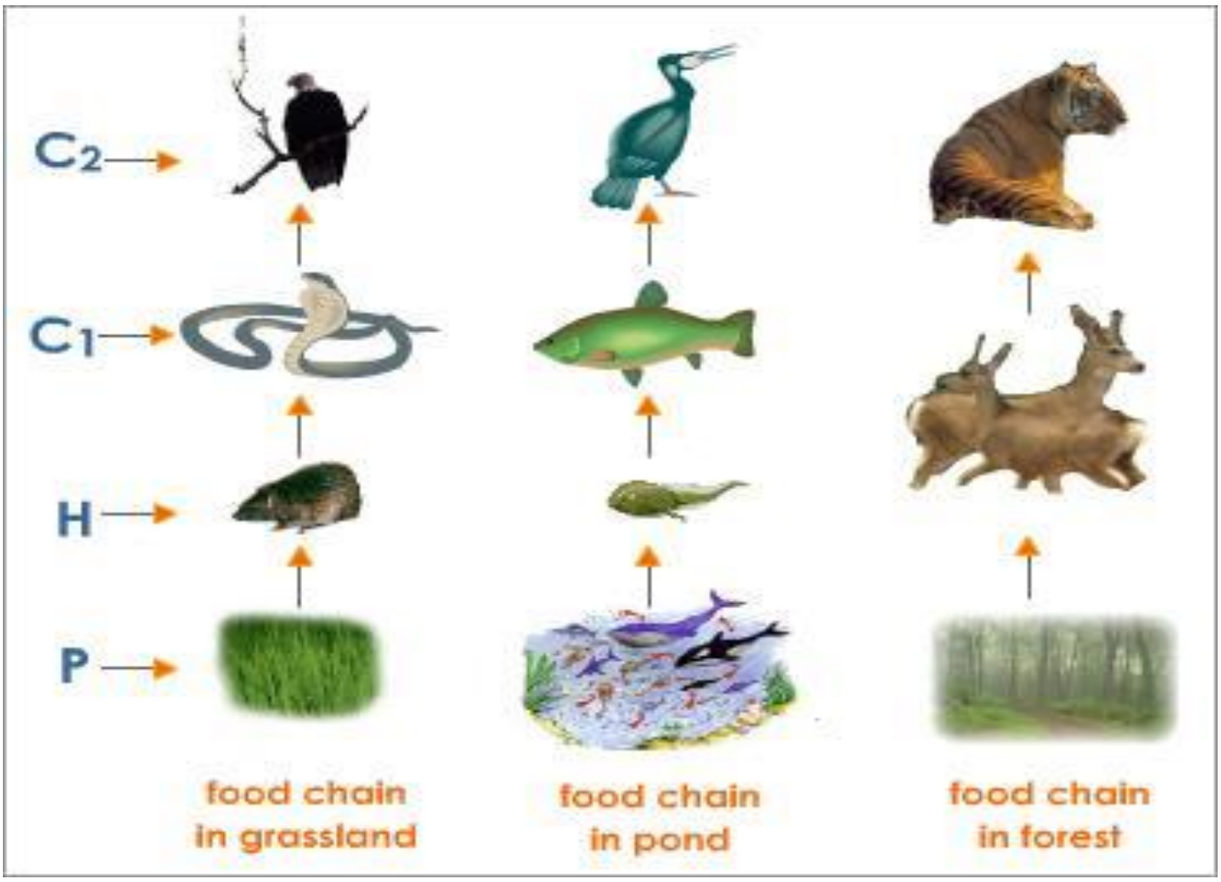
e.g.

Grasses → Grasshopper → Frogs → Snakes → Hawk/Eagle



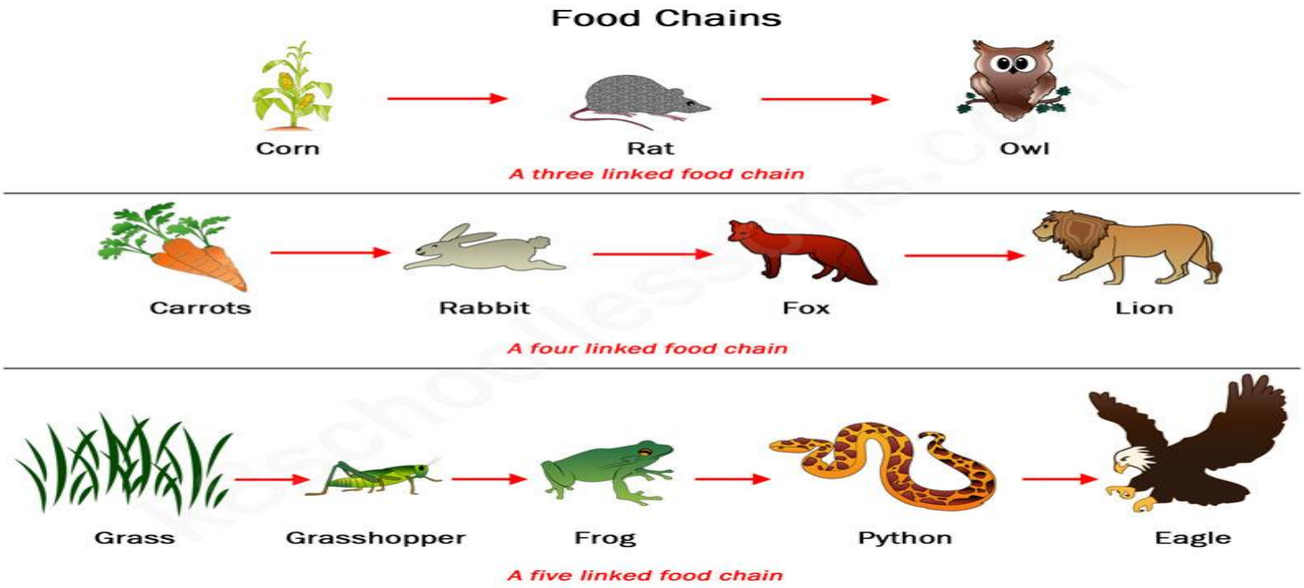
Food chain and trophic level

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:

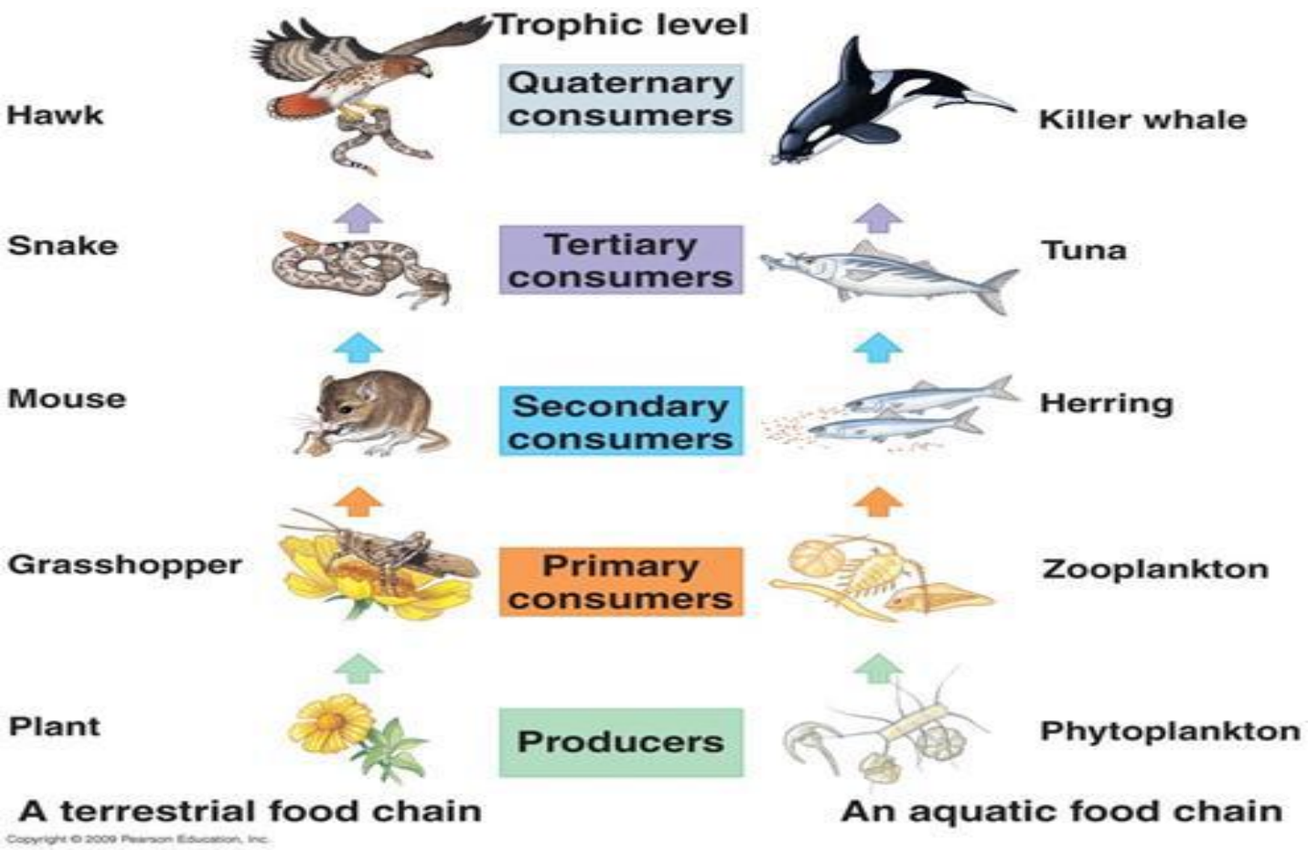
1. **(Producers) Autotrophs**

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 :

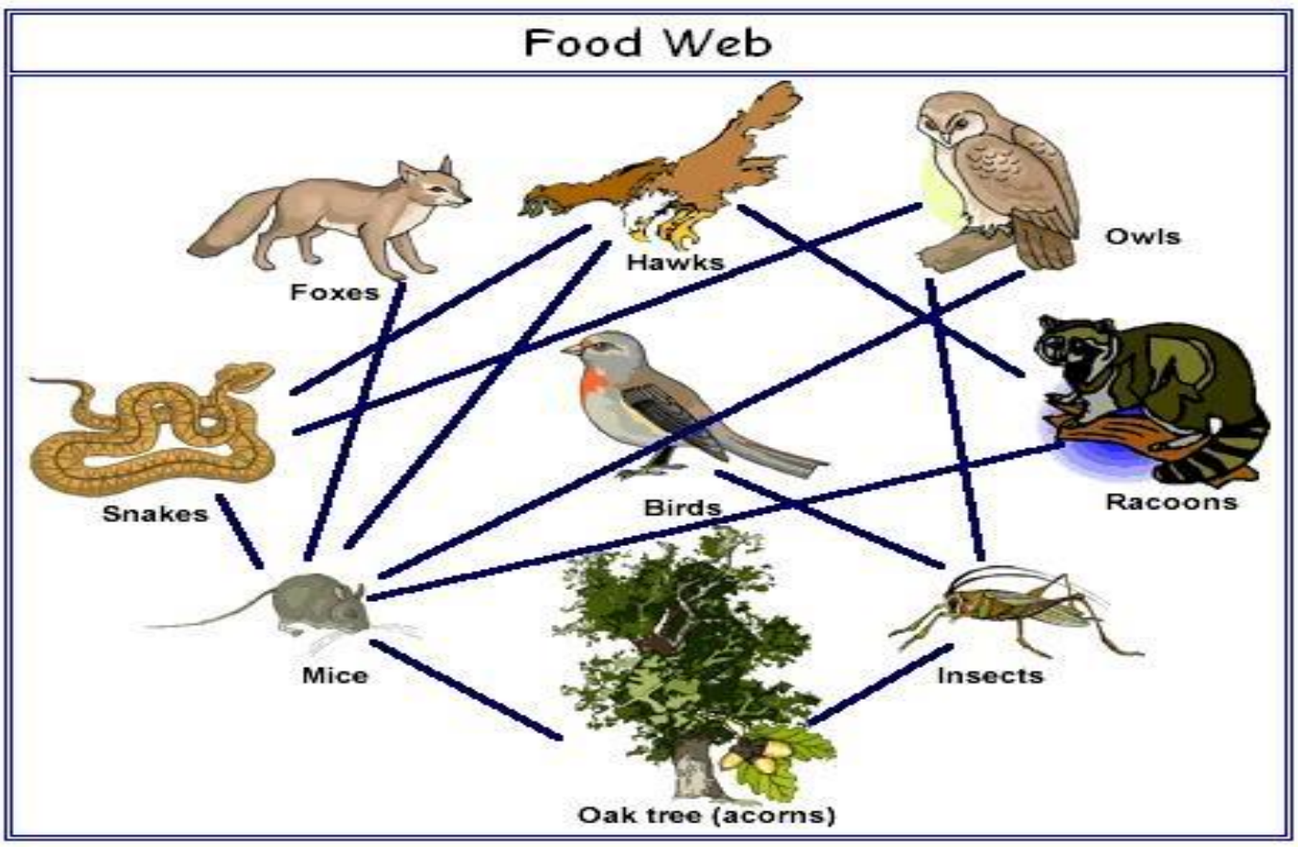
c) help in recycling the nutrients.

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



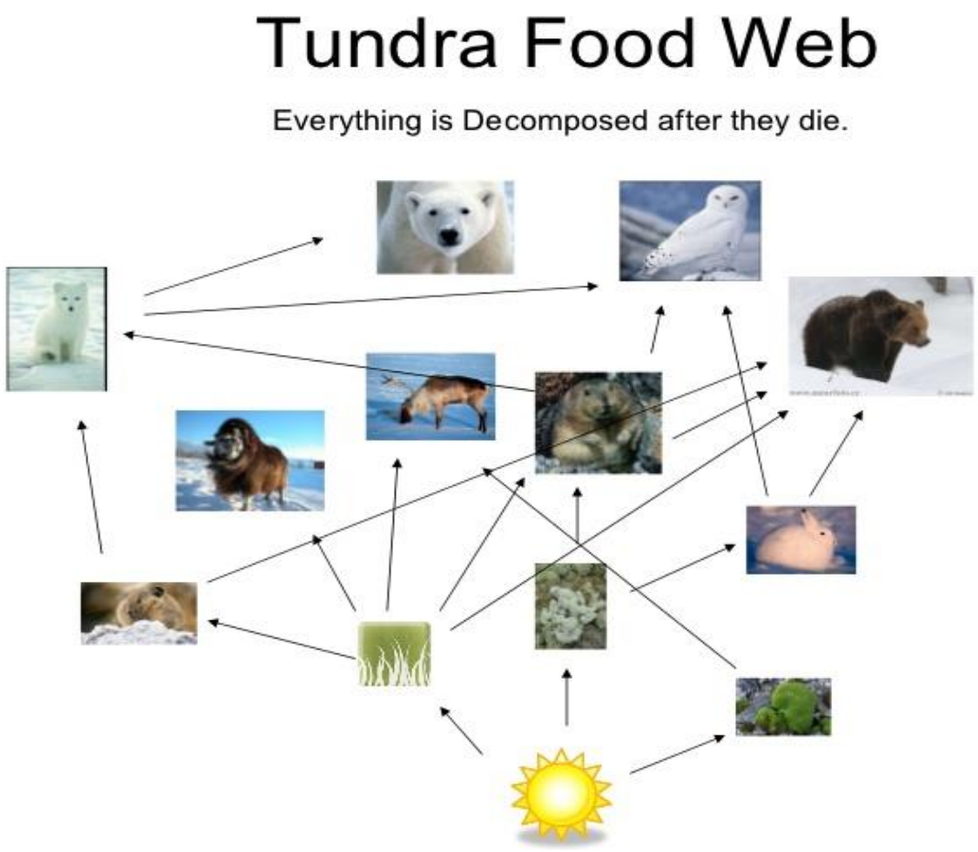
Food web

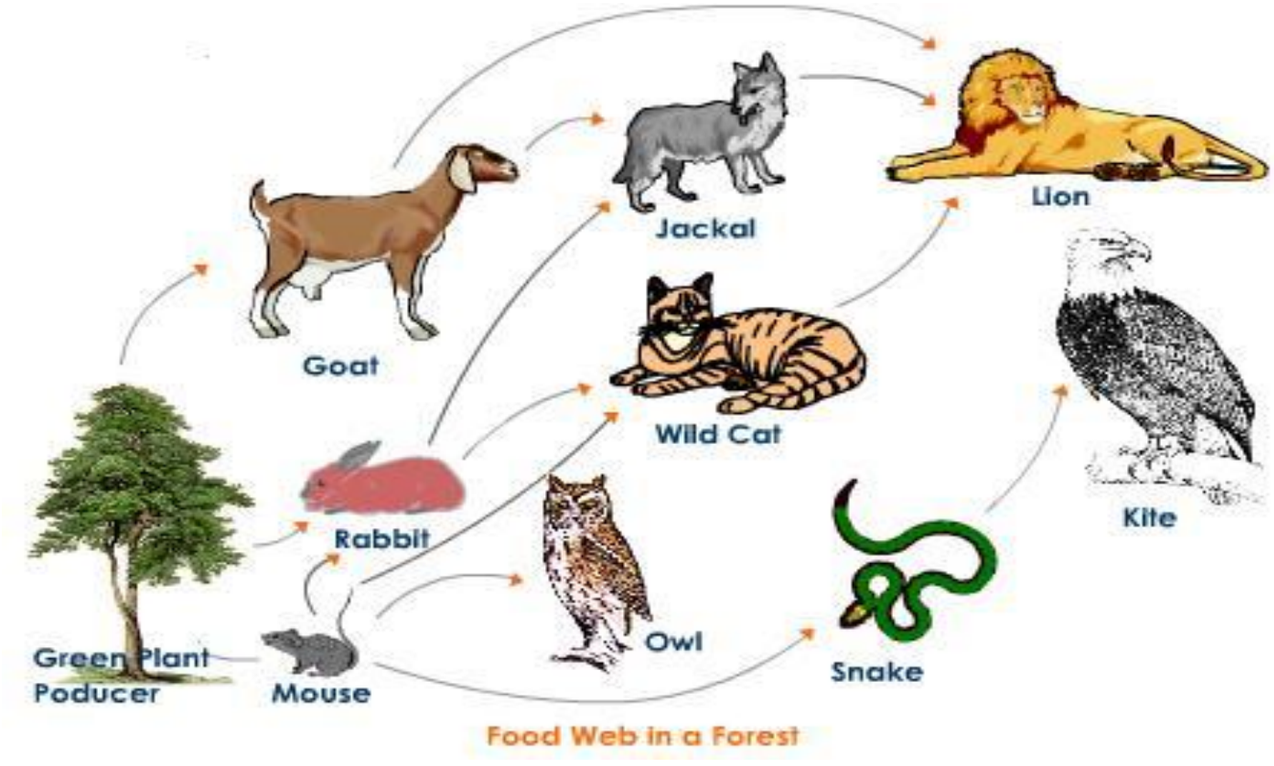
1. In a food web one trophic level may be connected to more than one food chain

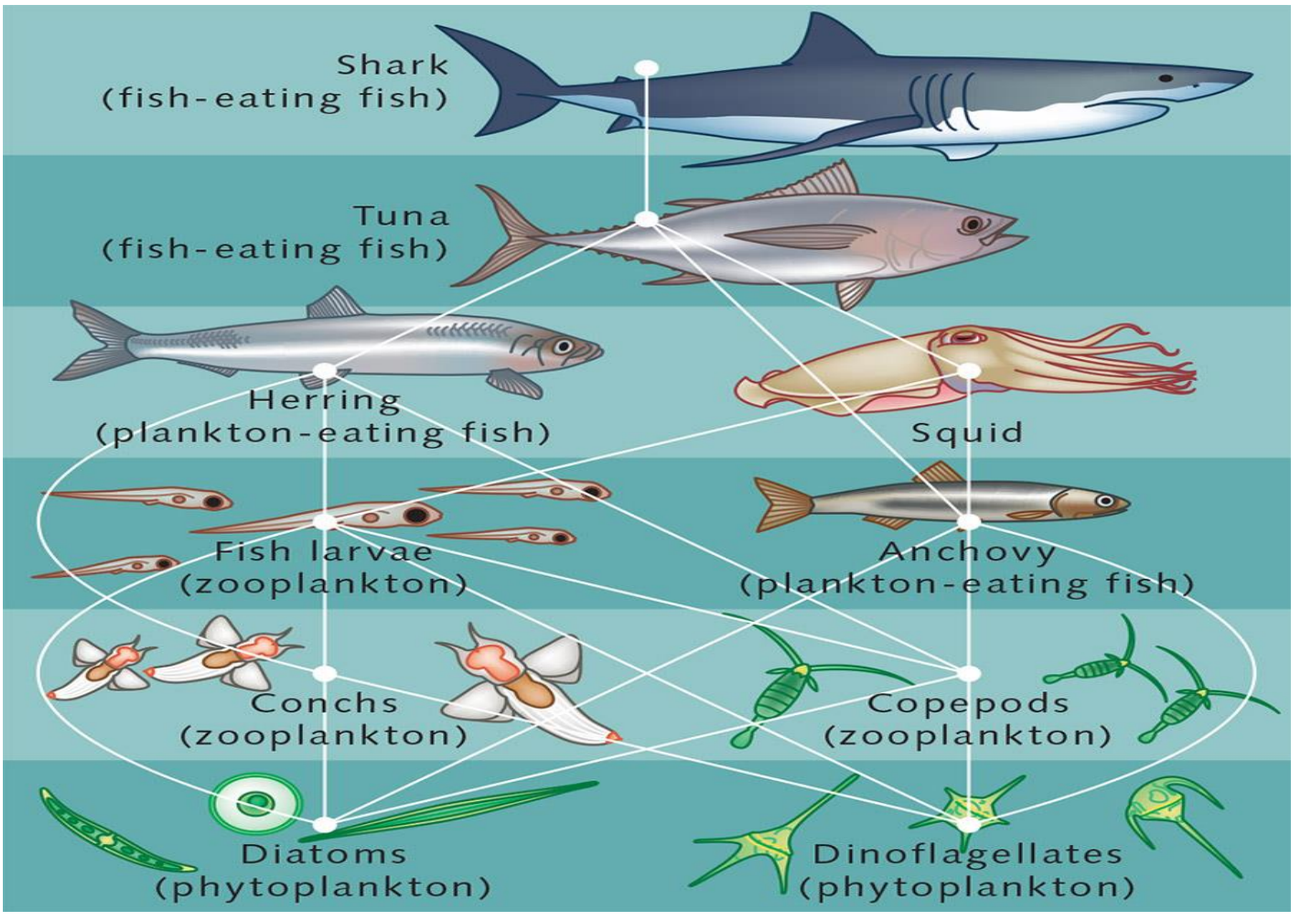
2. Food web is the geographical description of feeding relationship among species in an ecological community

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.

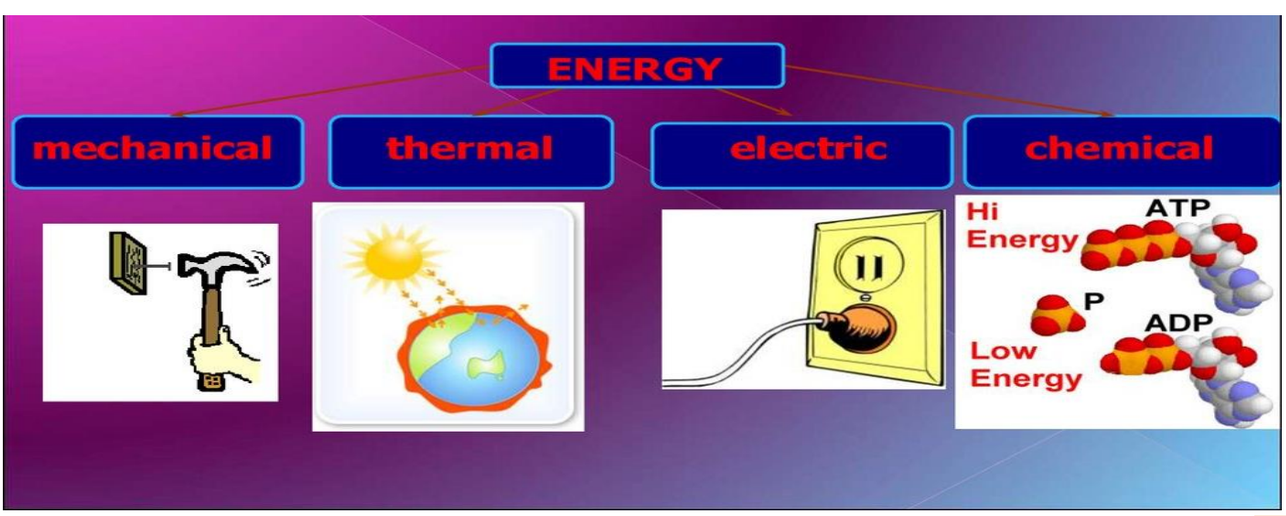
different forms of energy

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

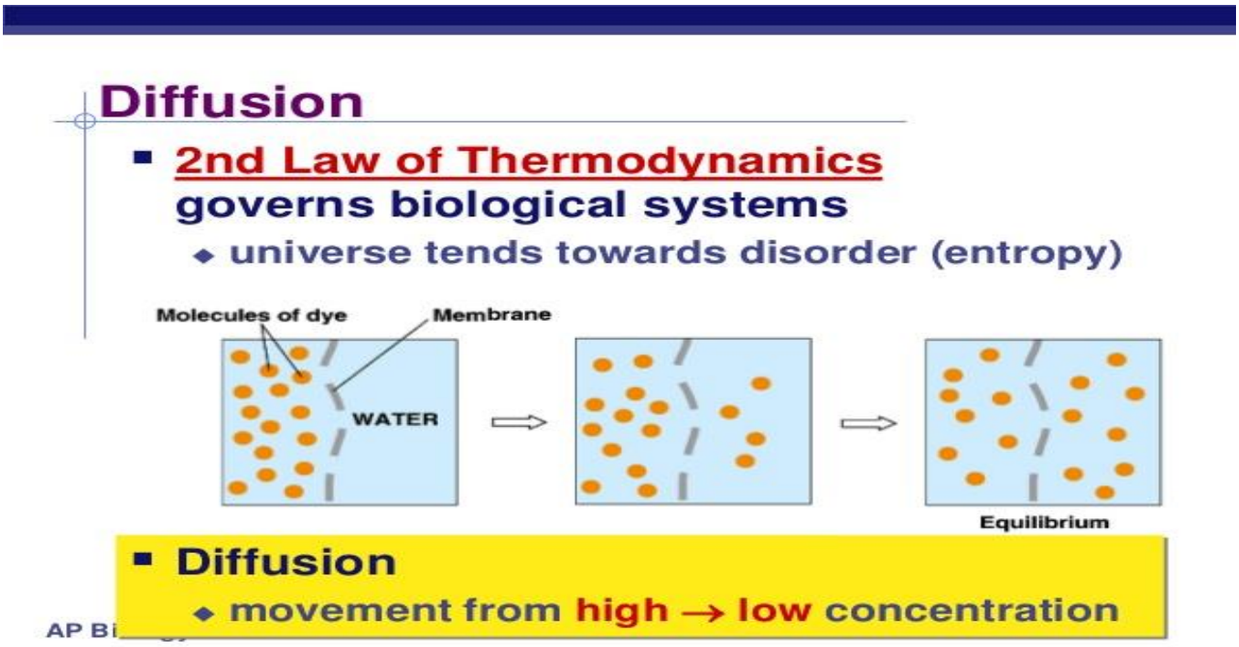
Its about the *quality* of energy

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.

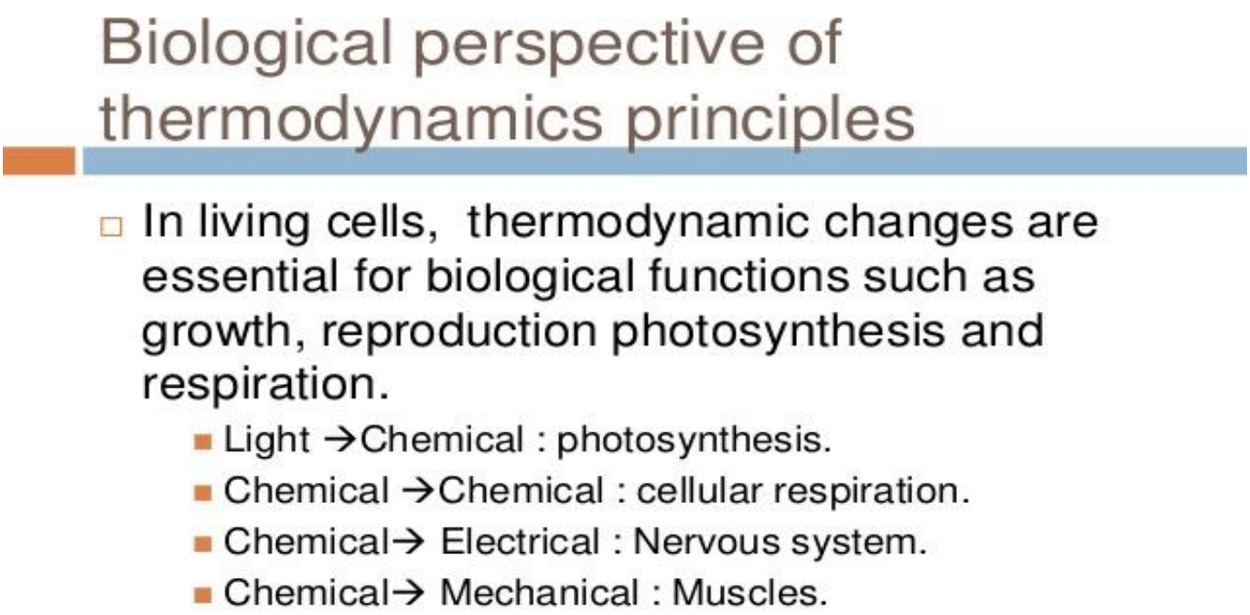
It asserts that a natural process runs only in one sense, and is not reversible

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



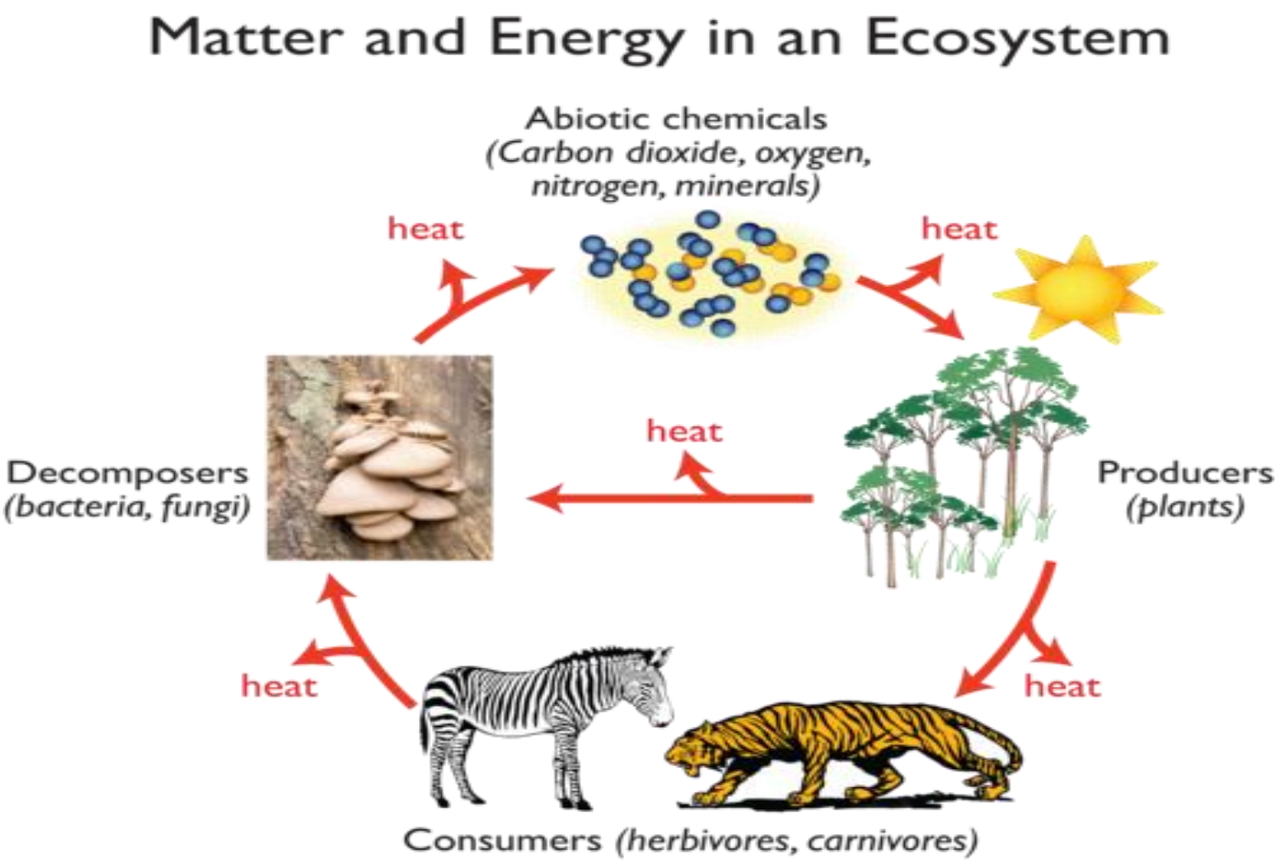
Biological perspective of thermodynamics principles

Light-chemical: Photosynthesis

Chemical-chemical: cellular respiration

Chemical-Electrical: Nervous system

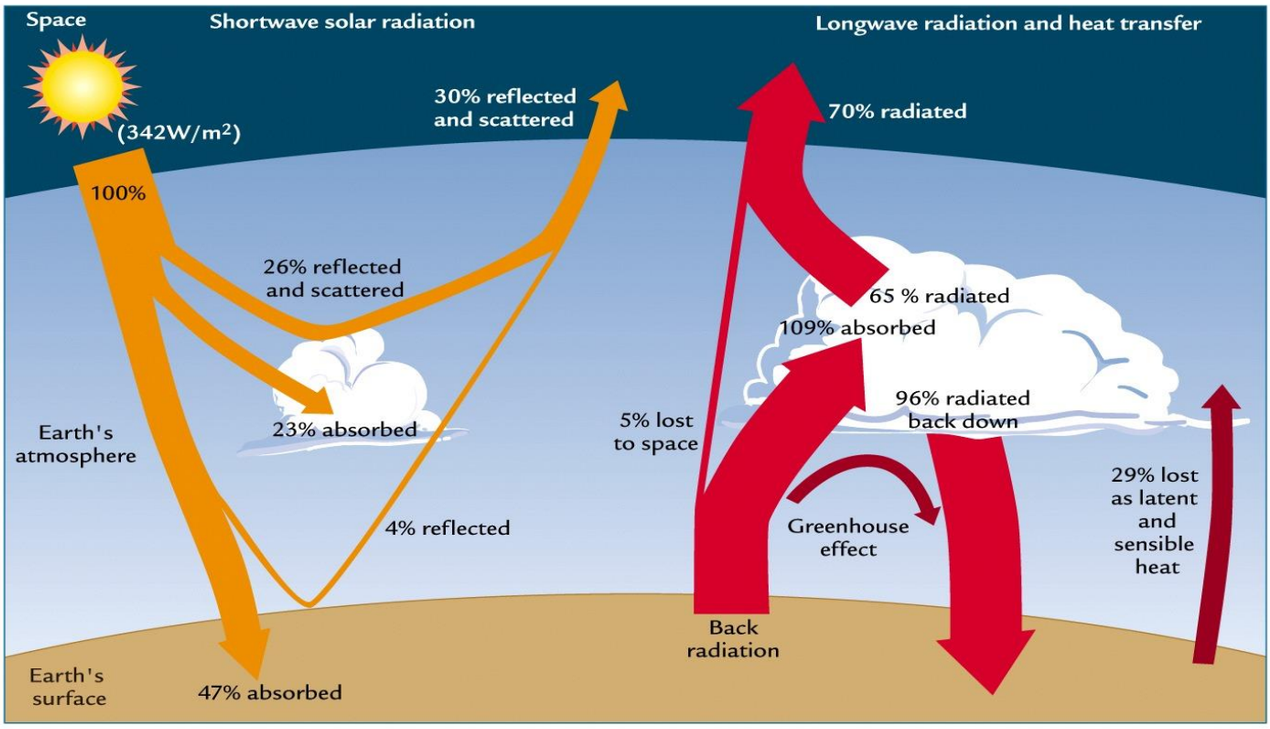
Chemical- Mechanical: Muscles



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

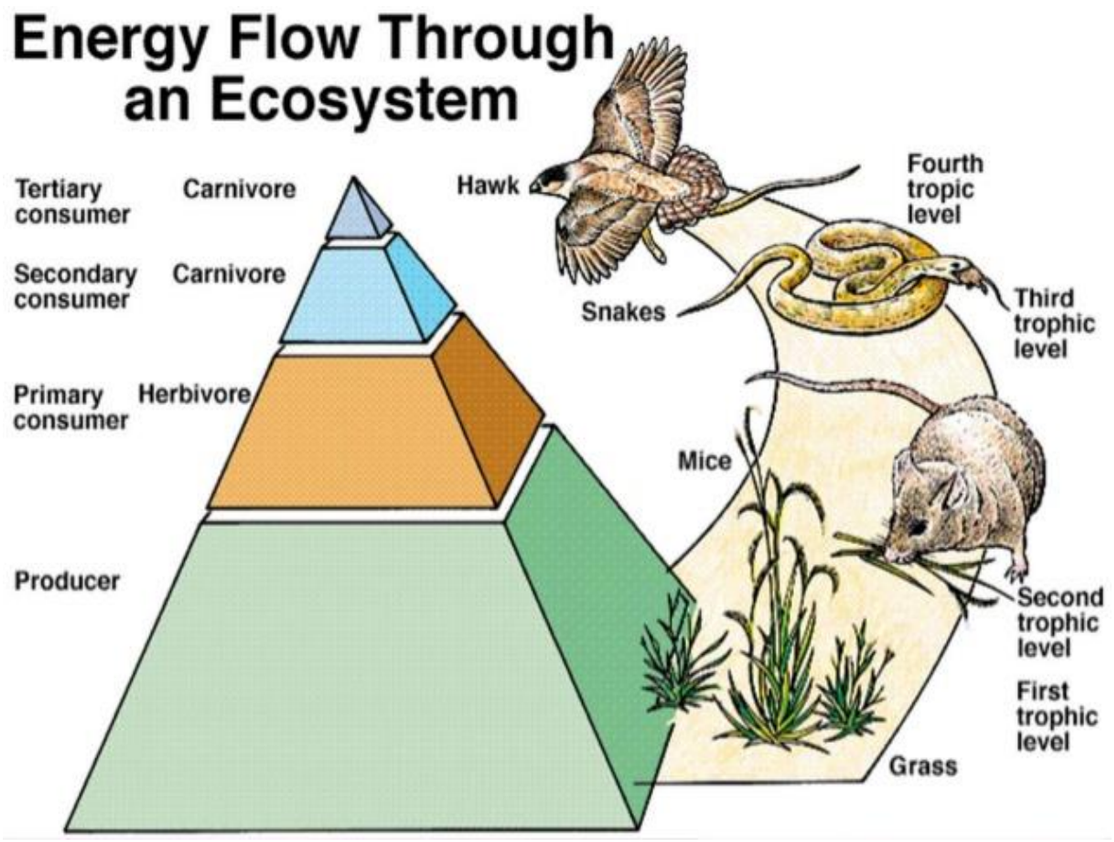
3. infrared rays-45%- longer wavelength-absorbed and reradiated as heat in a complex manner by atmosphere, clouds, and various natural and man – made objects and surfaces

Flow of energy in Ecosystem

Important factor as describe

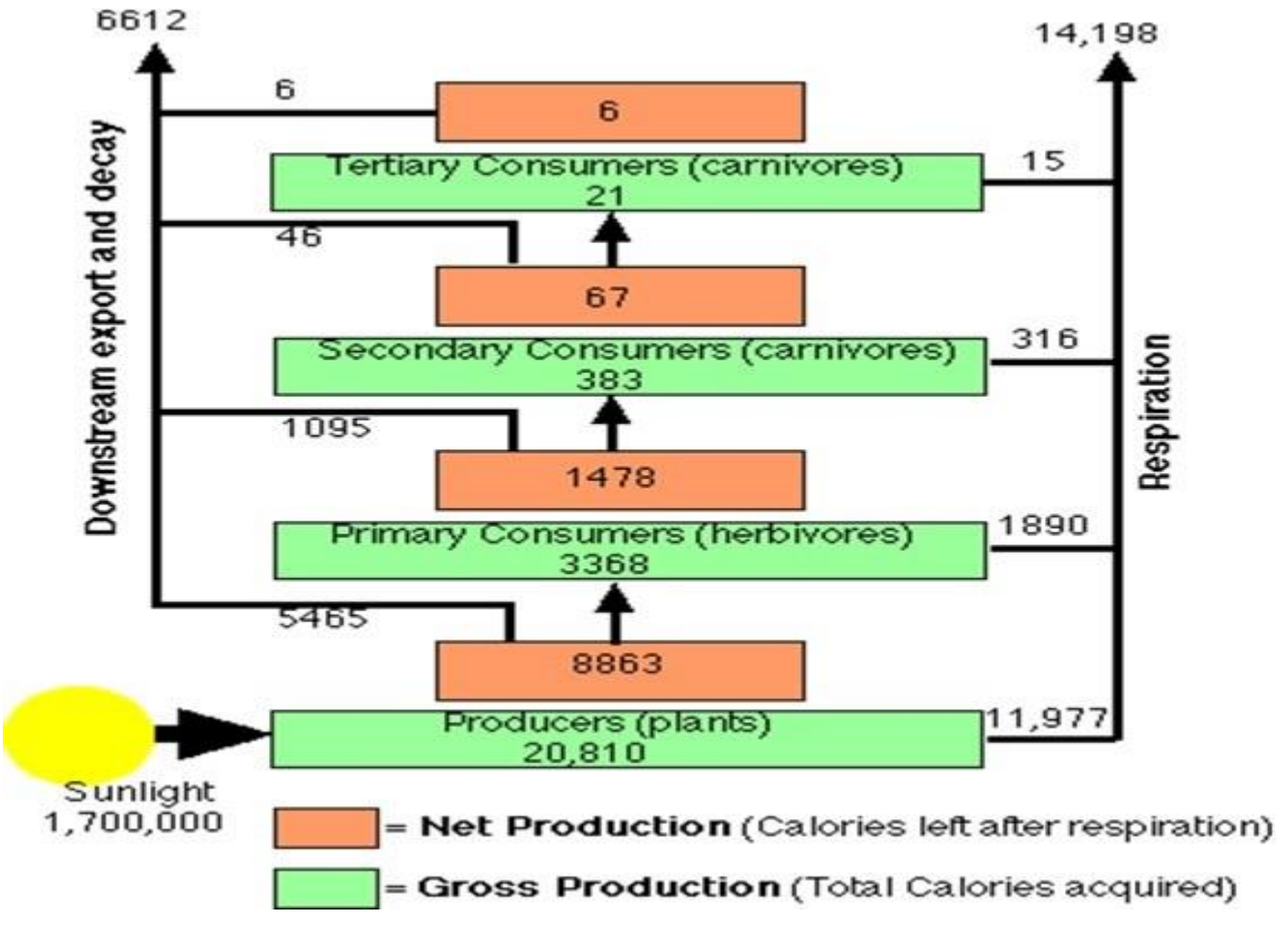
Types and number of organism would live in ecosystem

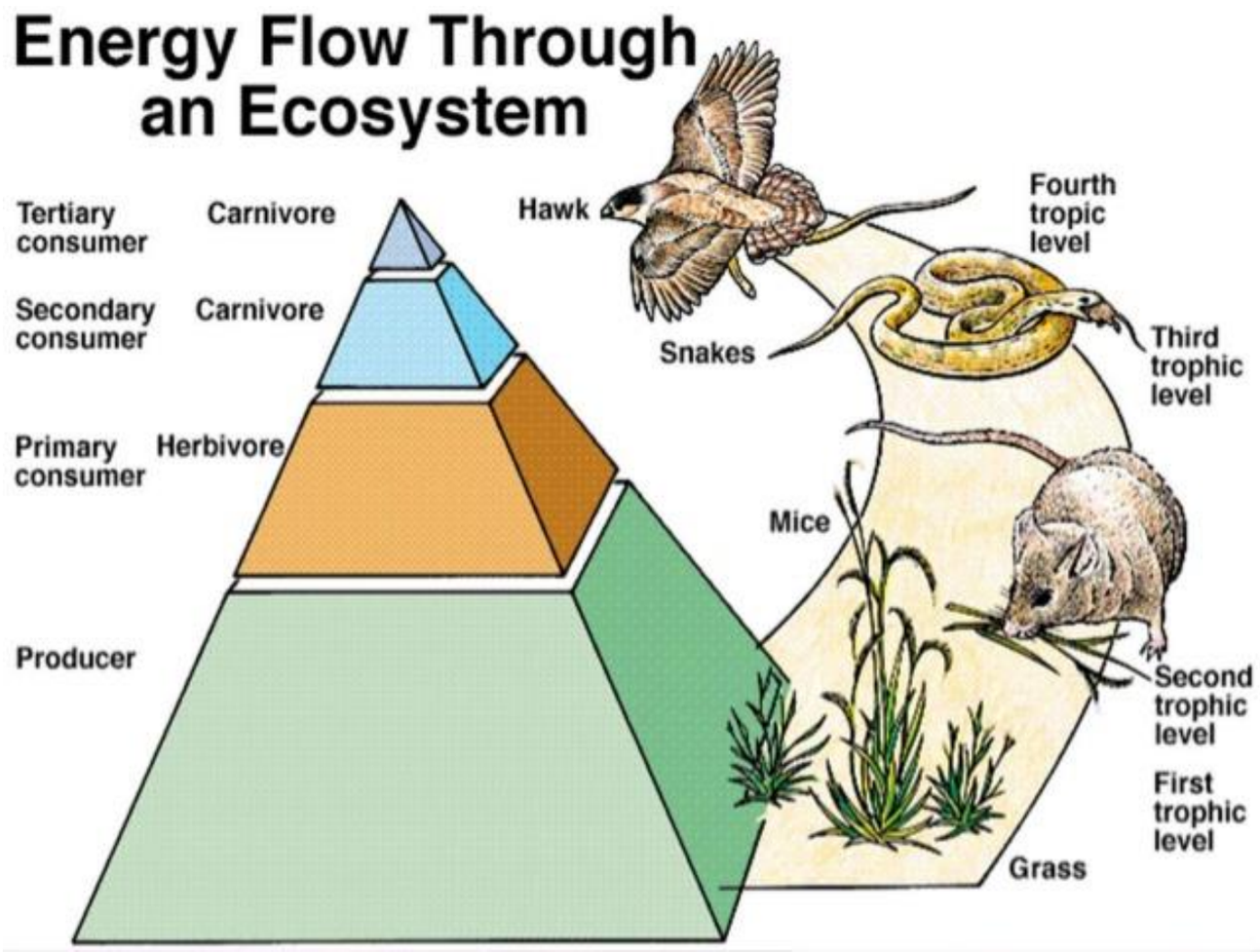
Ecological Pyramids- relative amount of energy, biomass, number of organisms at each level in ecosystem



Flow of energy in Ecosystem

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





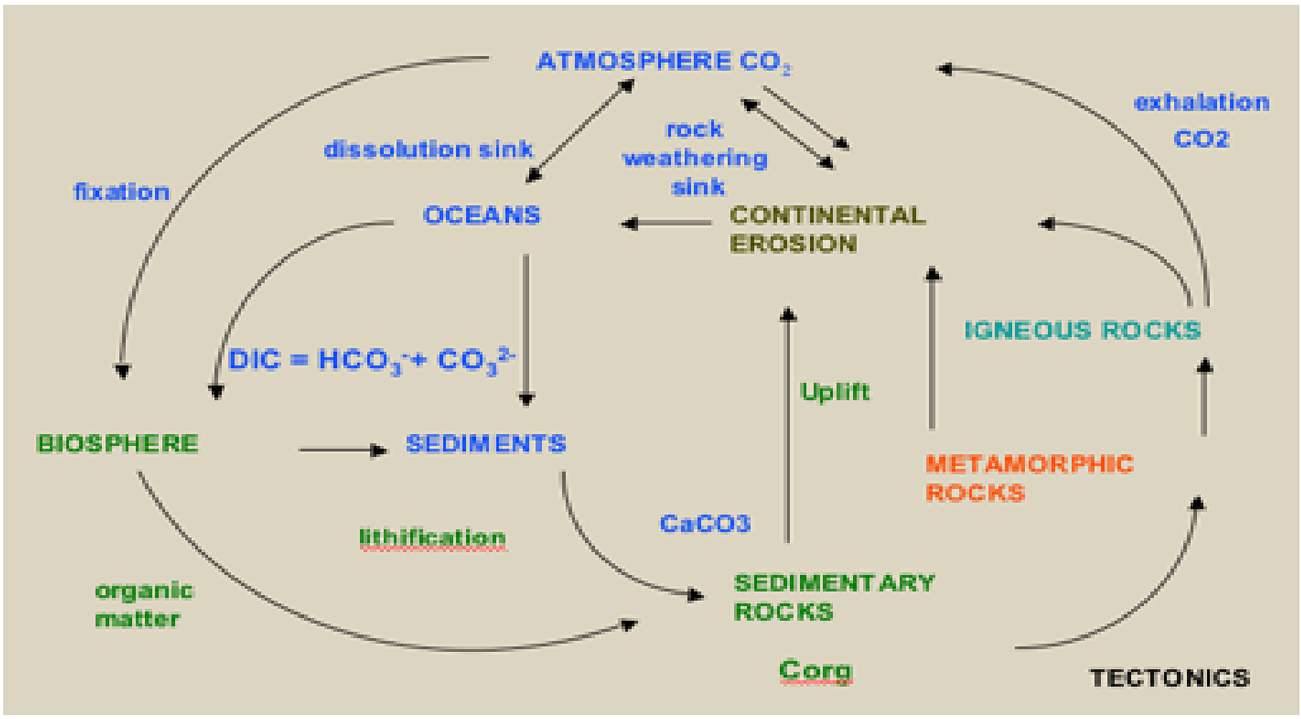
Module 30 Biogeochemical cycles

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%-

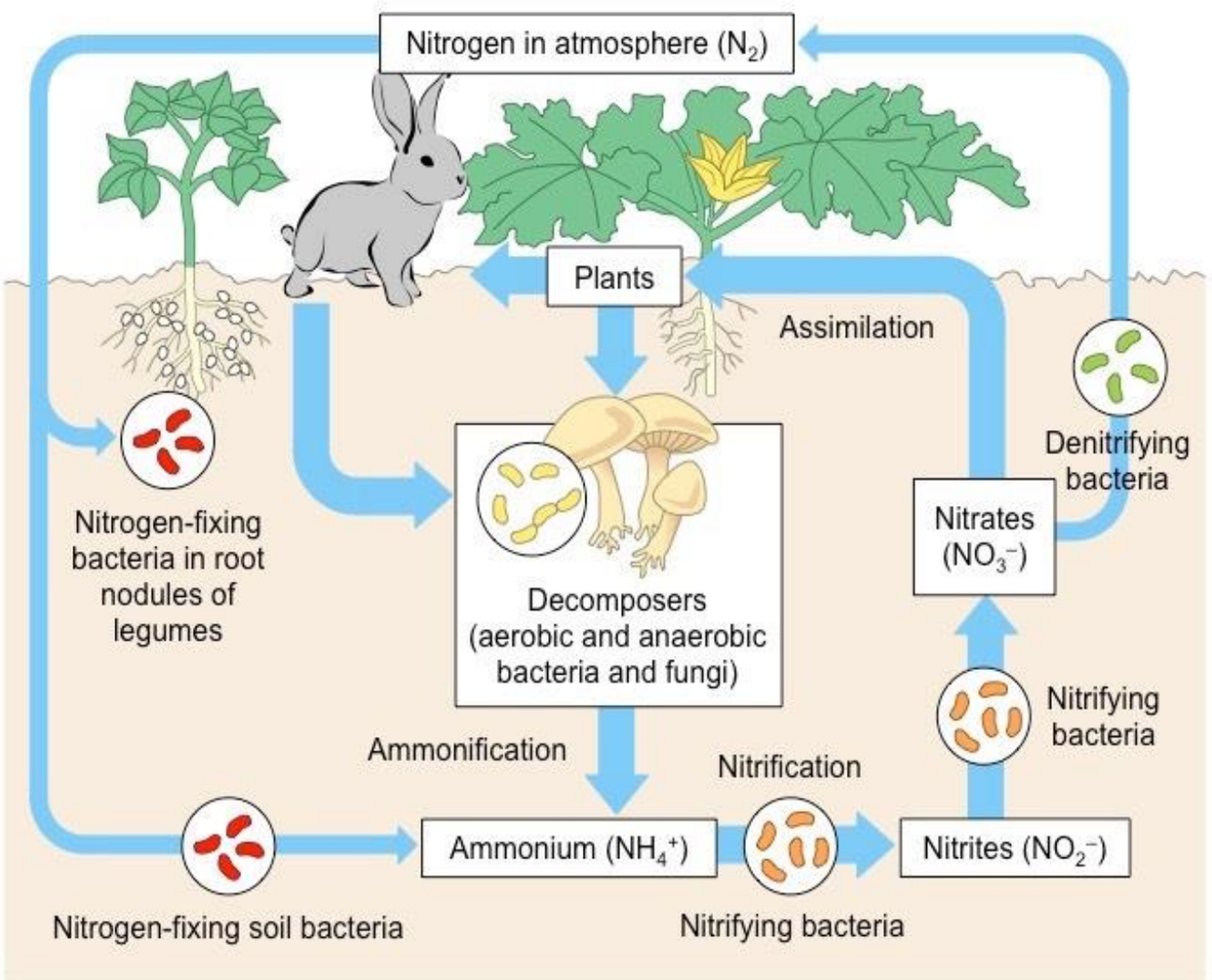
safety valve

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.

$N_2 + O_2$ ——— $2NO$

$2NO + 2\,O$ ——— $2\,NO_2$

$2NO_2 + O$ ——— N_2O_5

$N_2O_5 + H_2O$ ——— $2\,HNO_3$

$2HNO_3 + CaCO_3$ ——— $Ca\,(NO_3)_2 + CO_2 + H_2O$

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:**

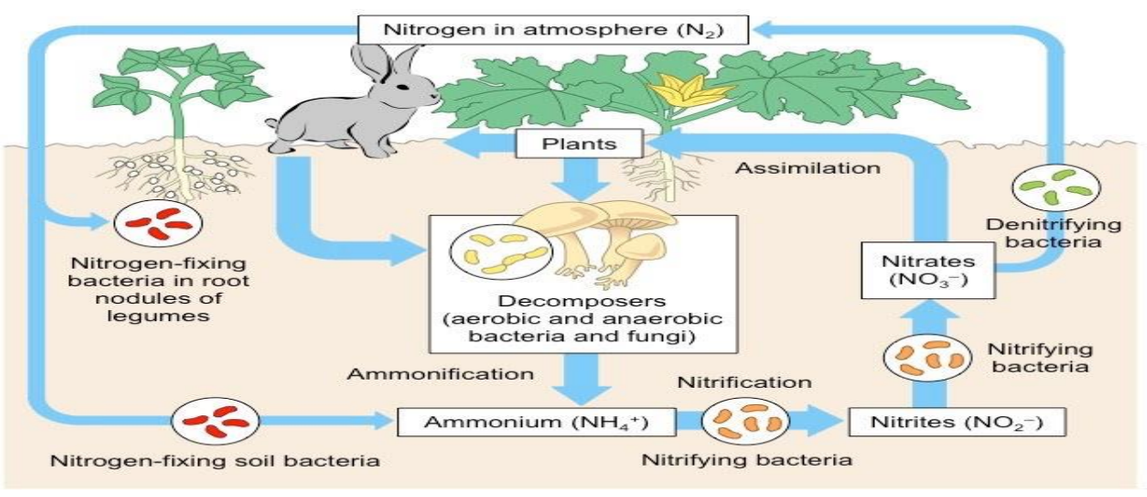
a) Mutualistic bacteria-beneficial association with

b) Leguminous (agricultural system)

c) Root nodules in none-leguminous plants

d) Free living nitrogen fixing bacteria-Soil

e) Cyanobacteria- Ocean ecosystem

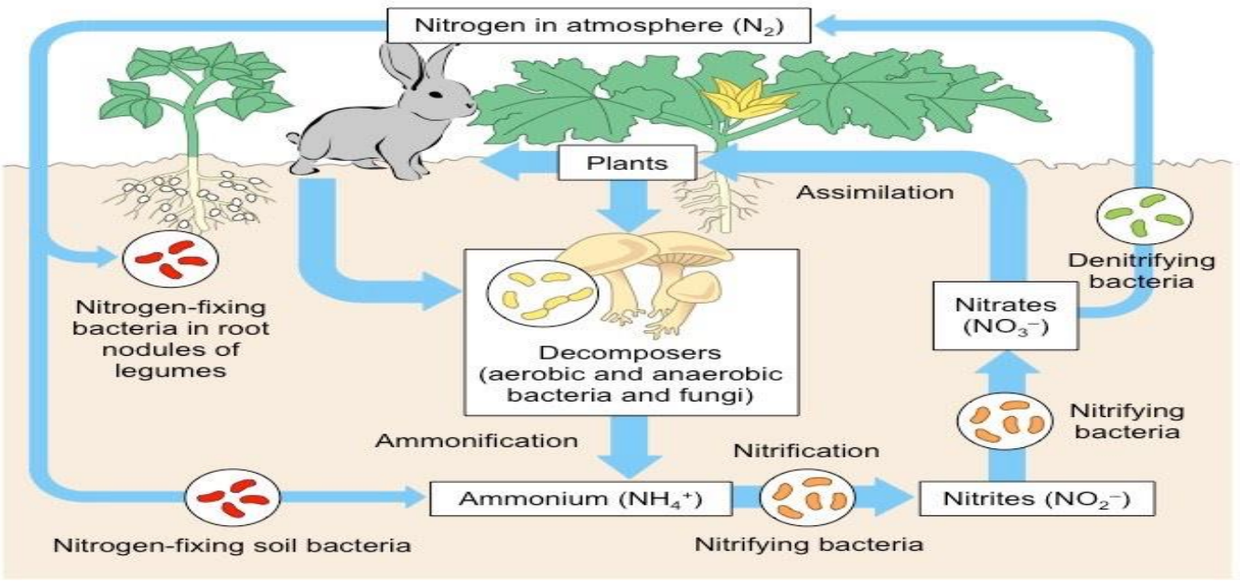


Lecture 35 Biogeochemical Cycles-Nitrogen (N_2) Cycle

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

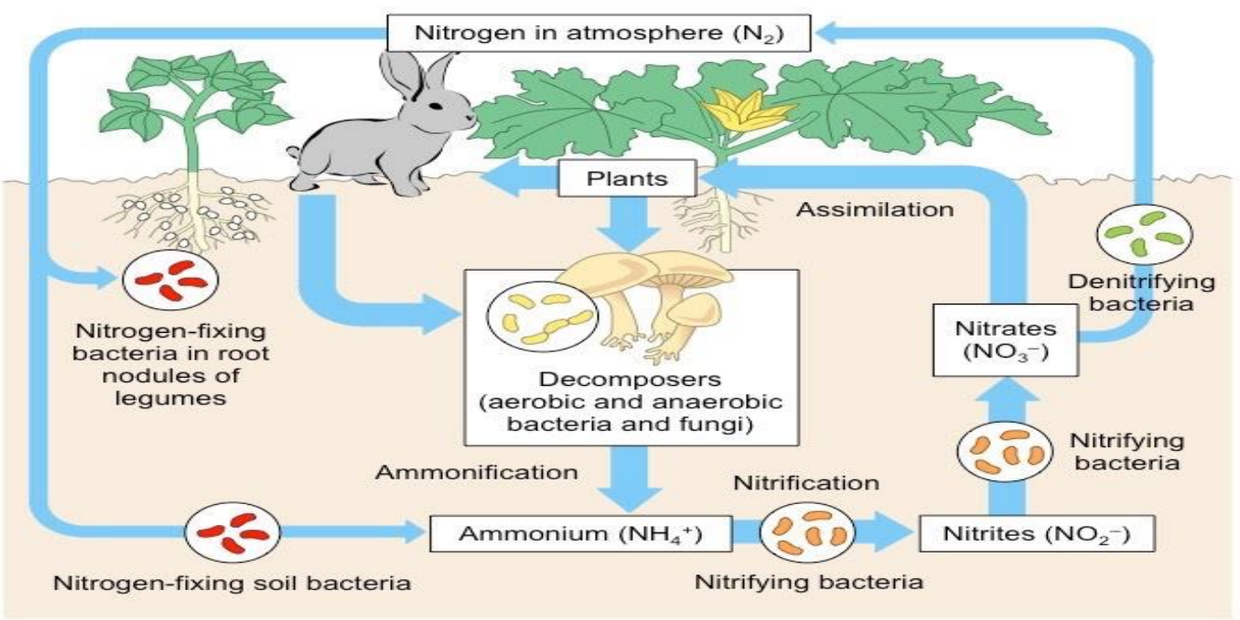
Lecture 36 Biogeochemical Cycles-Nitrogen (N_2) Cycle

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.

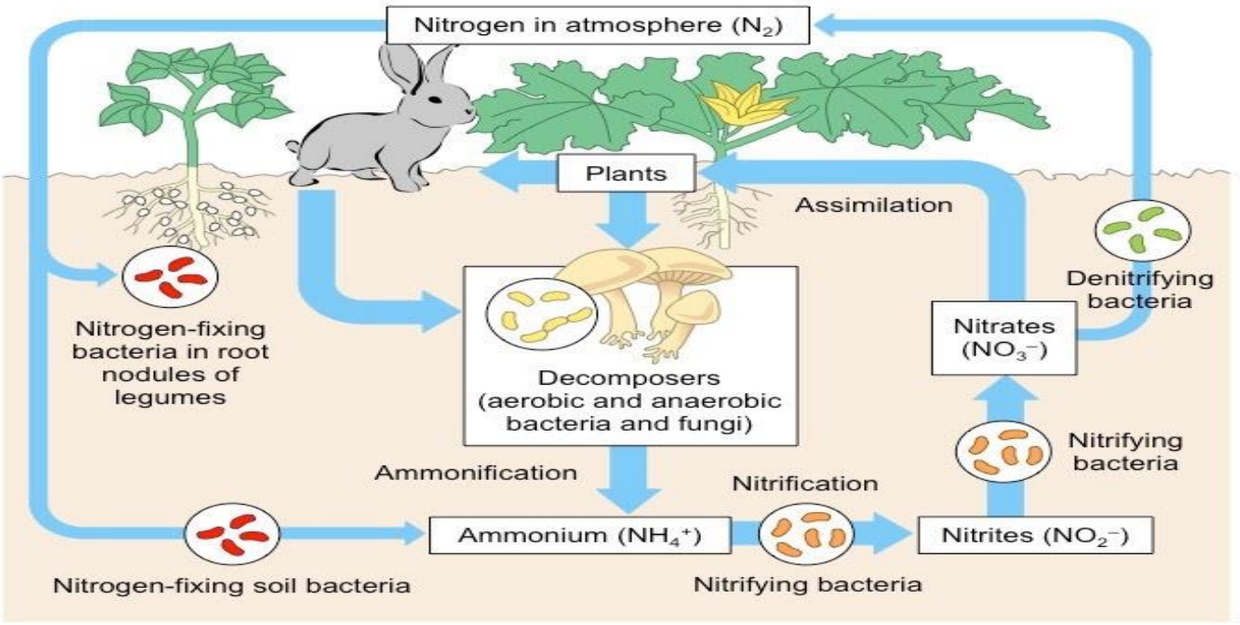
Nitrification-ammonia is oxidized into nitrate

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

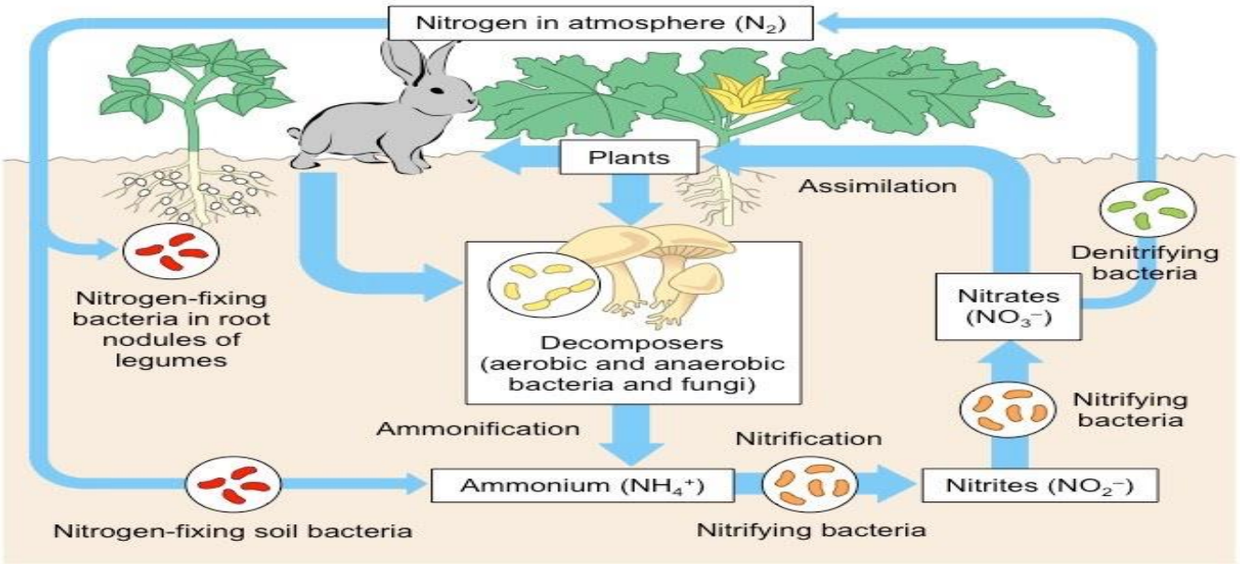
Primary producers- nitrite ions, nitrate ions or ammonium ions- through roots- plant protein

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*



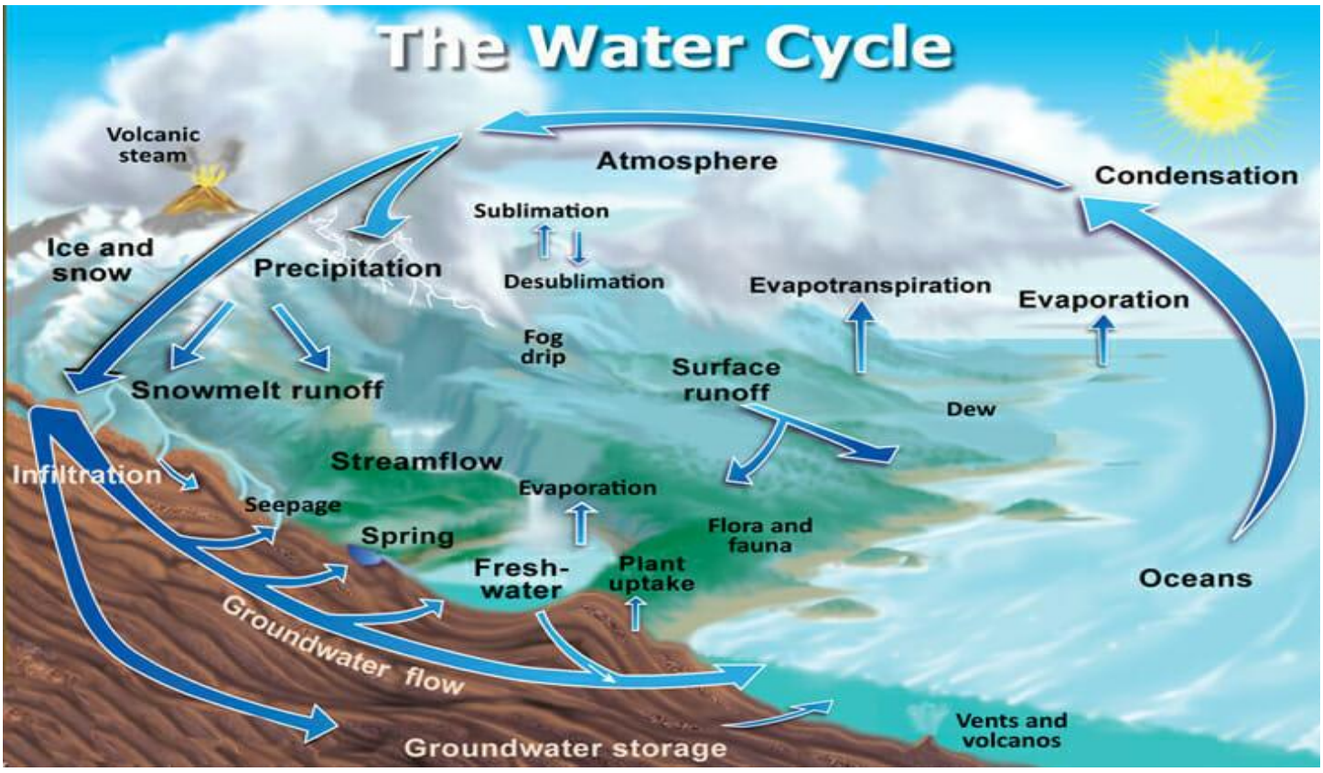
Lecture 39 Biogeochemical Cycles-Hydrological Cycle

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

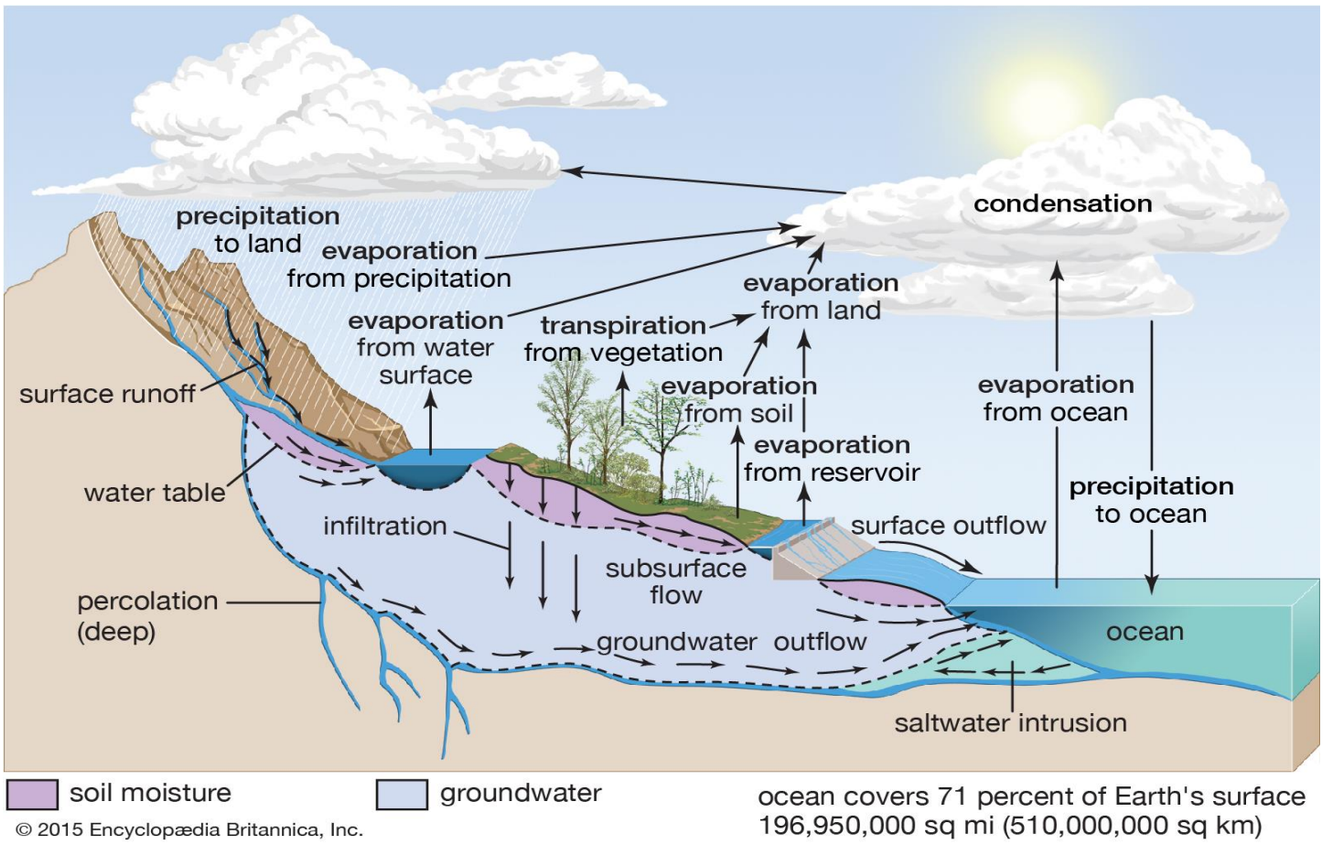


Facts of hydrological cycle

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

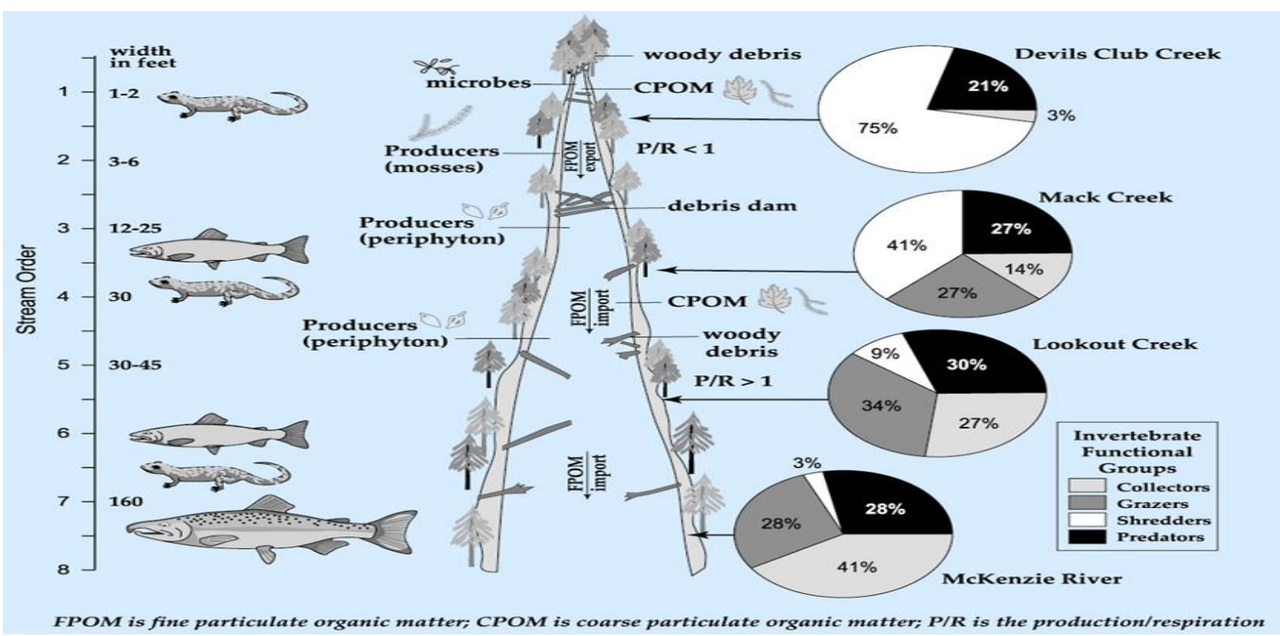
3. Down hill loop releases energy, used for electric power generation and used by ecosystem

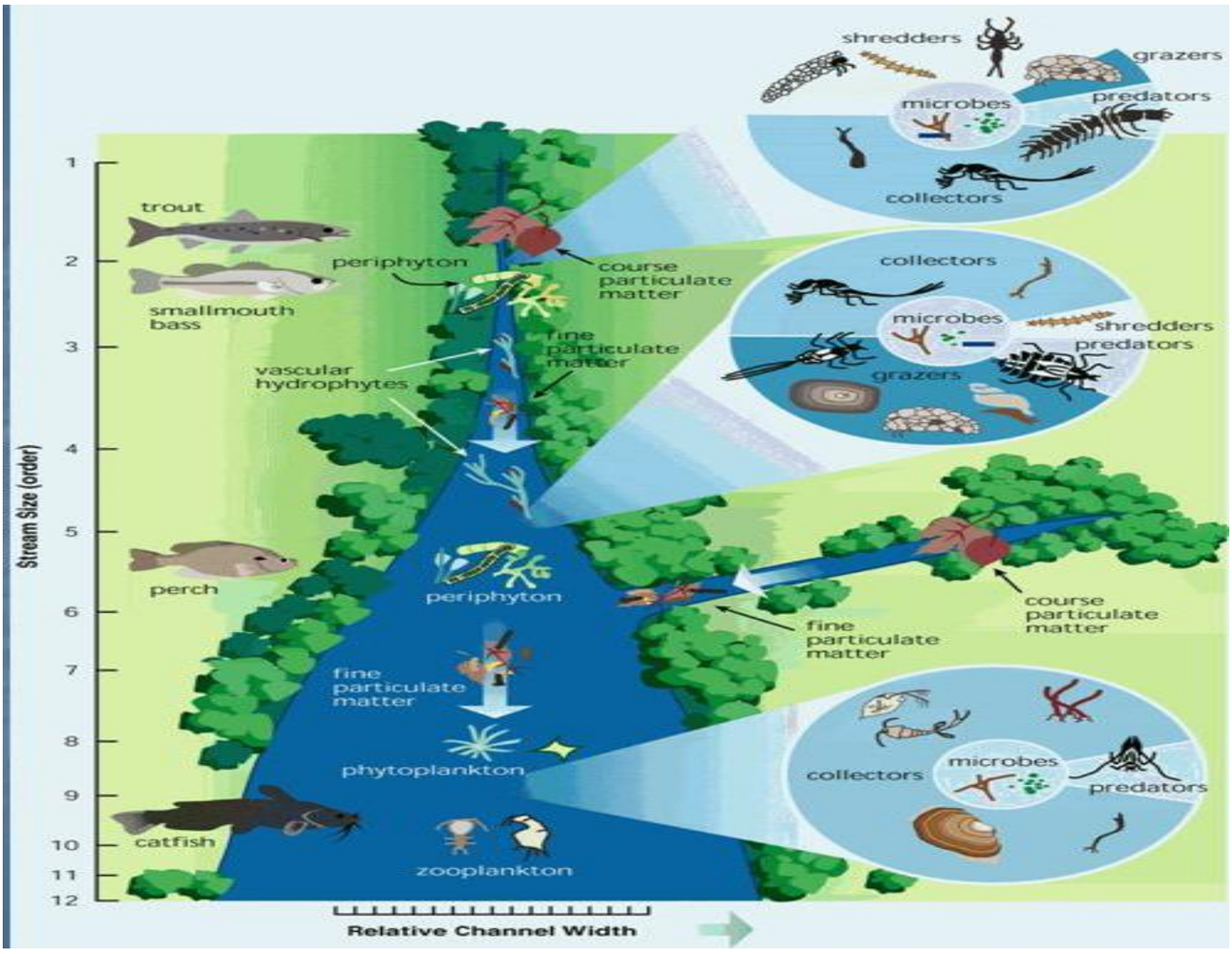
4. Aquifers- under ground water-largest global water reservoir-porous underground strata mostly limestone, sand, gravel, clay that hold water like elongated tank

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



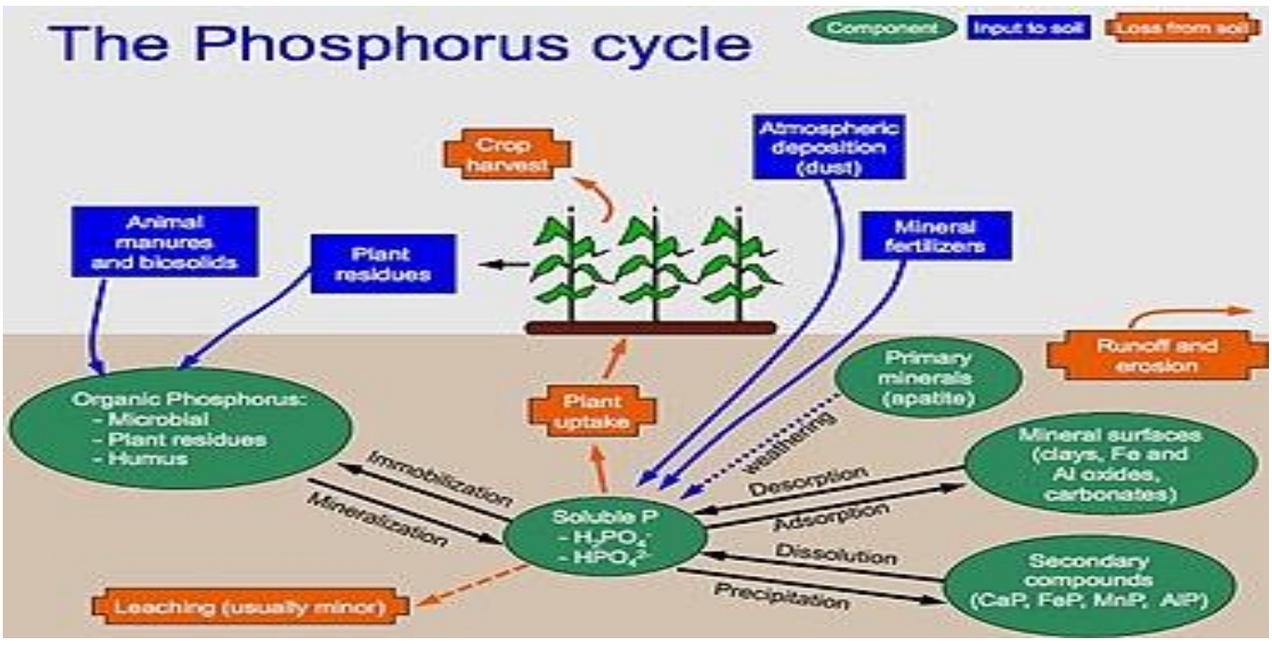


Lecture 41 Biogeochemical Cycles-Phosphorous Cycle

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

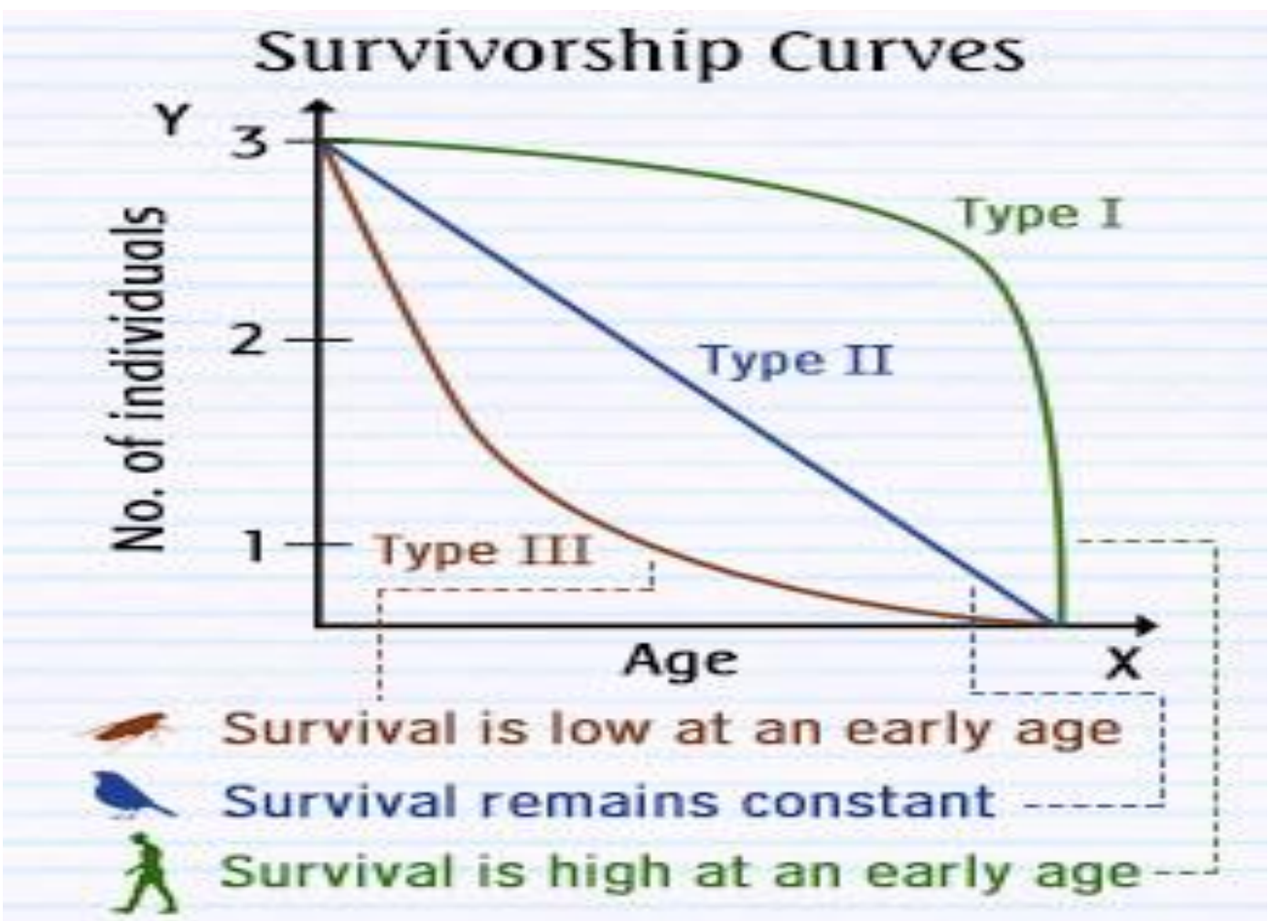
Minimum Mortality- constant for a population- represents the minimum loss under ideal or non-limiting conditions

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



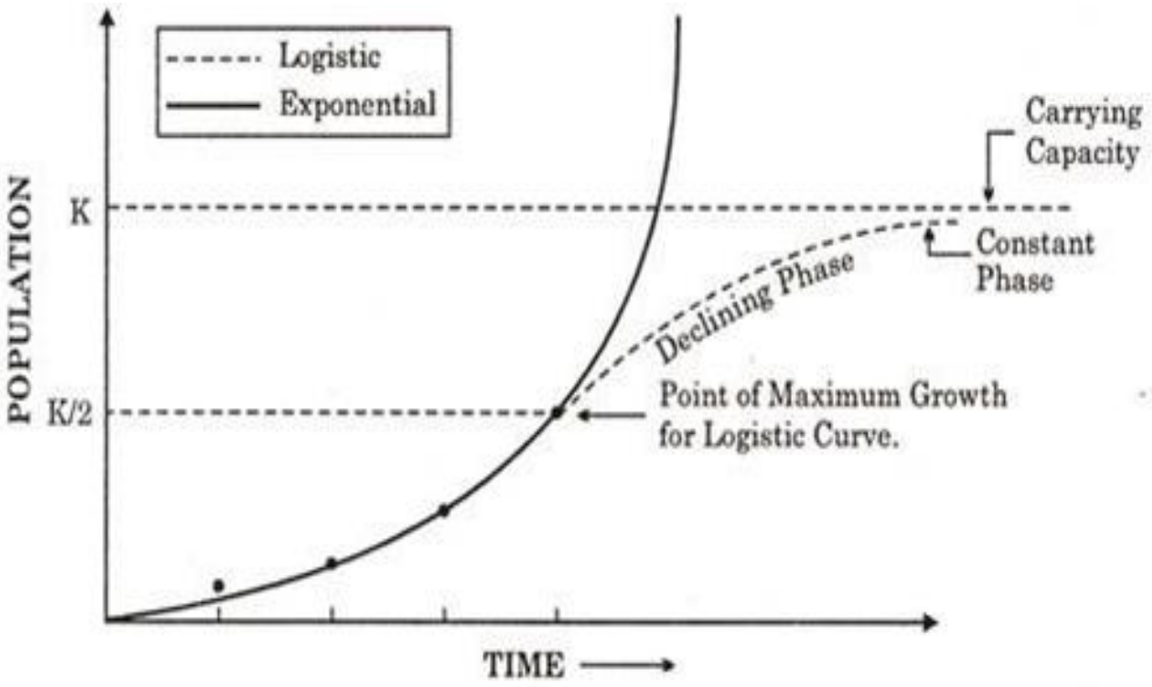
Population Ecology-carrying capacity

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

Growth curves can be

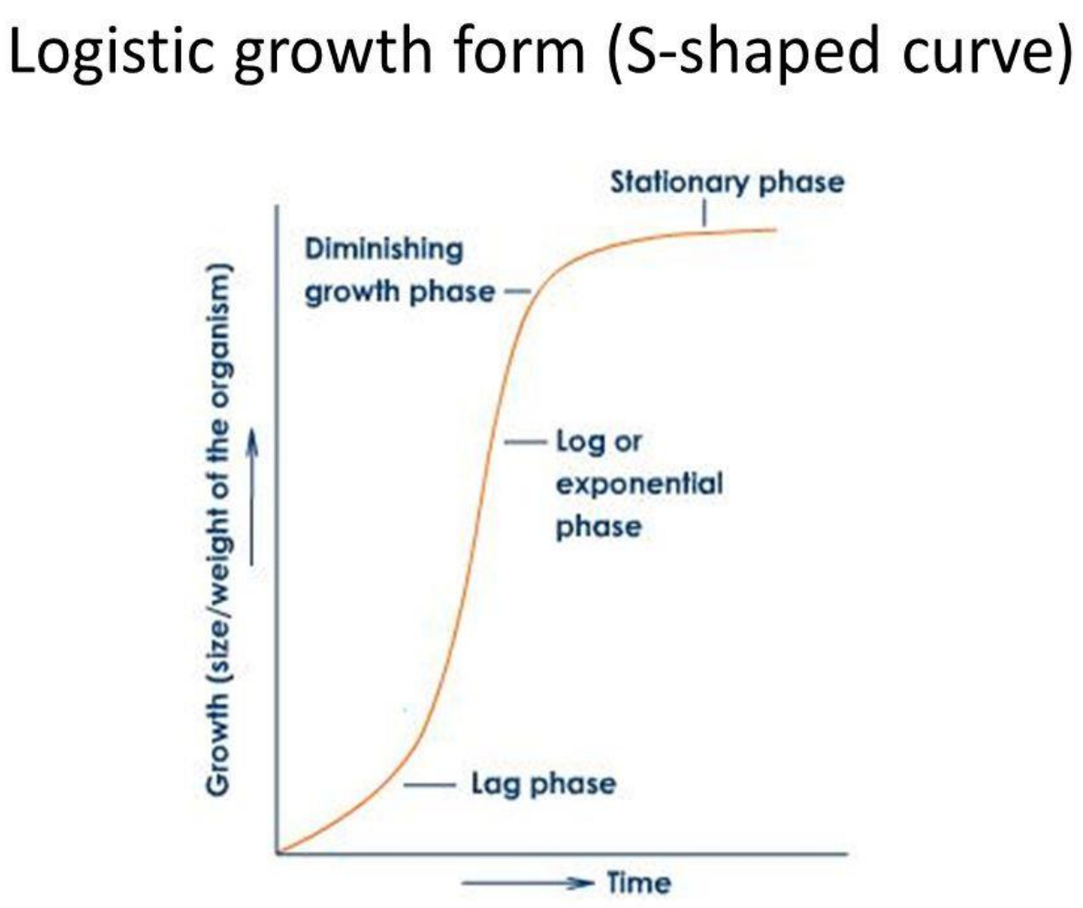
J-shaped

S (sigmoid) shaped



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

Population Ecology-Survivorship curve



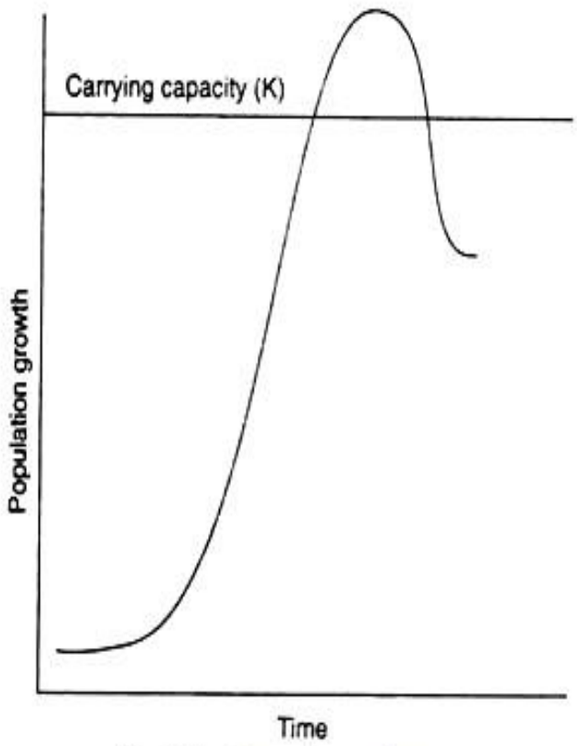
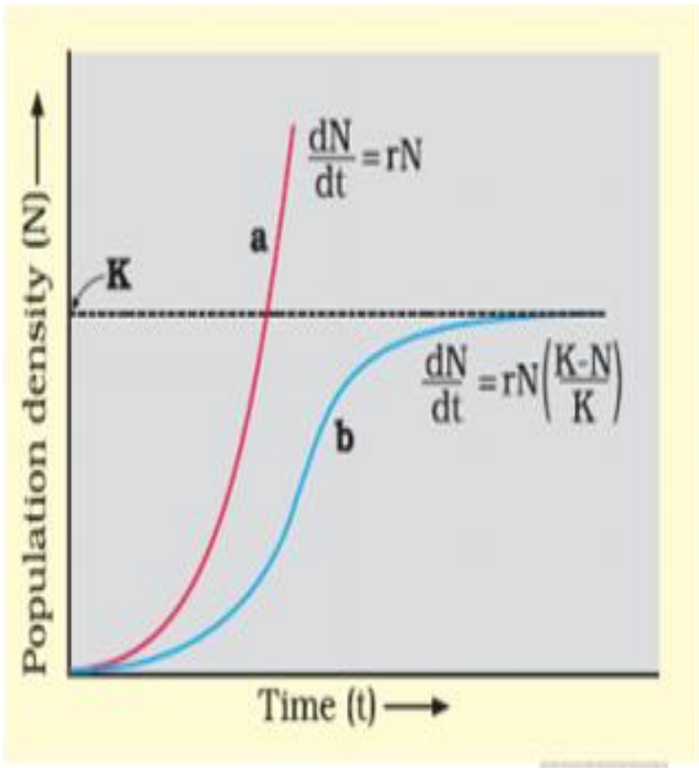
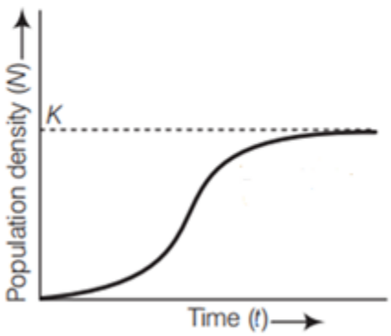
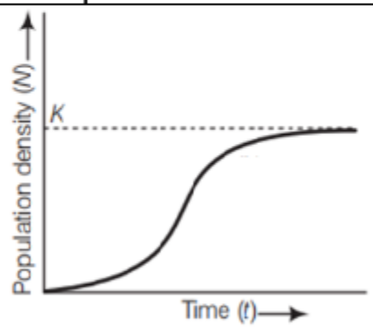


Fig. 4.43 : J-shaped growth curve



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

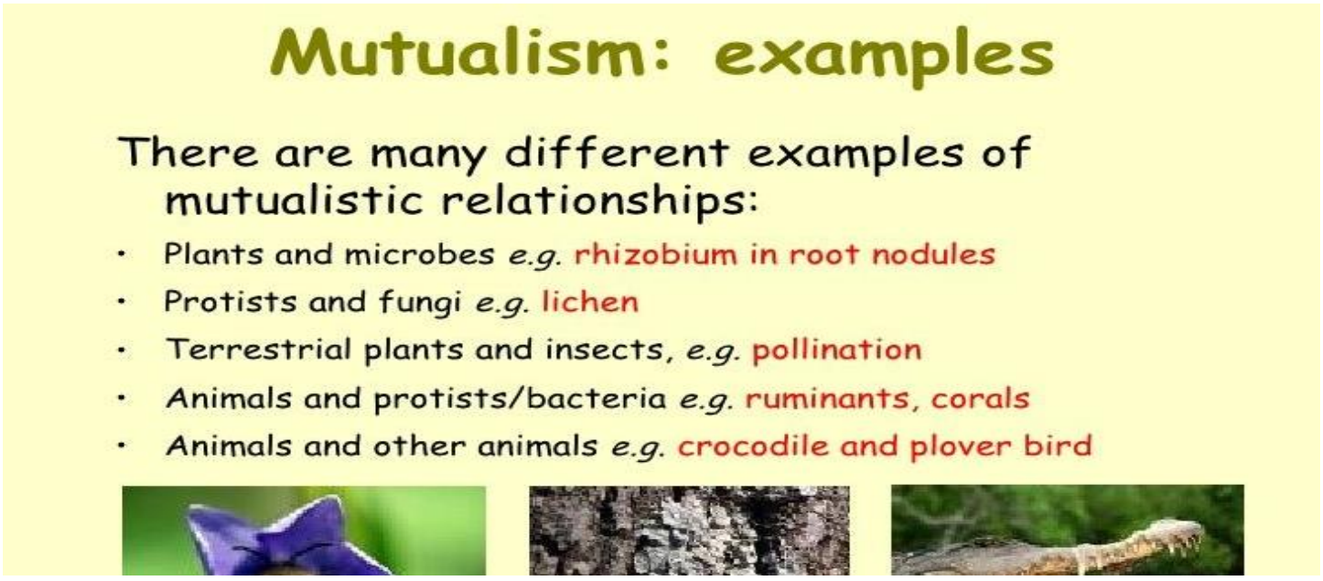
Commensalism: example- grazing cattle and cattle egrets. As the cattle graze in the grass, they stir up the insects living there, allowing the cattle egret a tasty meal. The cattle egrets get a meal, but the cattle receive nothing in return from the long-necked birds, nor are they harmed by the relationship.

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)

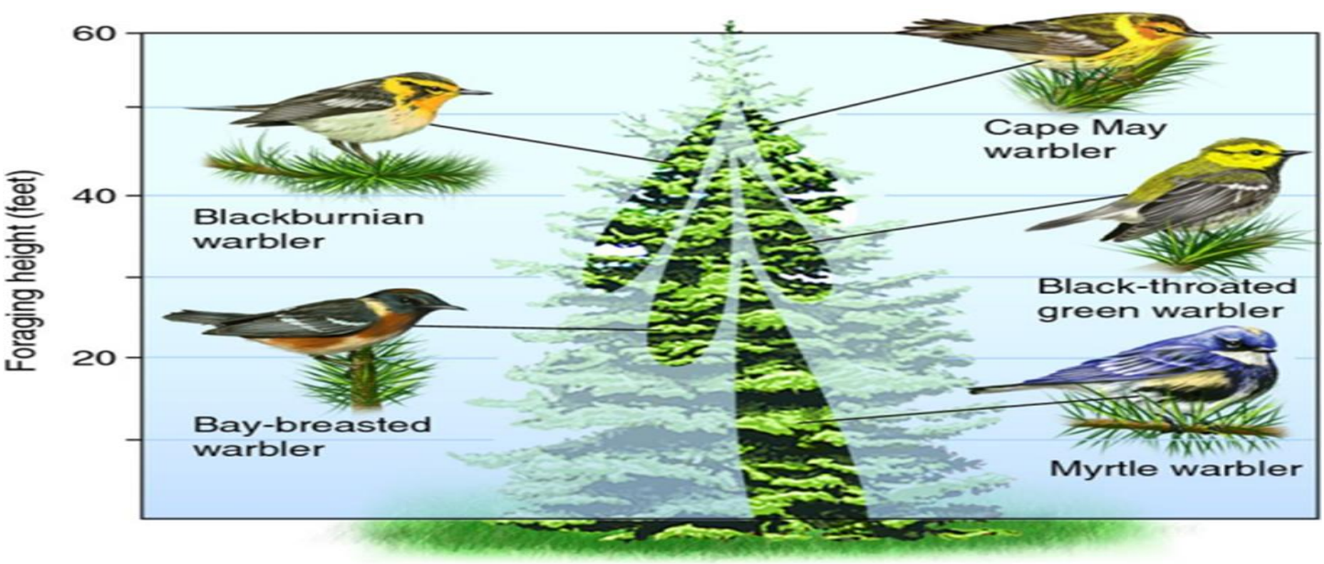
It describes an interaction in which the presence of one species has a negative effect on another, but the first species is unaffected.

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

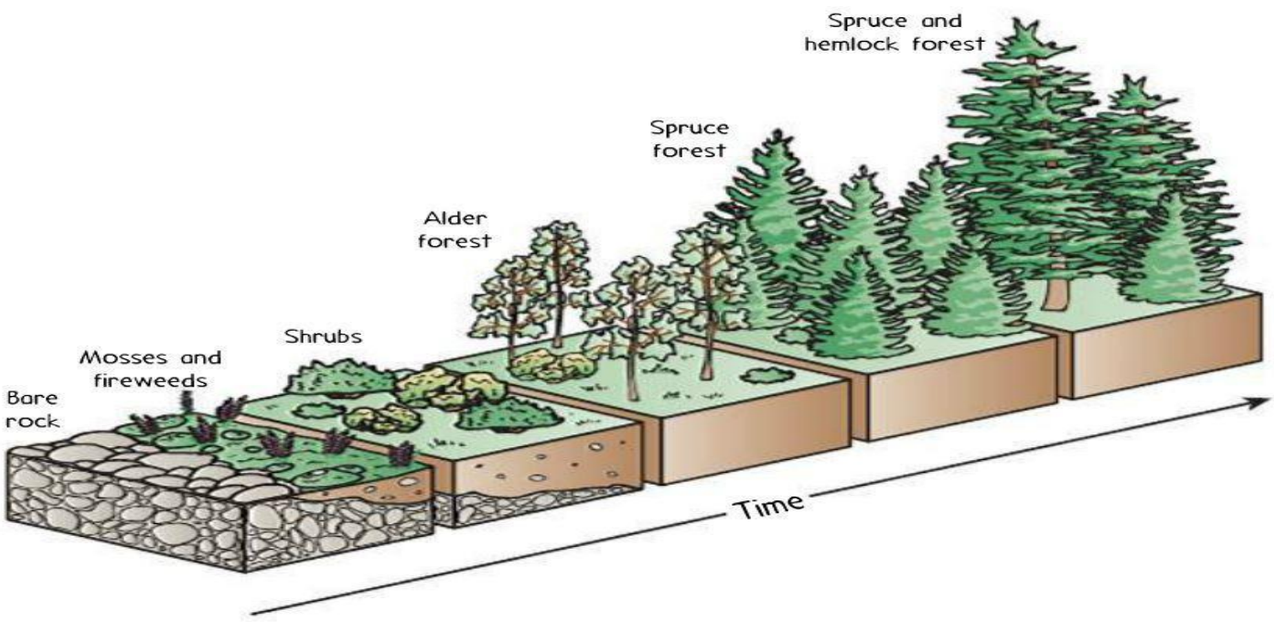
Succession • The process by which communities of plant and animal species in an area are replaced by another over a period of time is known as ecological succession

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

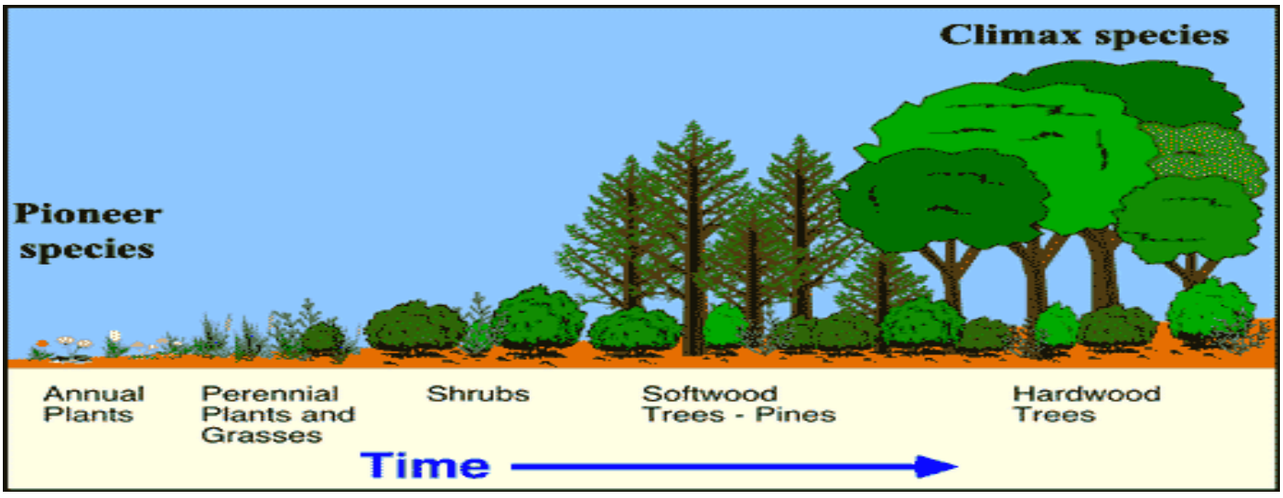
Seral stage

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

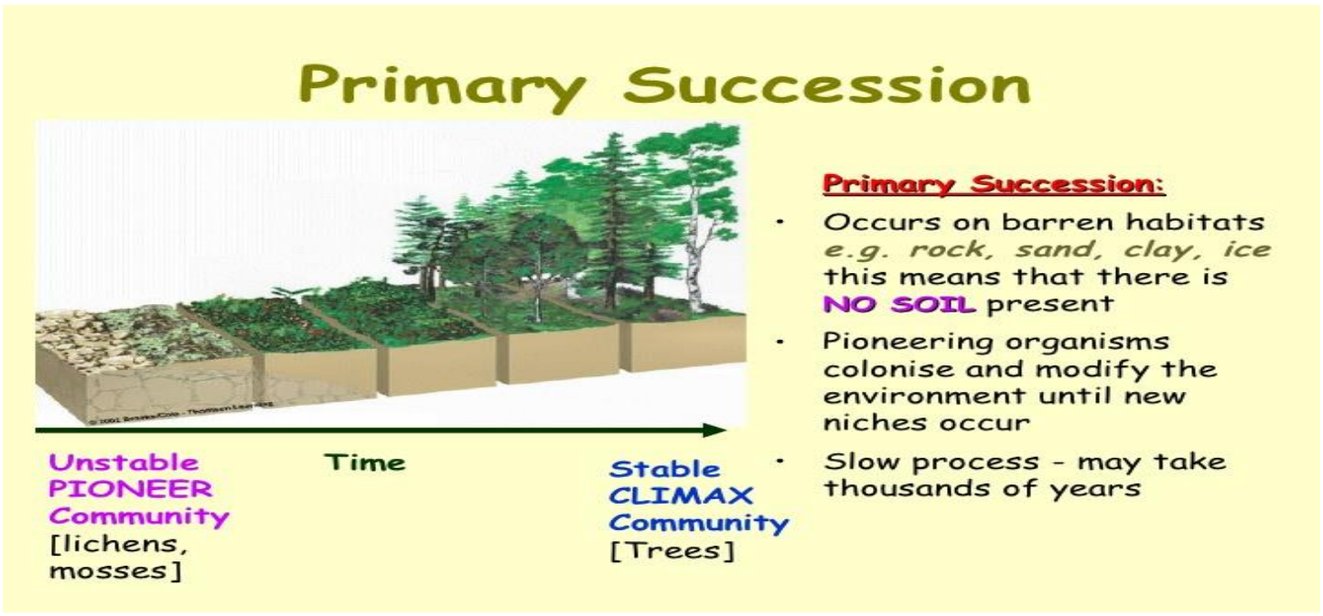


Seral stage

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

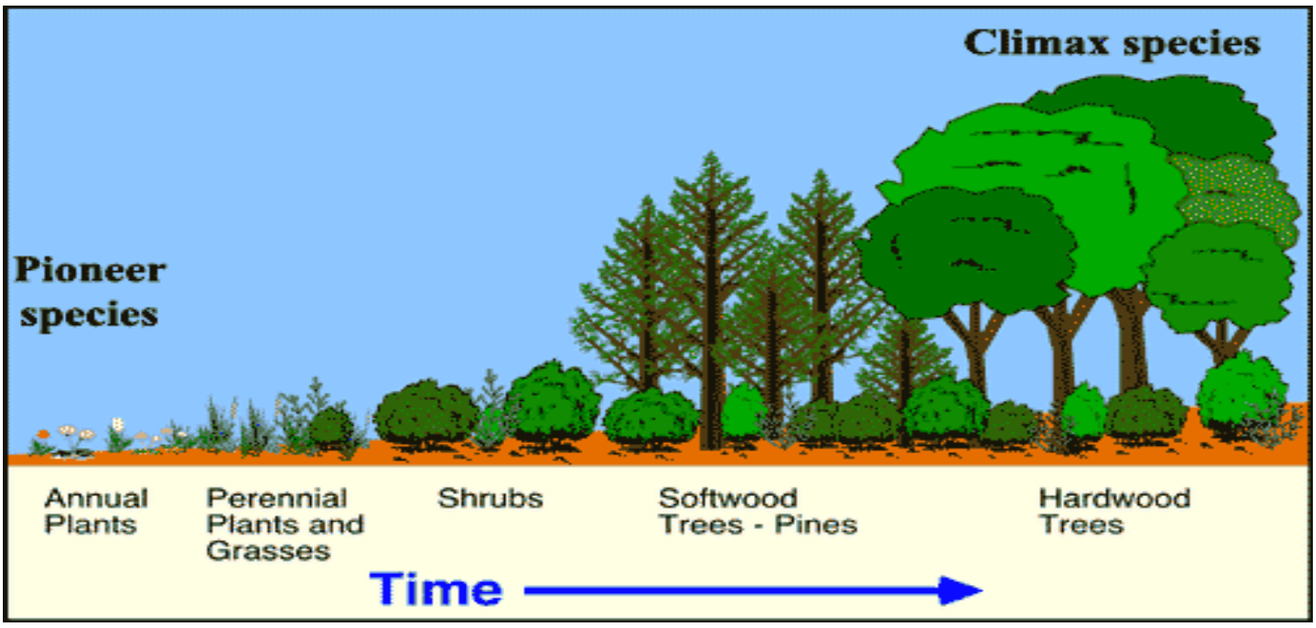
Each successional stage is called a **seral stage,**

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

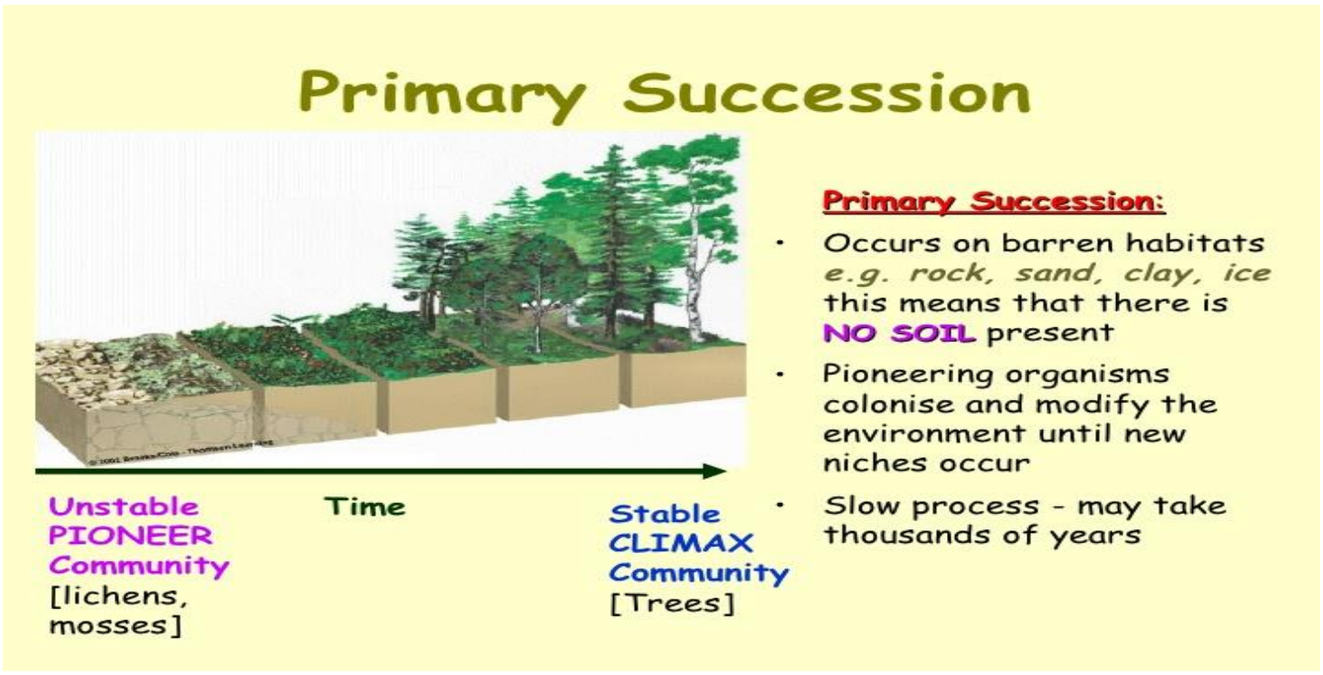


Two types:

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.

.

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

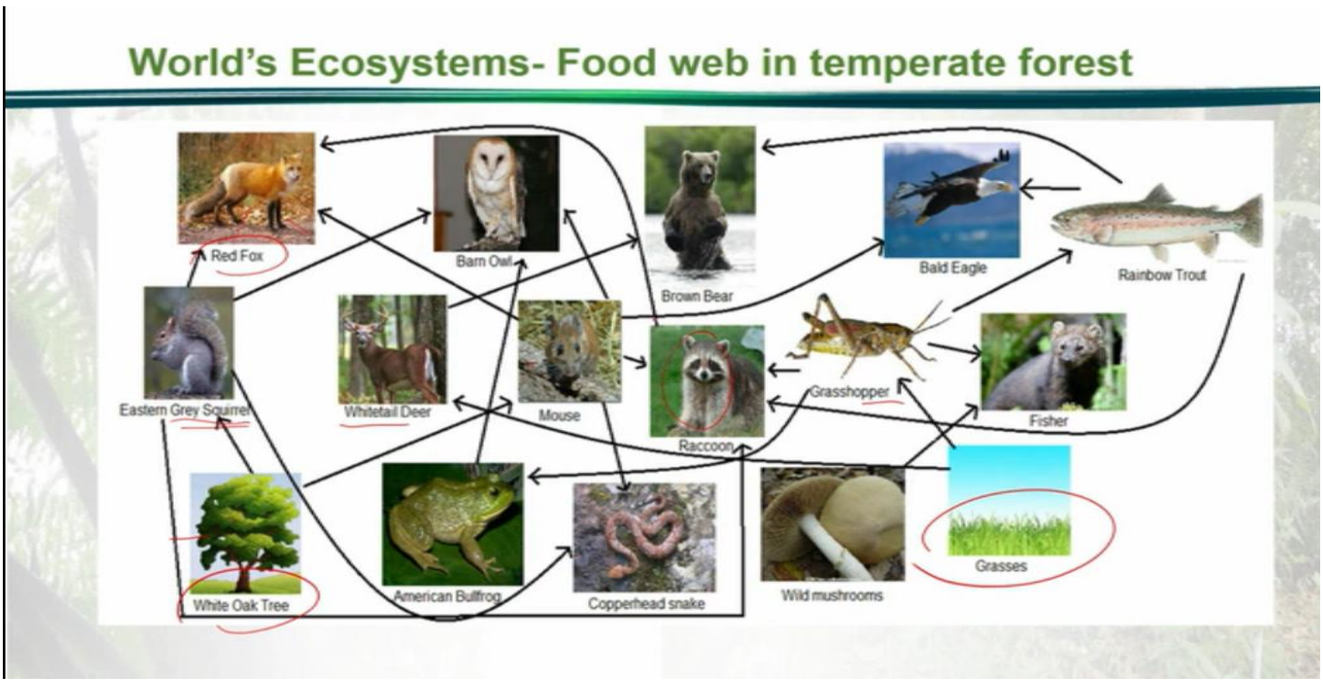
Flora and fauna : Prominent

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.

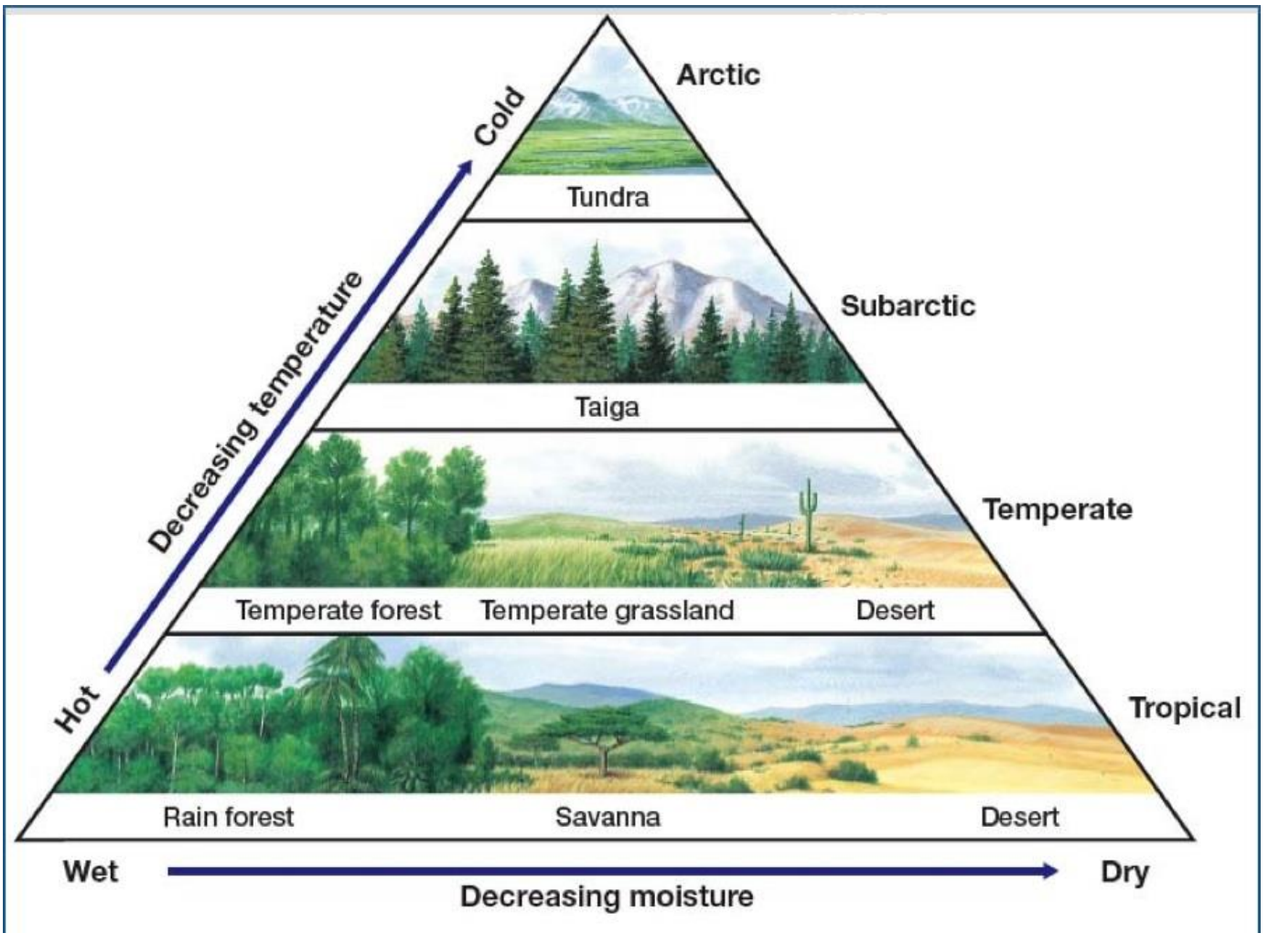
Lecture 72 World's Ecosystems-Grassland Ecosystem

Grasslands:

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

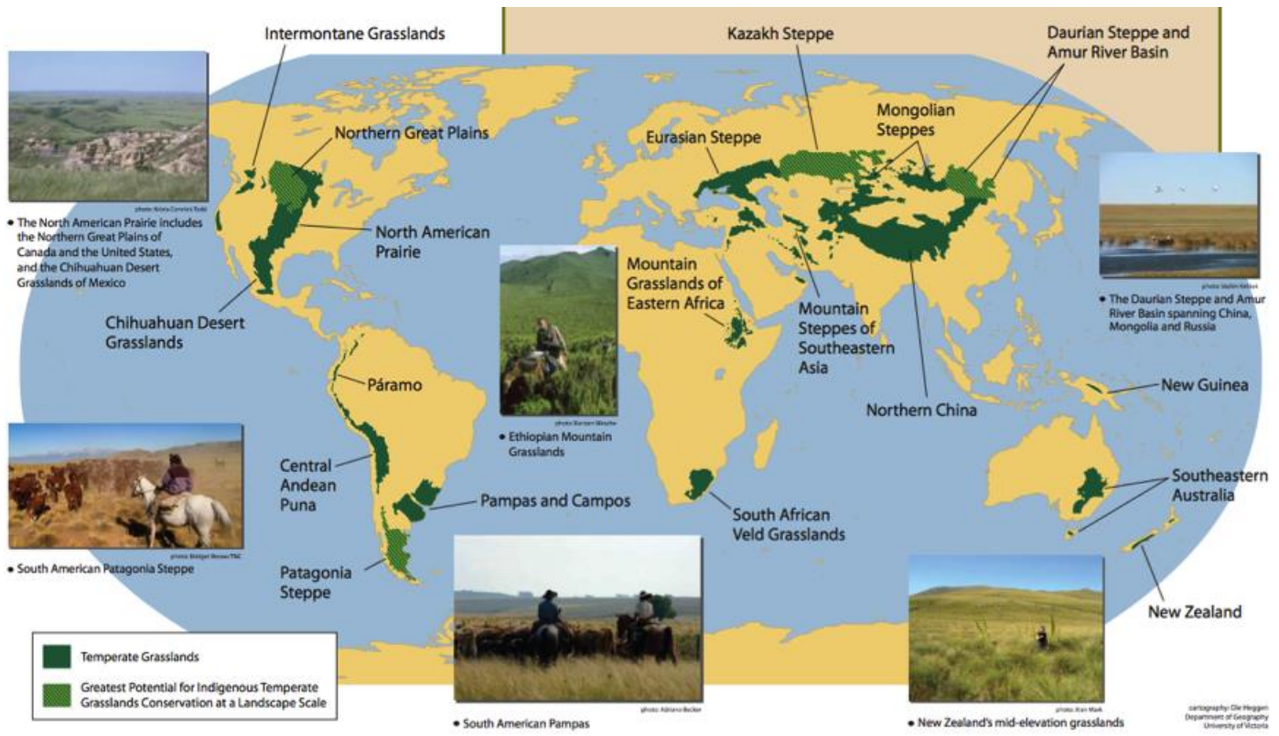
Grasslands Distribution : They occur in both tropical and temperate regions where environmental conditions are better than that of the desert but rainfall is not enough to support the growth of trees

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

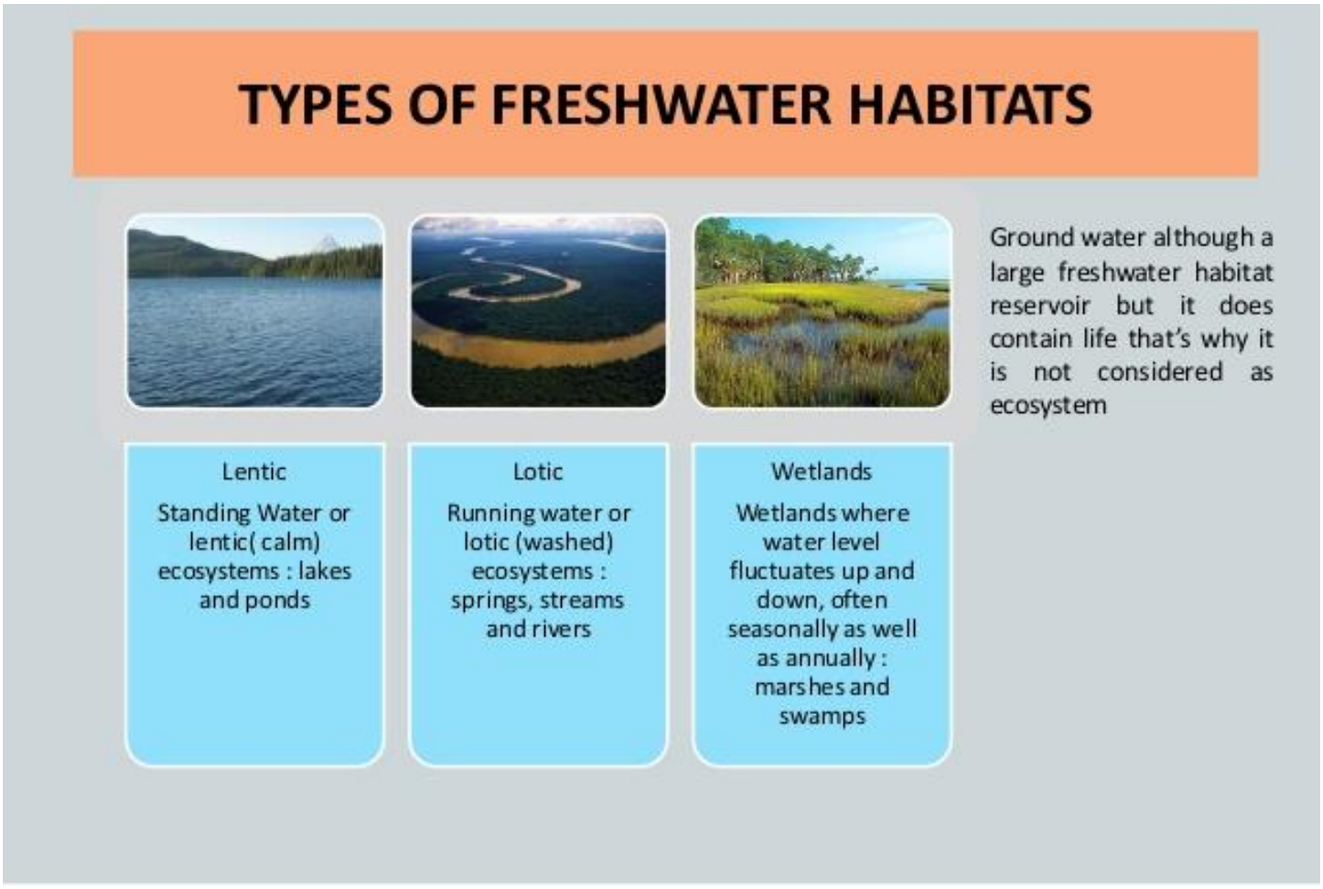
are classified on the basis of salinity into following two types:

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**



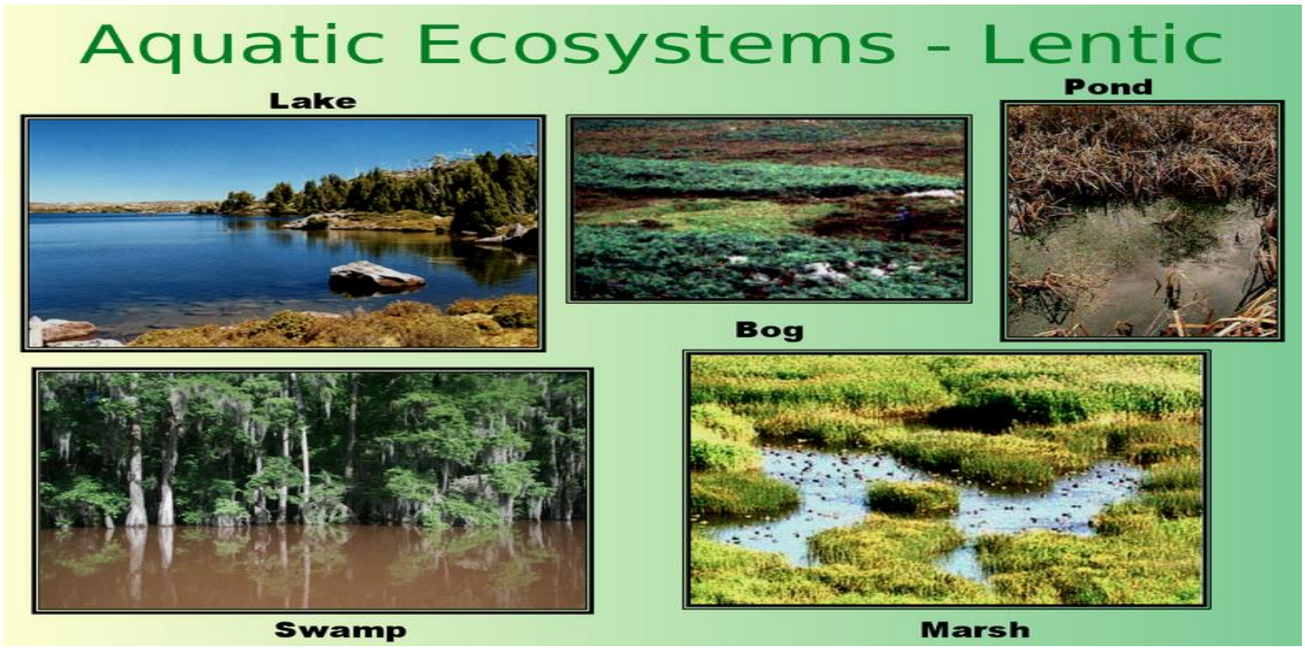
Lecture 79 Types of aquatic ecosystem

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.

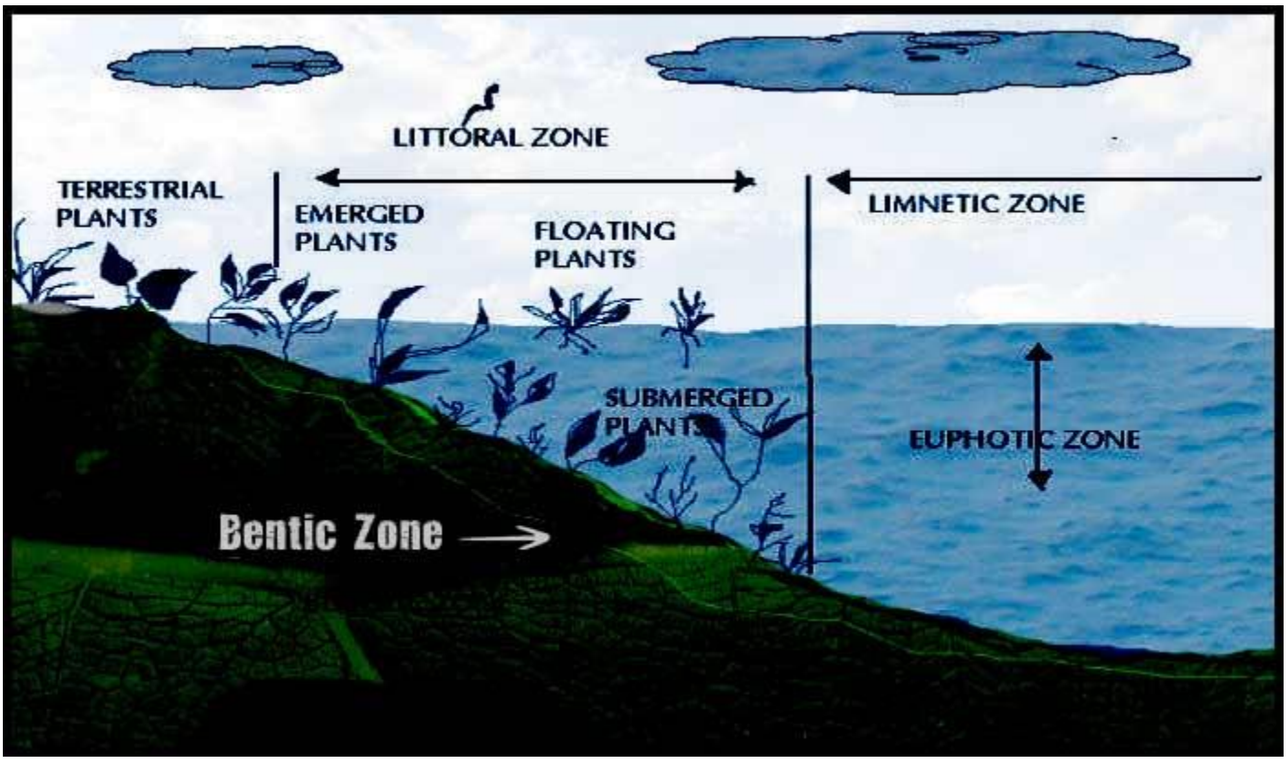
(iv) Birds such as herons, water fowls and ducks occurs in and around water.

Fresh Water Ecosystem

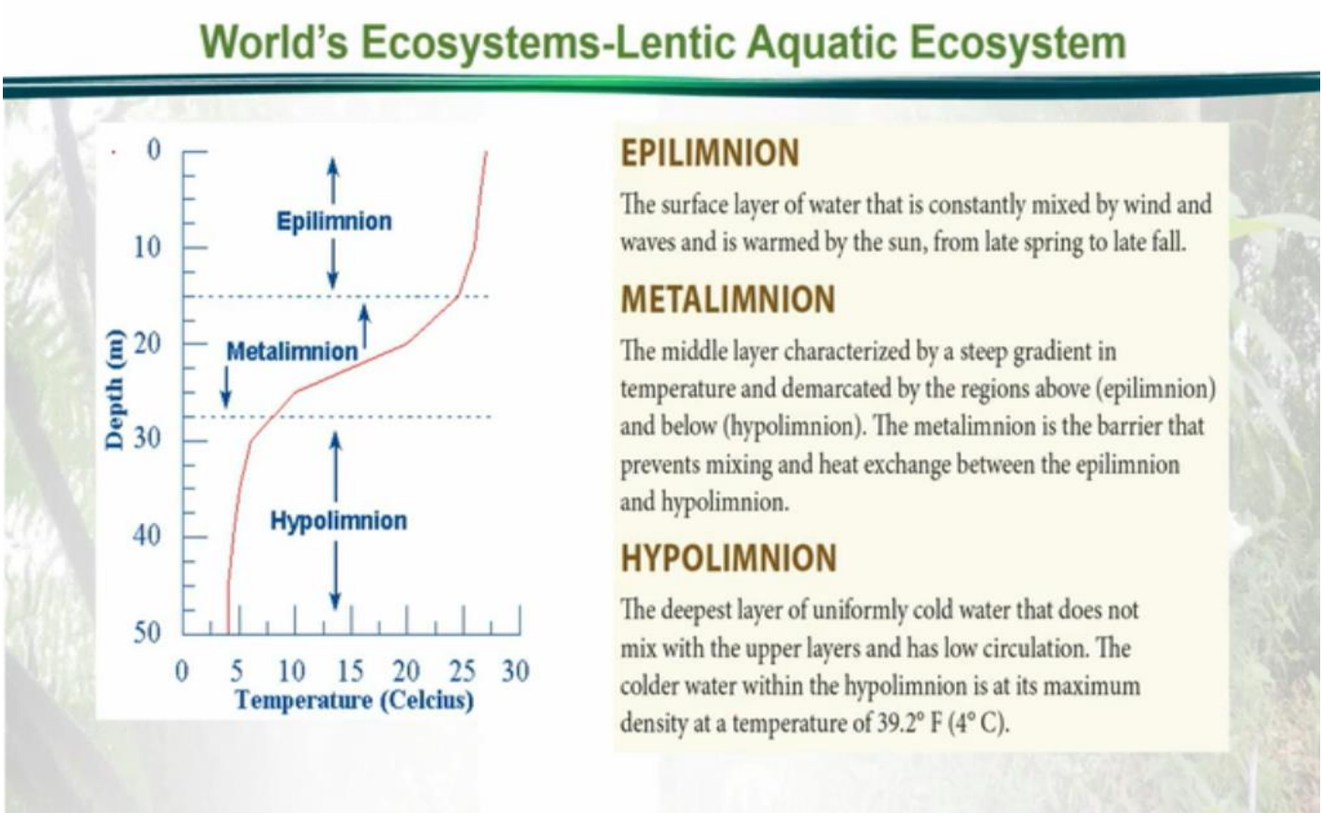
The common animals in ponds and lakes include

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

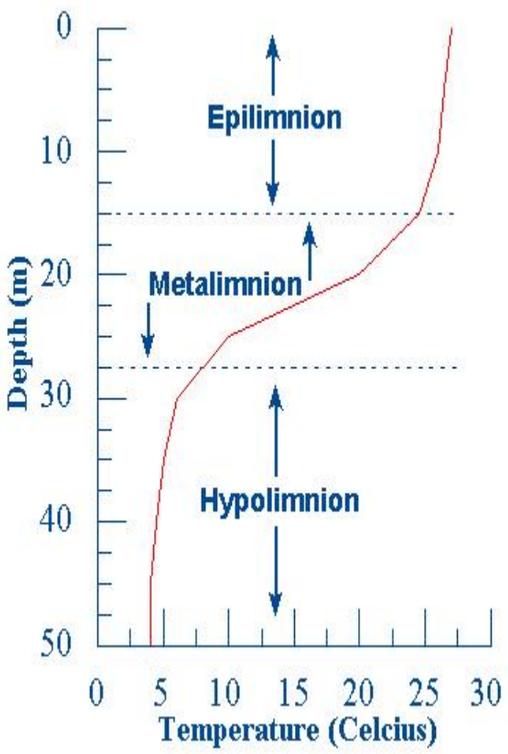
(ii) Actively swimming fishes, frogs, tortoises (Nekton).

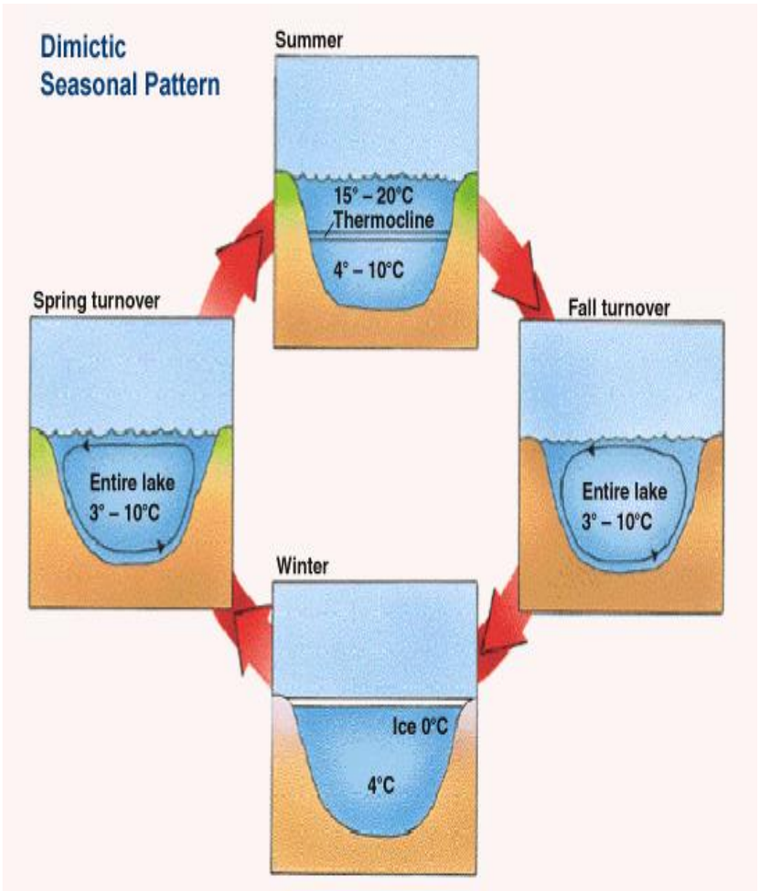


Lecture 81 Thermal stratification in lakes



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 Pakistan Geography-Markhor

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

Lecture 97 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 felcorneri*, Collared Pika, Persian Jird, Migratory Hamster, Stone Marten, Forest Dormouse

Lecture 98 Steppic Forest in Southern Latitudes

10. **Steppic Forest in Southern Latitudes**

Northern Kalat, Chiltan, Zargham, Kalipat mountain ranges, higher parts of Suleiman Hills

Flora: stunted *Juniperus macropoda, Pistacia, khinjak, Berberies baluchistanica, Rosa webbiana*

Fauna: Straight Horned Markhor, Persian Wild Goat, Persian Jird, Migratory Hamster, Stone Marten, Afghan Hegehog

Lecture 99 Arid Sub-Tropical Habitat

11. Monsoon influenced arid Sub-tropical

12. Less Pronounced Monsoon influence

13. Baluchistan Desert Scrub Forests

11. Monsoon influenced arid Sub-tropical

Humid summers, dry mild winters. Typified Karachi environment. Malir, Lakji Hills, Kirthar, Sindh Kohistan

Flora: *Euphorbia caduifolia, Zizyphus nummularia, Acacia Senegal, Commiphora mukul*

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

Lecture 100 Less Pronounced Monsoon influence

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

Flora: *Acacia modesta* (Phulai), *Olea cuspidate, Dodenea viscosa, Monotheca buxifolia*

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

Lecture 101 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.

Lecture 102 Baluchistan Desert Scrub Forests

13. Baluchistan Desert Scrub Forests

Usually associated with higher hills, stony plateaus. Very cold winters, no monsoon influence but occasial winter and spring showers. Typified by Northern Kalat, lower parts of Suleiman hills, most of the Baluchistan valleys, Kurram valley, most of Waziristan . Heavily overgrazed

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

Lecture 103 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

Lecture 104 Sand Dunes

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

Lecture 105 Pakistan's Ecosystem-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

Lecture 106 Pakistan's Ecosystem-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

Lecture 107 Thermoregulation

Definition

Ability of an organism to regulate its body temperature.

Temperature influences many body activities,

- Metabolism
- Growth
- Reproduction

Factors affecting Thermoregulation

Mechanism of thermoregulation is influenced by

- Availability of food
- Water
- Shelter

Categories of animals

Animals are adapted to various activities for regulation of body temperature during unfavourable environment.

1. **Endotherms**
2. **Ectotherms**

Optimum Temperature

Enzymes a biological catalyst need a specific temperature called optimum temperature for their proper functioning.

Improper temperature makes the enzymes unable to perform their catalytic activity. In high temperatures the three dimensional structure of enzymes may denature.

Lecture 108 Ectotherms

Definition

- Organisms that control their body temperature by means of external source.

- They are on the mercy of environmental temperature.
- Their body temperature fluctuates with respect to external environmental temperature.

Characteristics of Ectotherms

- Low metabolic rate
- Generate body heat from external environment
- Body insulation is very poor

Examples

Cold blooded animals

- Fish
- Amphibians
- Reptiles
- Invertebrates

Lecture 109 Endotherms

Definition

- Animals that produce their own body heat through internal mechanisms.
- Their internal body temperature is independent of external environmental temperature.
- Warm blooded animals, birds and mammals.

Characteristics of Endotherms

- High rate of metabolism
- Generate heat from body cellular activities
- Body insulation by fur or feathers

Survival mechanisms in hot environment

- Sweating
- Panting
- Vasodilation
- Aestivation

Survival mechanisms in cold environment

- Fat deposits
- Fur
- Feathers
- Vasoconstriction
- Hibernation

Lecture 110 Hibernation

A condition in which animals become inactive usually in cold environments for their survival.

Animals hibernate due to following reasons,

- Very low temperature

- Shortage of food

Hibernating animals possess,

- Low metabolic rate
- Low respiratory rate
- Low body temperature

This condition may lasts for weeks or months.

True hibernation occurs in small mammals, such as rodents, shrews, and bats etc.

Lecture 111 Hibernation vs Winter sleep

True hibernation occurs in small animals in which temperature substantially falls to remain alive in cold environment. Animals remain inactive for weeks or even for months.

Hibernation in large animals like bears is termed as winter sleep.

Body temperature does not falls substantially and sleeping animals can wake and active quickly.

It lasts for short period of time. Large animals have more energy reserves that enables them to survive in winter.

Lecture 112 Aestivation

Aestivation or summer sleep is a period of inactivity and low metabolic rate in animals in response to high temperature and dry season.

Aestivation is common in many invertebrates, reptiles, and amphibians.

Aestivation is a kind of adaptation in some animals that helps them to survive in extended periods of drying. The animal usually enters a burrow as its environment begins to dry. It generally does not eat or drink and emerges again after moisture returns.

The Australian burrowing frog, *Cyclorana alboguttatus,* in its burrow and water-retaining skin.

Reptiles like chuckwalla *(Sauromalus obesus)* survives in summer temperatures of 40° C (104° F). To withstand these hot and dry conditions, chuckwallas disappear below ground and aestivate.

Lecture 113 Mycorrhizae

A mutualistic relationship between fungi and roots of higher plants by which both partners are get benefited.

A very remarkable group of Ascomycetes fungi, the Clavicipitaceae, grow in the tissues of many species of grass.

The fungal networks in Mycorrhizae capture minerals from the soil and transport them to the plants while in turn plants provides nutrients like sugars to fungus.

Major types of Mycorrhizae

1. Endomycorrhizas or Arbuscular mycorrhizas
2. Ectomycorrhizas
3. Ericoid mycorrhizas

Endomycorrhizas or Arbuscular mycorrhizas:

They are found in up to two-thirds of all plant species, including most nonwoody species and tropical trees. Fungus incorporates into cortical cells of roots of higher plant.

Ectomycorrhizas:

Ectomycorrhizal fungi form symbioses with many trees and shrubs, dominating boreal and temperate forests and also some tropical rainforests.

Ericoid mycorrhizas:

Ericoid mycorrhizas are found in the dominant species of heathlands (barren infertile lands) including the northern hemisphere heaths and heathers (Ericaceae) and the Australian heaths (Epacridaceae).

Lecture 114 Root nodules

It is a mutualistic association between nitrogen fixing bacteria and roots of plants of legume family.

The process of nitrogen fixation is done by different kinds of microorganisms.

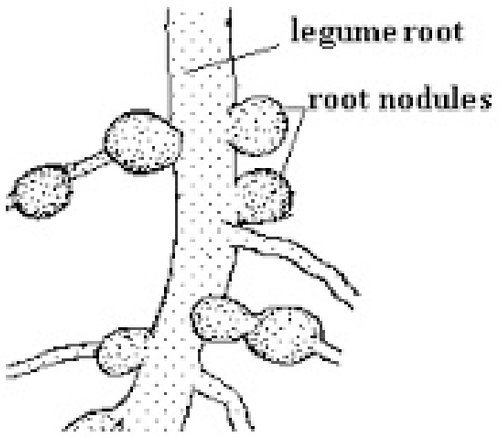
Types of nitrogen fixing bacteria

Azobactor

- Free living aerobic bacteria

Clostridium

- Free living anaerobic bacteria



Chlorobium

- Photosynthetic bacteria

Thiobacillus

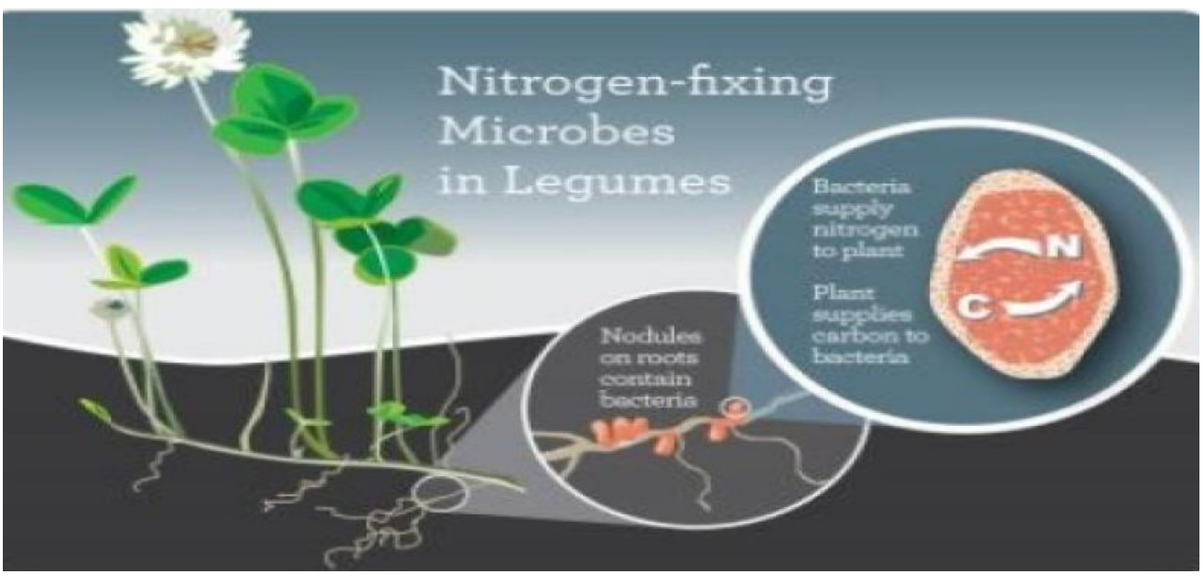
- Chemosynthetic bacteria

Nostoc

- Blue green algae

A special vascular system develops in the host, supplying the products of photosynthesis to the nodule tissue and carrying away fixed nitrogen compounds to other parts of the plant. The nodule tissue provides shelter and carbon to bacteria.

This whole picture summarizes the process of nitrogen fixation.



Lecture 115 Parasitism

Parasitism is a kind of association in which one organism called parasite lives on the expense of other organism, called a host. The host usually survives at least long enough for the parasite to complete one or more life cycles.

Unlike the typical predator, a parasite usually is much smaller than its host and rarely kills its host. Most parasites remain closely associated with their hosts. They draw nourishment from host, and may gradually weaken them over time.

Endoparasite

Some parasites live inside the body of their hosts and are named as endoparasite.

- ❖ Pathogens
- ❖ *Entamoeba histolytica*
- ❖ Tapeworms
- ❖ Hookworms

Ectoparasite

Parasites that attach themselves to the outsides of their hosts are called Ectoparasite.

- Mosquitoes
- Mistletoe plants
- Sea lampreys

Healthy tree on the left and an unhealthy one on the right, which is infested with parasitic mistletoe.

Blood-sucking parasitic sea lampreys attached to an adult lake trout.

The definitive or final host is the host that harbors the sexual stages of the parasite. A fertile female in a definitive host may produce thousands of eggs in its lifetime. Each egg gives rise to an immature stage that may be a parasite of a second host. This second host is called an **intermediate host**, and asexual reproduction may occur in this host.

Lecture 116 Interspecific adaptations

Predators exert selective pressure on their prey, leading them to have better adaptations to survive and evade capture. In turn, the predators themselves evolve to become better hunters.

This back-and-forth evolutionary process between predator and prey generally leaves both species more refined.

By gaining certain kinds of adaptations predator and prey both become more active in their responses.

Common Interspecific adaptations,

- Camouflage
- Counter-shading
- Aposematic coloration
- Mimicry
- Chemical warfare

Lecture 117 Camouflage

Camouflage is a kind of coloration or patterns that help an animal to appear to blend with its surroundings.

Many prey species use the camouflage (the ability to change color) of certain shapes or colors or (chameleons and cuttlefish).

Cryptic coloration (L. *crypticus, hidden)* *is a* type of camouflage that occurs when an animal takes on color patterns in its environment to prevent the animal from being seen by other animals.

The color pattern of this tiger (*Panthera tigris*) provides effective camouflage that helps when stalking prey.

Praying mantises sit in flowers of a similar color and ambush visiting insects.

Some insect species have shapes that make them look like twigs ,bark, thorns, or even bird droppings on leaves.

A leaf insect can be almost invisible against its background, as can an arctic hare in its white winter fur.

Lecture 118 Counter-shading

Counter shading is a type of color pattern in animals in which there is a dark pigmentation on the upper surface of body and light pigmentation on the lower surface of body.

Counter shading helps an animal to blend in with its surrounding environment.

Counter shading is a kind of camouflage common in frog and toad eggs.

These eggs are darkly pigmented on top and lightly pigmented on the bottom. When a bird or other predator views the eggs from above, the dark of the top side hides the eggs from detection against the darkness below.

On the other hand, when fish view the eggs from below, the light undersurface blends with the bright air-water interface.

Penguins are another example that exhibit phenomenon of counter shading.

Lecture 119 Aposematic coloration

Some animals protect themselves by being dangerous or distasteful to predators by using prominent coloration. These color patterns are known as **warning** or **aposematic coloration.**

The sharply contrasting white stripes of a skunk and bright colors of poisonous snakes give similar messages.

They flash a warning: “Eating me is risky.” Examples are brilliantly colored poisonous frogs is another example.

when a bird such as a blue jay eats a foul-tasting monarch butterfly it usually vomits and learns to avoid them.

Biologist Edward O. Wilson Described two rules, based on coloration. These rules evaluate possible danger from an unknown animal species we encounter in nature.

- First, if it is small and strikingly beautiful, it is probably poisonous.
- Second, if it is strikingly beautiful and easy to catch, it is probably deadly.

Lecture 120 Mimicry

Mimicry (L. *mimus,* to imitate) occurs when a species resembles one, or sometimes more than one, other species and gains protection by the resemblance.

These six species of *Heliconius* are all distasteful to bird predators. A bird that consumes any member of the six species is likely to avoid all six species in the future.

Some butterfly species, such as the non-poisonous viceroy, gain protection by looking and acting like the monarch, a protective device known as mimicry.

Viceroy butterfly mimics

monarch butterfly.

Some moths have wings that look like the eyes of much larger animals. *Hind wings of Io moth resemble eyes of a much larger animal.*

When touched, snake caterpillar changes shape to look like head of snake.

Lecture 121 Chemical warfare

Chemical warfare is another common strategy to escape from predators.

Chemical warfare refers to use of chemical substance as a weapon for defence purpose.

Some predators use chemical warfare to attack their prey. For example, spiders and poisonous snakes use venom to paralyze their prey and to deter their predators.

Some prey species discourage predators with chemicals that are poisonous (oleander plants)and irritating (stinging nettles and bombardier beetles).

Bombardier beetle

Some possess foul smelling (skunks, skunk cabbages, and stinkbugs), or bad tasting (buttercups and monarch butterflies).

Foul tasting

monarch butterfly

When attacked, some species of squid and octopus emit clouds of black ink, allowing them to escape by confusing their predators.

Lecture 122 Biome

A large regional community is known as biome. Each biome is differentiated from one another on the base of,Plants Animals Climate.

Main elements of a biome are,

- Habitat
- Biodiversity
- Climate
- Plant and animal adaptation
- Human activity

There are two broad categories of biomes,

1. **Aquatic biomes**
2. **Terrestrial biomes**

Aquatic biomes:

Aquatic biomes are further classified into,

-Saltwater biome

-Freshwater biome

Terrestrial biomes:

-Tundra biome

-Desert biome

-Grassland biome

-Forest biome

Lecture 123 . species composition

Species composition is all the different living organisms that develop or compose a community within an ecosystem. Species composition is an important tool for the determination of community structure of a specific place.

Study of species composition tells us how an ecosystem works as well as the importance of each species in that ecosystem.

It is expressed as a percent.

Species composition can be expressed on either an individual species basis, or by species groups.

It is used as an important indicator for analyzing ecological and management processes occurring at a particular site.

Species composition can be used as an indicator by two ways,

- Ecological indicators
- Management indicators

Ecological indicators

- Species composition is used as an ecological indicator to evaluate natural biodiversity and to estimate environmental change.
- It provides typical knowledge about the vegetation of a particular site that is linked with different other species for food.

Management indicators

- Species composition also reflects the effects of a disturbance regime or the efficacy of efforts to mitigate disturbance effects. The management of community in a specific site is directly connected with assessment or manipulation of species composition

Lecture 124 Species richness

Species richness is the measure of number of species per unit area found in a particular site or place. Species richness is a common measure of variety of life on earth.

Species abundance

Species abundance is the number of individuals per species, and relative abundance refers to the evenness of distribution of individuals among species in a community.

Species evenness

Species evenness is a measure of the relative abundance of the different species that contribute to the richness of an area.

As species richness and evenness increase, species diversity also increases.

Lecture 125 . Species diversity and dominance

In ecology, diversity is a measure of the evenness in distribution of the individual organisms among the species present. Species diversity is linked with both species richness and species evenness.

Species dominance

Species dominance refers to the biological supremacy of species that influence the ecosystem by controlling the energy flow in that ecosystem.

Species dominance has an inverse relation with species diversity.

Communities with low diversity usually have low evenness and are often highdominance assemblages.

Species hotspots

Species hotspots are geographic regions that support high level of species diversity.

Tropical rainforests are one of important species hotspots region in the world because they are home to more than **50% species**.

Lecture 126 Succession

The change in composition and organization of community over period of time is known as succession or ecological succession. It is a kind of "community relay" that allows the plants and animals to replace one another in a predictable manner.

The phenomenon of succession is often associated with single local community.

It is a unidirectional process and includes various changes in ecosystem.

During succession some species colonize an area and their populations become more numerous, while populations of other species decline and may even disappear. The process of ecological succession occurs due to,

- Human activity
- Fire
- Storms and hurricanes
- Soil erosion
- wind

Autogenic succession

- In autogenic succession the successional process
- is controlled by living or biotic component of an
- ecosystem

Allogenic succession

- The entire successional process is controlled by ▪ non living or abiotic components of ecosystem.
- Ecological succession is a process of gradual changes that causes the plants, animals, fungi and microorganism to become established in an area.

Types of succession

Succession is of two types

1. Primary succession
2. Secondary succession

Succession benefits

1. Development of an ecosystem.
2. Sustainability of ecosystem.
3. Recovery of ecosystem from damage caused by humans or any other natural disaster.
4. Balance of nature.

Lecture 127 Primary succession

The process by which a new community is propagated or initiated in an area where previously no life forms exist is **termed as primary succession**. Primary succession takes thousands of years to develop by the gradual accumulation of nutrients.

Communities begin to establish in areas which are devoid of life.

The first community to become established in an area is called the **pioneer community.**

The organisms that develop this pioneer community are called **pioneers**.

Examples are lichens and mosses whose seeds or spores are distributed by the wind and carried by animals.

Death, decay, and additional nutrients add to the community. Over thousands of years nutrients accumulate, and the characteristics of the ecosystem changes.

Seral stage

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

Sere

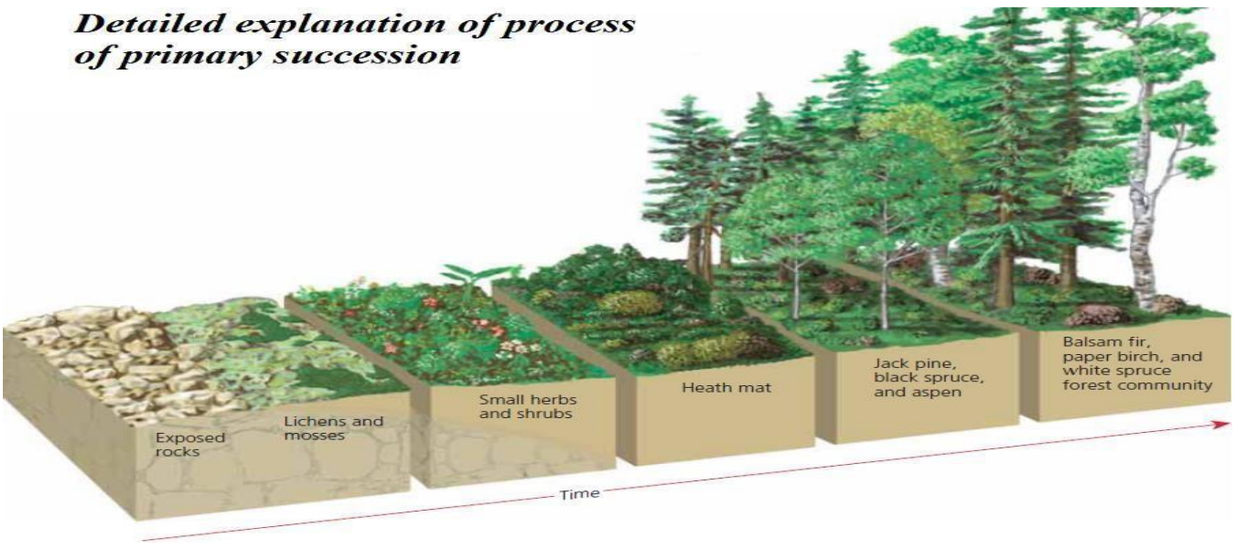
The entire successional sequence is termed as a **sere**.

Biomass increases, nutrients are conserved more efficiently, and productivity declines in the course of succession.

Climax community

The relatively stable and uniform community developed by the pioneers through different successional stages is named as climax community. It is a final and mature stage of any community.

Primary succession on a sand dune. Beach grass is the first species to become established. It stabilizes the dune so that shrubs, and eventually trees, can grow.



Lecture 128 Secondary succession

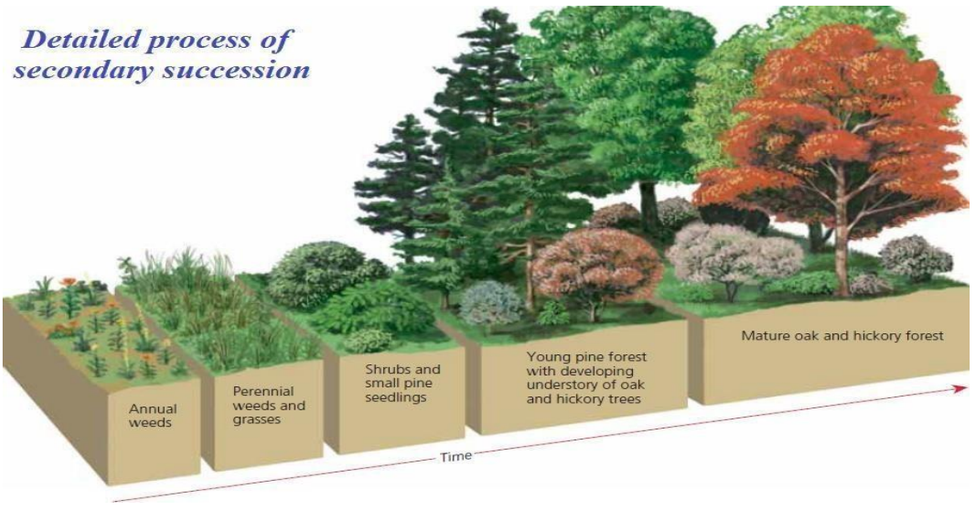
Development of an ecosystem in an area where previous existing ecosystem was disturbed by climatic and geological events is termed as **secondary succession.**

It develops rapidly than primary succession because previous disturbed community has left its marks in form of improved soil and seeds.

Secondary succession begins in an area where an ecosystem has been disturbed, removed, or destroyed, but some soil or bottom sediment remains. This remaining soil or sediments provide a framework that initiates the pioneers to grow.

Candidates for secondary succession include

1. Abandoned farmland
2. Burned or cut forests
3. Heavily polluted streams
4. Flooded lands



Secondary ecological succession of plant communities on an abandoned farm field. A new disturbance, such as deforestation or fire, would create conditions favoring pioneer species such as annual weeds to grow.

Lecture 129 -Pollution

Pollution is anything in the environment that is harmful to the health, survival, or activities of humans or other organisms.

Pollution is any detrimental change in an ecosystem.

Most kinds of pollution are the results of human activities. Large human populations and demands for increasing goods and services contribute to pollution problems.

Pollutants can enter the environment naturally through,

Volcanic eruptions Human activities -
Burning coal and gasoline

-Discharging chemicals into rivers and the ocean.

The pollutants come from two types of sources.

1. Point sources

2. Non point sources

Point sources are single, identifiable sources.

Examples are,

• Smokestack of a coal-burning power or industrial plant,

• The drainpipe of a factory,

• The exhaust pipe of an auto mobile.

Nonpoint sources are dispersed and often difficult to identify.

Examples are pesticides blown from the land into the air and the runoff of fertilizers and pesticides from farmlands, lawns, gardens, and golf courses into streams and lakes.

It is much easier and cheaper to identify and control or prevent pollution from point sources than from widely dispersed nonpoint sources.

There are two main types of pollutants.

- **Biodegradable pollutants**
- **Non-degradable pollutants**

Biodegradable pollutants are harmful materials that can be broken down by natural processes. Examples are human sewage and newspapers.

Non-degradable pollutants are harmful materials that natural processes cannot break down.

Examples are toxic chemical elements such as lead, mercury, and arsenic.

Lecture 130 -Organic pollutants or biostimulants

Organic pollutants or biostimulants, primarily from agricultural fertilizers and sewage waste, have a major impact on aquatic environments. When these excessive nutrients enter aquatic systems, they stimulate plant growth.

Rapid phytoplankton growth or algal blooms creates hypoxic (that is, low-oxygen, less than 2 mg/liter) or even anoxic (no oxygen) environments in which few organisms can survive.

Large concentrations of algae also reduce water clarity, preventing light from reaching the bottom and reducing the growth of seagrasses.

Eutrophication

A long-term increase in excess nutrients into an ecosystem causes higher biological activity this is known as eutrophication or harmful algal blooms.

It decreases the oxygen content rapidly

Lecture 131 -Water pollution

Water pollution refers to any undesirable change in the quality of water that makes it consumption unfit for human and other animals. Polluted water has serious impact on health of living organisms.

Sources of water pollution

- Domestic waste
- Industrial waste
- Untreated sewage
- Oil spills
- Agricultural runoff
- Suspended or particulate matter
- Mining activities
- Acid rain

Industrial and human wastes find their ways into groundwater, streams, lakes, and oceans. When they do, water becomes unfit for human consumption and unfit for wildlife.

Human activities are main cause of water pollution. Water pollution is contaminating all water bodies like lakes, rivers, oceans, aquifers and groundwater day by day.

Effects of water pollution

- Food chain imbalance
- Diseases
- Death of living organisms
- Loss of vegetation
- Habitat loss
- Ecosystem destruction

Lecture 132 -Air pollution

Befouling of air due to release of certain pollutants released due to human activities is known as **Air pollution**.

Air pollution also presents serious problems that are fatal to human and other living things.

Air pollutants can be in the form of,

- ❖ Solid particles
- ❖ Gases
- ❖ Liquid droplets

Kinds of air pollutants

- Carbon monoxide
- Sulphur dioxide
- Nitrogen dioxide
- Lead
- Particulate matter
- Chlorofluorocarbon (CFC)

Effects of Air pollution

- Acid rain
- Greenhouse effect
- Global warming
- Ozone layer destruction

Acid rain or deposition

Burning fossil fuels releases sulfur dioxide and nitrogen oxides into the atmosphere. Sulfur dioxide and water combine to produce sulfuric acid, which falls as acid deposition. Acid deposition lowers the pH of lakes.

Greenhouse effect

Carbon dioxide released from burning fuels accumulates in the atmosphere and prevent the escape of heat coming from earth. This effect is termed as Greenhouse effect.

Global warming

Carbon dioxide reflects solar radiation back to the earth. This reflection of solar radiation is predicted to cause an increase in world temperature, polar ice caps to melt, and ocean levels to rise.

Ozone layer destruction

The release of chlorinated fluorocarbons from aerosol cans, air conditioners, and refrigerators contributes to the depletion of ozone layer (the earth's ultraviolet filter). It will increase the chance of skin cancer.

When wastes and poisons enter food webs, organisms at the highest trophic levels usually suffer the most.

The accumulation of matter in food webs is **called biological magnification.**

Lecture 133 -Noise pollution

Transportation (cars, trains, airplanes, shipping) and industry (construction or factory) are the leading sources of noise pollution.

Animals rely on hearing to,

➢ Communicate

➢ Avoid predators

➢ Obtain food

Effects of noise pollution,

❖ Hearing loss

❖ Loss of communication

❖ Physiological effects because of increased heart rate and metabolism

Noise from sonar or explosives causes marine mammals to dive deeper. On long, deep dives, more nitrogen enters the blood from the lungs in the form of bubbles and kills the animal.

In humans, this **illness is known as the bends.**

To avoid noise, wildlife may alter their behavior, possibly leaving critical habitat or forage areas, though responses will vary with the kind of noise and the species.

Waterfowl, for example, are particularly disturbed by low-flying aircraft.

Lecture 134 -Climate change

The global climate has changed throughout geologic time on timescales that vary from a few years to millions of years. Some short term global changes occur during volcanic eruptions.

In 1991 Mount Pinatubo in the Philippines erupted, producing huge quantities of gas and ash reaching the stratosphere. It blocked some of the solar radiation from reaching the earth's surface, resulting in a worldwide cooling.

It is estimated that 20,000,000 tons of SO_2 gas erupted into the stratosphere. The resulting H_2SO_4 (sulfuric acid) reflected 2 to 4 percent of the incoming solar radiation back into the space, reducing the mean global temperature at the surface about 0.5°C.

Now a days greenhouse gases have increased the greenhouse effect in the atmosphere due to which the temperature of earth is increasing day by day. This phenomenon is **known as Global warming.**

Human activities are the main cause of this event to occur.

Lecture 135 -Greenhouse effect

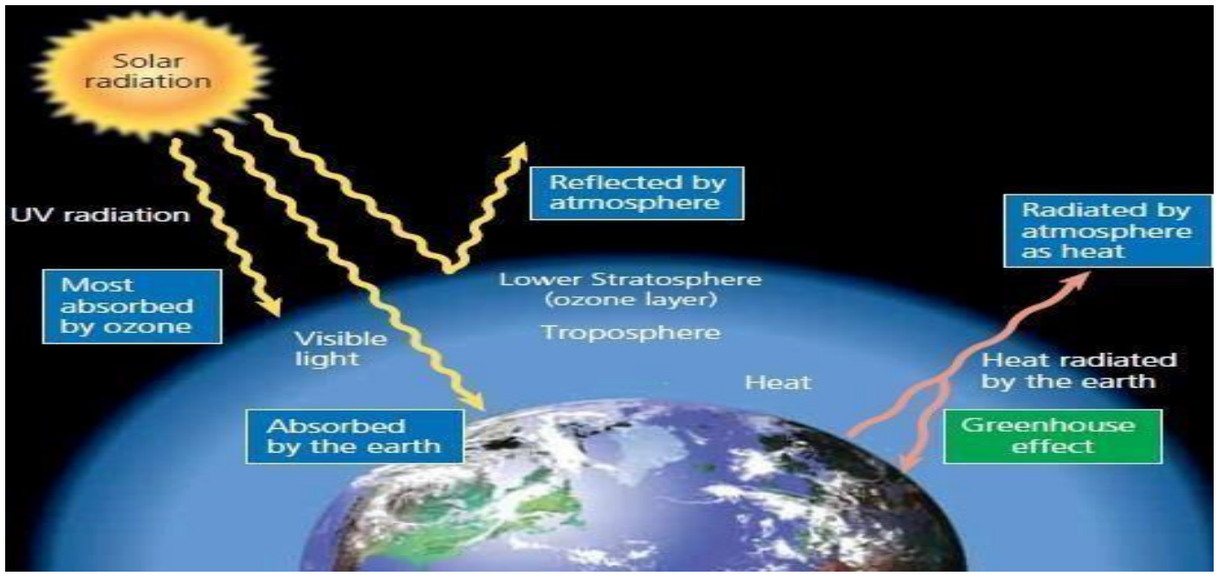
Small amounts of certain gases, including water vapor (H2O), carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), in the atmosphere play a role in determining the earth's average temperatures and its climates.

These **greenhouse gases** allow mostly visible light and some infrared radiation and ultraviolet (UV) radiation from the sun to pass through the atmosphere.

The earth's surface absorbs much of this solar energy and transforms it to longerwavelength infrared radiation (heat), which then rises into the lower atmosphere.

Some of this heat escapes into space, but some is absorbed by molecules of greenhouse gases and emitted into the lower atmosphere as even longer-wavelength infrared radiation.

Some of this released energy radiates into space, and some warms the lower atmosphere and the earth's surface. This natural warming effect of the troposphere **is called the greenhouse effect.**



Causes of Greenhouse effect
Human activities such as,

- Burning fossil fuels

Deforestation

- Growing crops release carbon dioxide, methane, and nitrous oxide into the atmosphere.

Lecture 136 -El-nino effect

Another type of short-term climate change is the so-called El Nino effect, which occurs every 2 to 7 years around Christmas time, when the typical weather pattern in the Pacific Ocean breaks down.

The trade winds weaken, and low pressure establishes itself in the central Pacific. It causes the winds to blow into the Pacific Basin from the west.

This change causes warm surface water to move toward South and Central America, reversing the directions of some currents and placing warm water along the coasts.

The warm water produces heavy rain over the coastal deserts, subjecting them to disastrous flooding and erosion. The western United States also experiences major flooding events as a result of El Nino.

1. This temporary influx of rain on arid and semiarid regions creates the conditions for disastrous down slope movements in the form of mud slides, destroying entire villages.

2. One result of this temporary climate change is the occurrence of major brush fires, which destroy not only vegetation but also wild and domestic animals.

3. Shifts in warm water in the southern Pacific and Indian Oceans cause cooler water to move along the coast of Australia, resulting in decreased rainfall.

4. The warm water El Nino brings to the coasts of North and South America substantially reduces the upwelling of cold, deep water, adversely affecting the cold water fisheries.

Lecture 137 -Global warming

The average temperature of earth surface is increasing day by day due to increase in concentration of greenhouse gases in the atmosphere. Human activities are main cause of it.

The earth is gradually heating up due to rise in temperature. This phenomenon **is called Global warming.** It is causing serious problems to the health of plants and animals and also the surrounding environment.

Causes of Global warming

- Burning of fossil fuels
- Volcanic eruption
- Industrial effluents
- Deforestation
- Transportation
- Power plants Effects of Global warming
- Rise in temperature
- Rise in Sea Level
- Climate change
- Extinction
- Droughts
- Loss of biodiversity

Lecture 138 -Effects of global warming

Some major effects are

1. ▪ Rise in temperature
2. ▪ Rise in Sea Level
3. ▪ Climate change
4. ▪ Extinction
5. ▪ Droughts
6. ▪ Loss of biodiversity

Rise in Temperature:

The intense heat waves and rising temperatures are becoming more common as greenhouse

gases are trapped in the atmosphere. The greenhouse effect thus leads to a rise in temperature, and as it becomes stronger, more heat is trapped within the planet.

Rise in Sea Level:

Warm surface temperatures cause glaciers, polar ice to melt. This in turn increases the amount of water in the world's oceans thus contributing to a rise in sea levels.

It threatens populations of coastal areas because of their higher vulnerability to flooding.

Climate change:

Gradual increase in temperature has also severely influenced the climate pattern of the earth surface. El nino effect is an example of changing climate due to Global warming.

Extinction:

The polar bear is considered to be an endangered species whose numbers are falling because of their inability to adapt to the volatile temperature changes in the Polar Regions.

Droughts:

A warmer climate will cause shortage of water supply and ultimately crop failure. If these water shortages are persistent it will cause a lot of disruptions in global food production by affecting agriculture and thus leading to situations such as starvation .

Loss of biodiversity:

Global warming causes drastic and irreversible changes both in the upper atmosphere and within the planet thus affecting it's every component including land, water, air etc.

It makes the organisms unable to survive in their native environments.

Lecture 139 -Ozone layer

A protective layer in the atmosphere that protects the life on earth from harmful effects of ultraviolet radiations from sun is known as Ozone layer. It contains high concentrations of **Ozone (O3).**

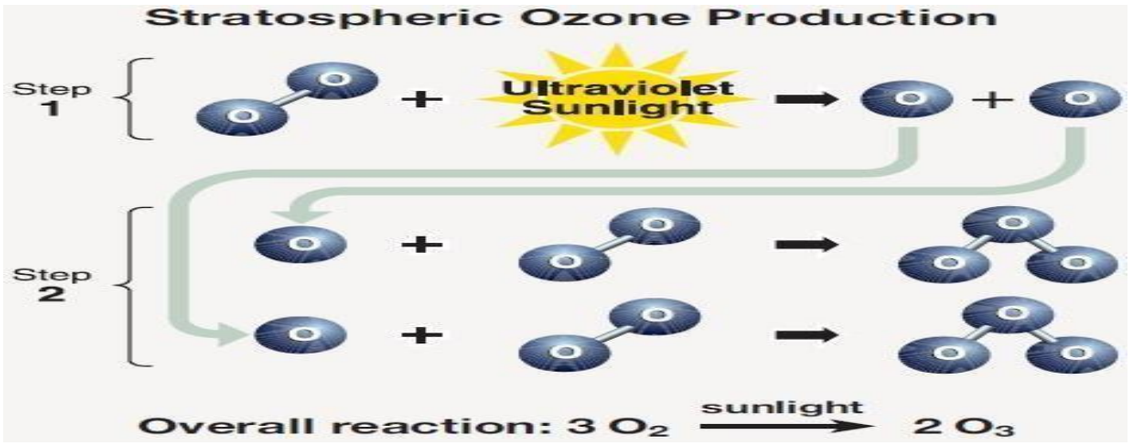
On the base of production ozone is divided into two types,

1. ▪ **Stratospheric ozone**
2. ▪ **Tropospheric ozone**

Stratospheric ozone:

In the first step, solar ultraviolet radiation breaks apart one oxygen molecule (O3) to produce two oxygen atoms.

In the second step, each of these highly reactive atoms combines with an oxygen molecule to produce an ozone molecule (O3).



Tropospheric ozone:

Nitrogen compounds released from automobiles is broken down by sunlight into nitrogen oxide (NO2). It is then converted in to nitrogen monoxide (NO), releasing an oxygen molecule that combines with oxygen (O2) in the atmosphere to form Ozone (O3).

Ozone abundances in the stratosphere and troposphere are determined by,

1. ▪ Amount of reactive gases
2. ▪ Sunlight intensity
3. ▪ Temperature

Ozone is a deadly poison. However, at the higher levels of the atmosphere, ozone performs an essential function. It shields the surface of the earth from ultraviolet (UV) radiation from the

Sun. This radiation is highly damaging to organisms, for example, it is known to cause skin cancer in human beings

Lecture 140 -Ozone-layer destruction

Ozone gas is continuously formed by the action of UV rays on molecular oxygen, and also degraded into molecular oxygen in the stratosphere. There should be a balance between production and degradation of ozone in the stratosphere.

This balance is disrupted due to ozone degradation by **Chlorofluorocarbons (CFCs).**

CFCs are released by refrigerants. CFCs discharged in the lower part of atmosphere move upward and reach into stratosphere.

In stratosphere, UV rays act on them releasing chlorine (Cl) atoms. Cl degrades Ozone releasing molecular oxygen.

So CFCs have permanent and continuing affects on Ozone levels.

This increase in release of Chlorofluorocarbons (CFCs) has created a large area of thinned ozone layer in Antarctic region, commonly called as the ozone hole.

Effects of Ozone depletion

▪ Skin cancer

▪ Snow-blindness (inflammation of cornea by UV-rays.

▪ Cataract

▪ Low crop production

Lecture 141 -Solid Waste

Solid wastes refer to everything that goes out in trash. Municipal solid wastes are wastes from homes, offices, stores, schools, hospitals, etc., that are collected and disposed by the municipality.

Solid waste is usually disposed of in landfills. Landfills take up space and, if not properly contained, can leach toxins into the soil and poison groundwater.

In countries with limited space, solid waste is burned at high temperatures that creates very hazardous ash, and pollutes the air with toxic chemicals.

Hospitals generate hazardous wastes that contain disinfectants and other harmful chemicals, and also pathogenic micro-organisms. Such wastes also require careful treatment and disposal.

The use of incinerators is crucial to disposal of hospital waste.

Irreparable computers and other electronic goods **are known as electronic wastes (Ewastes).**

E-wastes are buried in landfills or incinerated.

Recycling involves manual participation thus exposing workers to toxic substances present in e- wastes

Solid waste management
All waste that we generate can be categorised into three types,

1. Recyclable
2. Bio-degradable,
3. Non-biodegradable.

Lecture 142 -Strategy to Protect Ecosystems

Protecting and sustaining ecosystems and the biodiversity contained within them than on saving individual species is a burning issue in all over the world.

Instead of preventing premature extinction of species, it is very important and interesting to protect threatened habitats and ecosystem services.

This ecosystems approach generally would employ the following four point plan:

- ❖ Map global ecosystems and create an inventory of the species contained in each of them and the ecosystem services they provide.
- ❖ Locate and protect the most endangered ecosystems and species, with emphasis on protecting plant biodiversity and ecosystem services.
- ❖ Seek to restore as many degraded ecosystems as possible.
- ❖ Make development biodiversity-friendly by providing significant financial incentives (such as tax breaks and write-offs) and technical help to private landowners who agree to help protect endangered ecosystems.

Lecture 143 -Stabilize Global Population

For sustainable balance among the world's biodiversity, ecological systems, and humans it is necessary to stabilize human population.

Humans already capture more than a third of the earth's terrestrial productivity and more than half of the world's fresh water.

As food production has doubled in the last thirty-five years, we now release more nitrogen and phosphorus into the environment than all natural sources combined.

The following is a partial list of some of actions that can helpful in attaining a stable population.

➢ Improve the educational and political status of women. When women are intellectually, economically, and politically empowered, they can make decisions about how many children they wish to have.

➢ Improve the survival and health of children. Low infant mortality rates and improved prospects for healthy children will definitely allow them to run family businesses and carry on family names.

➢ Provide easy access to family planning resources. Education on spaced births, delayed marriage, breastfeeding, and birth control will allow parents to choose when and whether to start families and how large those families will be.

Lecture 144 -Waste management

The improper disposal of wastes is one of the major causes of environmental degradation.

Therefore, the management of wastes is of prime importance.

Solid waste management

All waste that we generate can be categorised into three types,

1. Recyclable

2. Bio-degradable,

3. Non-biodegradable.

Collection and Disposal:

Domestic wastes are collected in small bins, which are then transferred to community bins by private or municipal workers. From these community bins, these are collected and carried to the disposable site.

At the site, garbage is sorted out and separated into biodegradable and nonbiodegradable materials.

Non-biodegradable materials such as plastic, glass, metal scraps etc. are sent for recycling. Biodegradable wastes are deposited in land fills and are converted into compost.

The waste if not collected in garbage bins, finds its way into the sewers. Some of it is eaten by cattle. Non-biodegradable wastes like polythene bag, metal scraps, etc. if swallowed by cattle can cost their lives.

All domestic wastes should be properly collected and disposed. The poor management causes health problems leading to epidemics due to contamination of ground water. It is especially hazardous for those who are in direct contact with the waste.

Lecture 145 -Introduction-to biodiversity

The **term biodiversity** was used by Edward Wilson to describe the combined diversity at all the levels of biological organisation.

Biodiversity is a vital renewable resource.

In our biosphere immense diversity or heterogeneity exists not only at the species level but at all levels of biological organisation ranging from macromolecules within cells to biomes.

Biological diversity, or biodiversity, is the variety of all life forms on the earth.

The variety of life on Earth at all its levels, from genes to ecosystems, and the ecological and evolutionary processes that sustain it.

Scientists have identified about 1.8 million species, and every year, thousands of new species are identified.

The identified species include almost a million species of insects, 270,000 plant species, and 45,000 vertebrate animal species.

Biodiversity vary with respect to changes in the following factors,

- Climate change
- Geology
- Natural selection
- Species evolution
- Sea level

Components of biodiversity

1. Species diversity
2. Population diversity
3. Community diversity
4. Ecosystem diversity
5. Genetic diversity
6. Biogeographic diversity
7. Functional diversity

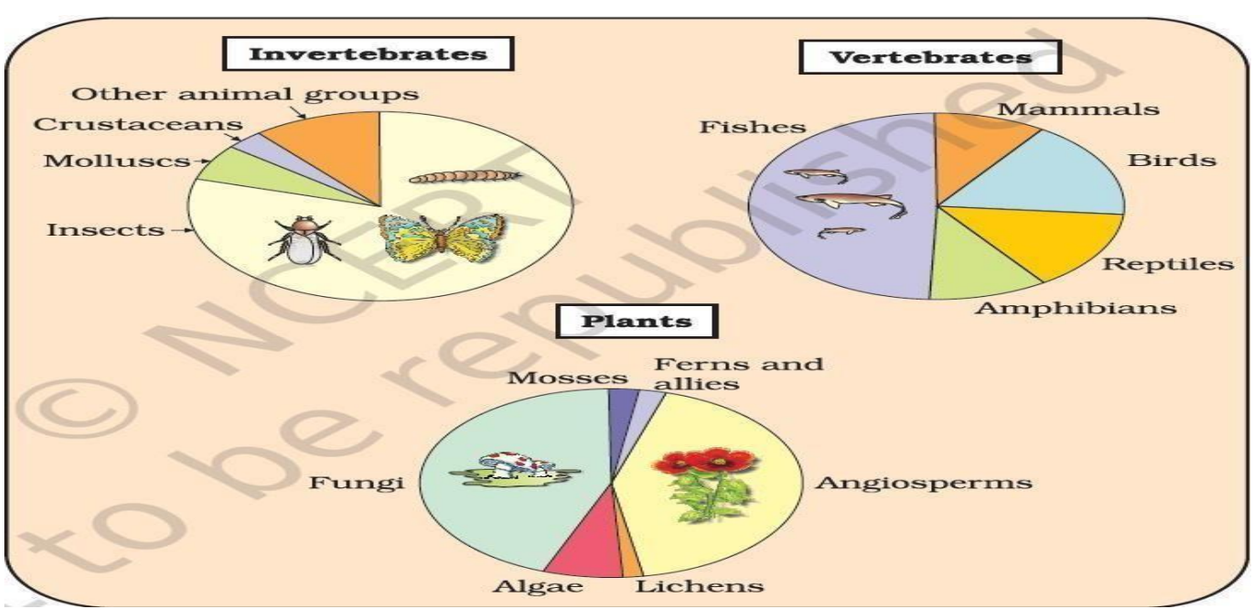
Lecture 146 -Species diversity

Species diversity refers to number and abundance of species present in different communities. Variation in the number and phylogenetic diversity (or evolutionary relatedness) of species present in an area.

More than 70 per cent of all the species recorded are animals, while plants (including algae, fungi, bryophytes, gymnosperms and angiosperms) comprise no more than 22 per cent of the total.

Among animals, insects are the most species-rich taxonomic group, making up more than 70 per cent of the total. That means, out of every 10 animals on this planet, 7 are insects.

The number of fungi species in the world is more than the combined total of the species of fishes, amphibians, reptiles and mammals.



Biologists are not sure about how many prokaryotic species there might be. The problem is that conventional taxonomic methods are not suitable for identifying microbial species and many species are simply not culturable under laboratory conditions.

Lecture 147 -Ecosystem diversity

Ecosystem diversity refers to variation in the interdependence of biotic communities and the abiotic (non-living) aspects of the environments in which the biotic communities are found. The earth's variety of deserts, grasslands, forests, mountains, oceans, lakes, rivers, and wetlands is another major component of biodiversity.

Each of these ecosystems is a storehouse of genetic and species diversity.

An ecosystem is a community of organisms (living things) which depend upon each other for their existence.

The variety of processes such as matter cycling and energy flow takes place within ecosystems as species interact with one another in food chains and webs.

Ecosystems can be managed or unmanaged. Most agricultural landscapes are managed ecosystems.

Ecosystems exist at different scales. Interactions between living and non-living things occur at all these scales at the same time.

Ecosystems develop in response to local conditions**,**

which are influenced by

1. **Climate patterns**
2. **Soil types**
3. ❖ **Topography**

Lecture 148 -Genetic diversity

Genetic Diversity is the variety of genetic material within a species or a population. Each species is made up of individuals that have their own particular genetic composition. This means a species may have different populations, each having different genetic compositions.

Genes are the basic units of life on Earth. They are responsible for both the similarities and the differences between organisms, e.g. the changes in colour and markings of birds within a particular species.

Genes are simply traits that we inherit from our parents. They can pass on to our children. For example, traits such as hair colour, eye colour, curly or straight hair and whether you can curl your tongue and so on.

Genetic diversity enables life on the earth to adapt to and survive dramatic environmental changes.

In other words, genetic diversity is vital to the sustainability of life on earth.

Because our environment is constantly changing, we need a diverse range of genes to be able to adapt. Preserving variety within populations of species is essential for preserving the ability of that species to cope with environmental change.

Genetic diversity will help the individuals to survive under following conditions of environmental stress, **• Climate change • Drought • Fire • famine • Invasive species**

Lecture 149 Types of biodiversity over spatial scale

Robert Whittaker (1972) created a system to describe biodiversity over different spatial scales.

1. **Alpha diversity**
2. **Beta diversity**
3. **Gamma diversity**

Alpha diversity

Alpha diversity refers to the diversity within a particular area or ecosystem, and it is usually expressed by the number of species in that ecosystem. This is equivalent to measuring the species richness of an area.

For example, if we want to monitor aquatic biodiversity on the offshore side of a fringing coral reef in the Ocean.

Then the alpha diversity of this reef is measured by the total number of species found in the area that we are monitoring.

We can compare the degree of species change as we move along the transect from one ecosystem to the next.

This comparison of so-called between-area diversity is referred to as **Beta diversity**.

Beta diversity is a comparison of diversity between ecosystems, usually measured as the amount of species change between the ecosystems.

Thus, beta diversity allows us to compare diversity between ecosystems.

Gamma diversity is a measure of the overall diversity within a large region, and so in some respects it is an expanded version of alpha diversity.

Thus, if we chose to survey all the reefs of a coast side of a ocean and measure species diversity over the whole area, then that would be gamma diversity.

We could expand the survey even further to include the reefs of the neighbouring Islands.

The gamma diversity would then include the species for all those islands.

Lecture 150 Importance of biodiversity 1

Biodiversity performs important biological services.

- ➢ Regulation of Climate
- ➢ Soil formation and protection
- ➢ Water resources protection
- ➢ Education and scientific value
- ➢ Recreation and ecotourism
- ➢ Pollution breakdown and absorption
- ➢ Economic value

- **Regulation of Climate**

Undisturbed forests maintain the rainfall in their immediate environment by contributing to the hydrological cycle.

Soil formation and protection

Biodiversity plays an important role in the formation of soil and the maintenance of soil structure and the retention of moisture and nutrient levels.

Water resources protection

Natural vegetative cover in watersheds protects ecosystems from extreme events such as flood and drought, and regulates and stabilizes water runoff thereby maintaining water cycles and water quality.

Education and scientific value

The natural environment has been the basis for many books, television programs and movies produced for entertainment and educational purposes, as well as in scientific ecological observations.

Recreation and ecotourism

The natural environment is used for recreation through activities, such as hiking, bird watching, nature walks and SCUBA diving. Ecotourism, as an industry, is growing rapidly in many developing countries.

Pollution breakdown and absorption

Ecosystems and ecological processes play an important role in the breakdown and absorption of many pollutants created by humans and their activities. Some such pollutants are garbage sewage and oil spills.

Economic value

1. **Goods**
2. **Food**
3. **Wood and Forest Products**

151-Threats to biodiversity

The biological wealth of our planet has been declining rapidly and the accusing finger is clearly pointing to human activities. The colonization of tropical Pacific Islands by humans is said to have led to the extinction of more than 2,000 species of native birds.

Many species persist on a greatly reduced area of their former range and on increasingly fragmented landscapes.

Ecosystems suitable for agriculture, such as tropical dry forests and tall-grass prairie, have almost completely disappeared from our planet.

Dams are disrupting freshwater ecosystems, while the marine world is threatened by overfishing and habitat destruction.

Humans are also transporting plants and animals around the globe both deliberately and unintentionally.

These “invaders” threaten other species or change entire ecosystems.

Human influence reaches even the farthest corners of the globe; species in the Arctic and Antarctic are contaminated by pollutants created thousands of miles away and carried through the atmosphere.

We are modifying the functioning of the entire planet, changing the earth’s atmosphere through,

- **Industrial release of carbon dioxide**
- **Diminishing the ozone layer by the production of chlorofluorocarbons.** In general, loss of biodiversity in a region may lead to,
- ❖ Decline in plant production.

❖ Lowered resistance to environmental distresses such as drought.

❖ Increased variability in certain ecosystem processes such as plant productivity, water use, and pest and disease cycles.

Main threats to biodiversity are,

1. Habitat loss and fragmentation
2. Over-exploitation
3. Invasive species
4. Extinction
5. Pollution

152-Habitat loss & fragmentation

Habitat loss is the permanent conversion of land to other uses. Habitat loss drives habitat fragmentation, and the two are tightly linked. Fragmentation of habitats is typically a consequence of habitat loss.

Habitat loss and fragmentation is the main threat to wildlife and the primary causes of species extinction. Although habitats can be fragmented or lost because of natural disturbances, such as earthquakes or geological forces but humans are the principal threat.

People have modified landscapes for thousands of years for agricultural production.

Today, agricultural activities are the major cause of habitat loss and fragmentation throughout the world

Human settlement, resource extraction, and industrial development generally result in small, isolated areas or patches of natural habitat surrounded by developed land.

Mangroves, sea grasses, salt marshes, coral reefs, kelp forests, and rocky shorelines are fragmented by natural forces such as

- ➢ **Wave action**
- ➢ **currents**
- ➢ **Tides**
- ➢ **Storm surge**
- ➢ **Human activities such (dredging, boating and nutrient enrichment)**

153-Invasive species

Species whose populations have expanded dramatically and out-compete or displace native species, potentially threatening the structure and function of intact ecosystems.

When alien species are introduced unintentionally or deliberately for whatever purpose , some of them turn invasive, and cause decline or extinction of indigenous species.

The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in the lake.

The recent illegal introduction of the African catfish Clarias gariepinus for aquaculture purposes is posing a threat to the indigenous catfishes in our rivers.

A well-known example is the brown tree snake, which was introduced inadvertently on many Pacific islands and subsequently caused the extinction of a number of native birds, bats and lizards.

There appear to be three major stages in the process of invasion by exotic species:

- **Dispersal**
- **Establishment**
- **Integration**

154-Overexploitation

Overexploitation of resources (or using resources at an unsustainable rate) is a critical problem in conservation.

The overexploitation or nonsustainable use of wildlife is closely linked and plays an increasing role in the loss of biodiversity

Overharvesting, nonsustainable use, and the illegal trade in some species are threatening not only their continued survival but also that of ecosystems and the livelihoods of communities and local economics that depend upon them.

Unsustainable hunting, fishing, logging, or gathering of wild populations leads to their commercial, ecological or global extinction.

Overexploitation can be divided into two major categories:

Directexploitation

Indirectexploitation

Direct exploitation:

Direct exploitation ranges from commercial activities such as logging operations or trade in endangered species to subsistence hunting.

Indirect exploitation:

Indirect exploitation encompasses the unintentional mortality of non target species such as fish or turtles killed as by-catch in fishery operations.

Both endanger species around the world.

155-Pollution 2

Pollution is any undesirable change in physical, chemical or biological characteristics of air, land, water or soil. Agents that bring about such an undesirable change are called as pollutants.

Everyday, thousands of pollutants are discharged into our environment.

Many pollutants lack regulation, and their lingering presence threatens biodiversity, affecting individual species or degrading entire ecosystems.

Sulfur and nitrogen oxides are released into the atmosphere when fossil fuels, such as coal in power plants, or oil in vehicles, or wood, are burned. These combine with water in the atmosphere to create sulfuric and nitric acid, which fall to earth as “acid rain”.

Acid rain also dissolves other harmful metals, such as mercury, which plants and animals then absorb. On land, pollution by acid rain and other air pollutants tends to affect plants more than animals.

Chlorinated hydrocarbons, such as the insecticide DDT (dichloro-diphenyl-trichloro ethane) and PCB (polychlorobenzene), are renowned for their toxic effects on the environment.

A particularly troubling characteristic of these pollutants is their ability to persist over long time frames and spread over large areas.

A phenomenon called bio magnification is well known for mercury and DDT.

A few toxic substances, often present in industrial waste waters, can undergo biological magnification (Bio magnification) in the aquatic food chain.

Bio magnification refers to increase in concentration of the toxicant at successive trophic levels

156-Deforestation

Deforestation is the conversion of forested areas to non-forested ones.

According to an estimate, almost 40 per cent forests have been lost in the tropics, compared to only 1 per cent in the temperate region.

One of the major reasons is the conversion of forest to agricultural land so as to feed the growing human population. Trees are axed for timber, firewood, cattle ranching and for several other purposes.

Effects of deforestation:

- Increase in carbon dioxide concentration in the atmosphere.
- Habitat destruction.
- Climate change.
- Loss of biodiversity.
- Hydrologic cycle disturbances.
- Soil erosion.
- Desertification.

Reforestation:

Reforestation is the process of restoring a forest that once existed but was removed at some point of time in the past.

It is basically a rehabilitation process of forests.

Reforestation may occur naturally in a deforested area.

However, we can speed it up by planting trees with due consideration to biodiversity that earlier existed in that area.

157-Resource depletion & biodiversity

Humans are either directly or indirectly exploiting about 40% of the earth's net primary production.

It involves converting natural areas to agricultural uses, frequently substituting less efficient crop plants for native species.

The main threats to biological diversity arise from habitat destruction by expanding human populations.

Habitat loss displaces thousands of native plants and

animals. Some of the most important threatened

natural areas include, ..

o Tropical rain forests,

o Coastal wetlands,

o Coral reefs.

Of these, tropical rain forests have probably received the most attention.

Tropical rain forests cover only 7% of the earth's land surface, but they contain more than 50% of the world's species.

Tropical rain forests are being destroyed rapidly, mostly for agricultural production. About 76,000 km2 (an area larger than Costa Rica) is being cleared each year.

Clearing of tropical rain forests achieves little, because the thin, nutrient-poor soils of tropical rain forests are exhausted within two years.

Tropical Deforestation

Forests are often cut and burned to make land available for agriculture.

Sadly, rain forests are a nonrenewable resource. Seeds of rain forest plants germinate rapidly, but seedlings are unprotected on sterile, open soils. Even if a forest were able to become reestablished, it would take many centuries to return to a climax rain forest.

158-Exploitation

Predation, Herbivory, **Parasitism**, **and Disease**

· The diversity of interactions between herbivores and plants, between predators and prey, and between parasites, parasitoids, pathogens, and hosts can be grouped under the heading of exploitation--interactions between species that enhance the fitness of one individual at the expense of another.

· **Exploitation weaves populations into a web of relationships that defy easy generalization**

· The number of exploitative interactions between species far exceeds the number of species in the biosphere, and the nature of exploitation goes far beyond the typical consumption of one organism by another.

· For instance, many parasites and pathogens manipulate host behaviour to enhance their own fitness at the expense of the host.

· Spiny-headed worms alter the behaviour of a variety of crustacean hosts in a way that increases the probability that the one host species will be eaten by another.

· A **pathogenic fungus** manipulates the growth program of its host plant in a way to produce **"pseudoflowers**," structures aimed at promoting the reproduction of the pathogen.

· In the process the pathogen usually kills the host plant and always renders it sterile.

· Predation by one flour beetle species on another can be used as a potent means of interference competition except in the presence of a protozoan parasite, which seems to give a competitive advantage to less predaceous species.

Examples

· **Predators, parasites, and pathogens influence** the distribution, abundance, and structure of prey and host populations.

· **Herbivorous stream** insects have been shown to control the density of their algal and bacterial food.

· The herbivorous moth larva Cactoblastis cactorum combined with pathogenic microbes reduced the coverage of prickly pear cactus in Australia from millions of hectares to a few thousand.

· A **parasitic infestation** reduced the red fox population in Sweden by 70%, which in turn led to increases in the abundance of several prey species eaten by foxes.

· This **parasitic disease** revealed the influence of a predator on its prey populations.

159-Ecological Relationships

• **Predator-prey, parasite-host, and pathogen-host relationships are dynamic.**

• Populations of a wide variety of predators and prey show highly dynamic fluctuations in abundance ranging from days to decades.

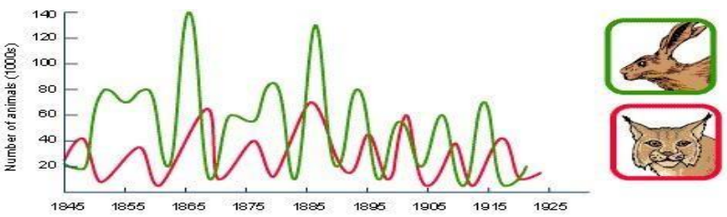
• A particularly well-studied example of predator-prey cycles is that of snowshoe hares and their predators, which have been shown to result from the combined effects of the snowshoe hares on the quantity and quality of their food and of the predators on the snowshoe hare population.

1. **<u>Predator Prey Relationships</u>**

Learning Objectives

Be able to describe the relationship between predators and their prey.

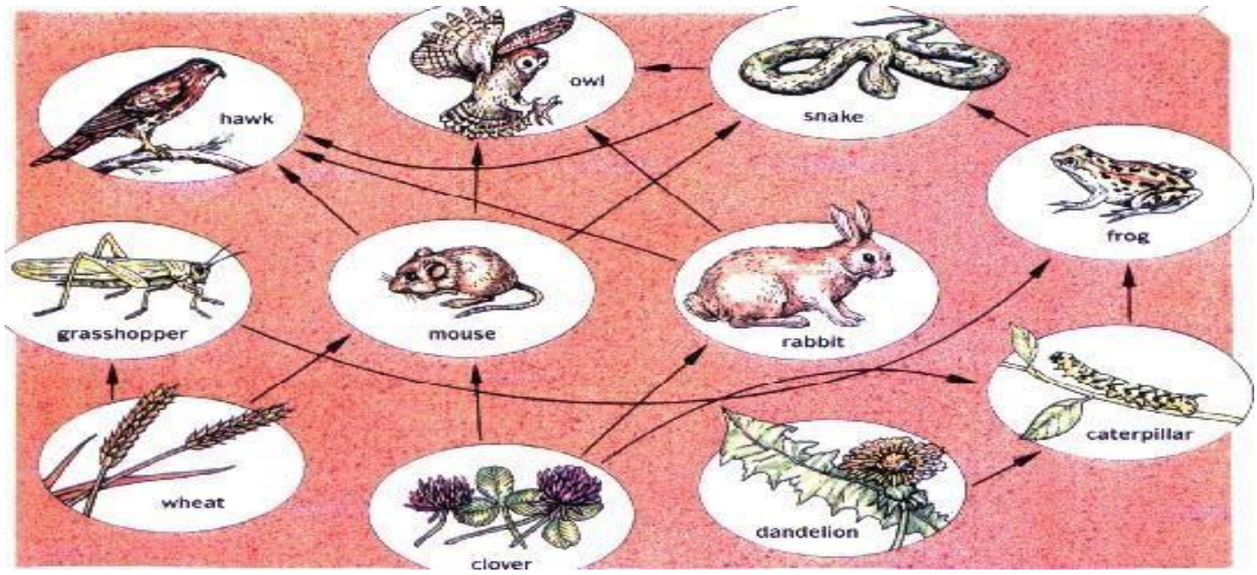
Be able to explain the shape of a predator – prey graph.



2. Food web - Interdependence

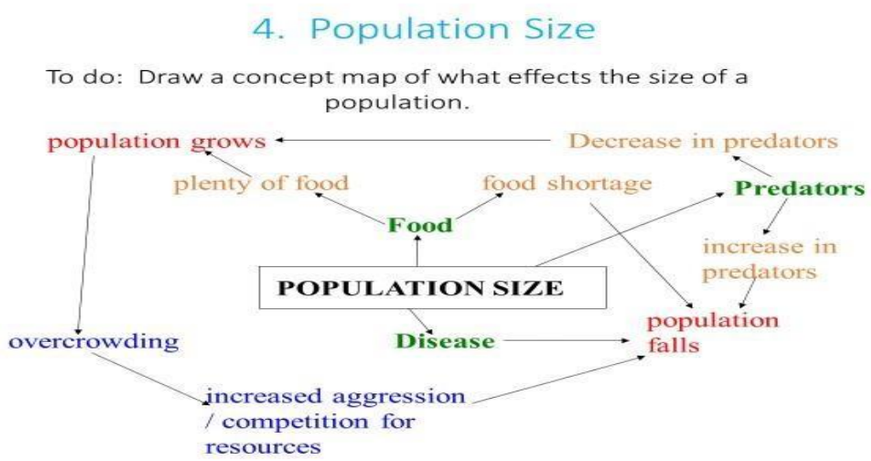
Starter

If the mouse is considered a pest and baited, find as many effects on the food web as you can, in 3 minutes.



3. Food web – Interdependence

and that was a simplified food web. Imagine the interactions in a less simplified web. Do you think the bobcat would be affected if the mosquito larvae were destroyed as a malaria risk?



160-Competition 1

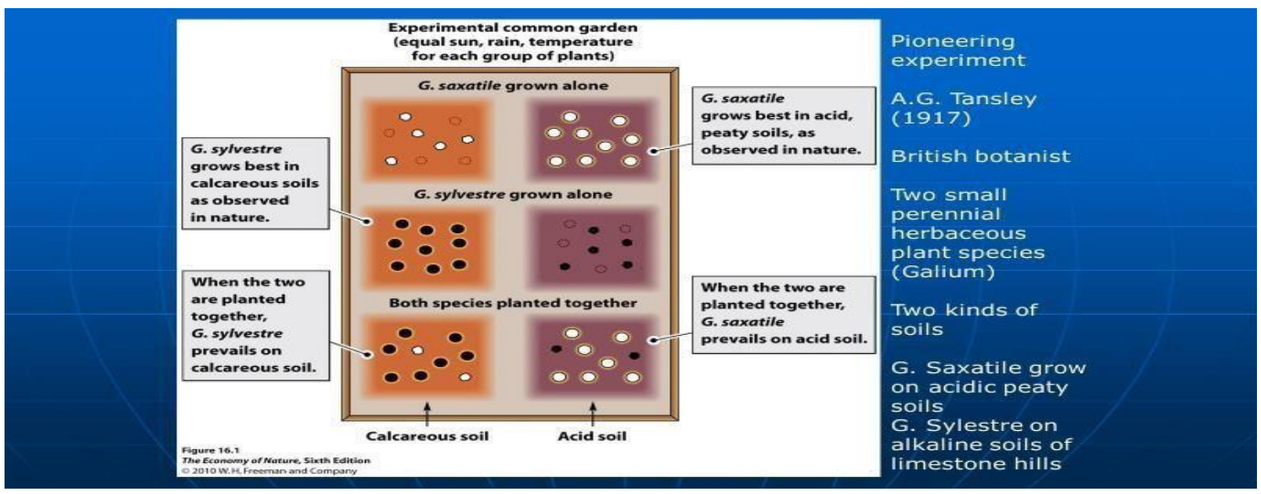
Modes of Competition

■ **Competition**: use or defense of a resource by one individual that reduces the availability of the resource to other individuals

■ **Intraspecific:** • Competition with members of own species.

■ **Interspecific:**

• Competition between individuals of different species - reduces fitness of both.



Competition results when resources are limited

■ Intraspecific competition: regulate population growth in a density-dependent manner.

■ Evolution tends to favor the individuals with high resource use efficiency and competition ability

■ Interspecific competition: depress both populations. Under intense interspecific competition, population of one species may decline and die out.

■ Outcome of interspecific competition:

depends on how efficiently individuals within each species exploit share resources.

161-Competition 2

13.1 Consumers compete for resources

■ Resource: any substance or factor that is both consumed by an organism and supports increased population growth rates as its availability in the environment increases

■ Examples: • food, water, nutrient,

• light, space

• Refuges, safe site

■ No-consumeable physical and biological factors are not resource: Temperature is not consumed, one does not change T for another

Space is an important resource for sessile animals

Barnacles on the rocky coast of Maine. Above optimal range of intertidal zone (small ones are larvae)

Competition between closely and distantly related species

■ Which one is more intense, closely related species or distantly related species?

■ On the Origin of Species:

■ Competition should be most intense between closely related species

■ Structure, Habitat, food resources

Competition between distantly related species is common

Example 1: barnacles, mussels, alage, sponges, bryozoans, tunicates in the intertidal zone compete for spaces

Example 2: fish, squid, diving birds, seals, and whales all eat krills

Example 3: birds, lizards eat same insects;

Ants, rodents, birds eat seeds in the desert systems.

Renewable and nonrenewable resources

■ **Renewable: constantly renewed or regenerated**

Natural resources outside ecosystem: such as light and precipitation

Resource regenerated

• Birth of prey provide foods for predator

Consumers directly depress such resources

• Decomposition provide nutrients for plants

Indirectly linked to consumers through food chain or abiotic factors.

■ **Non-renewable: space** • Once occupied, space becomes unavailable to others

Limiting resources

■ **Consumers require many different resources, but not all resources limit population growth**

■ **Liebig's law of minimum**

Populations are limited by the single resource that is most scarce relative to demand

Justus von Liebig (1840)

Limiting resources: may vary

David Tilman's diatom study: both P and silicon

<0.2 mM of phosphate or <0.6 mM

silicate, diatom pop.growth stops.

Positive interaction and synergistic effect

Synergistic effect: Two resources together enhances population growth more than the sum of both individually Peace and Grubb (1982) Plant fertilization and Light treatments

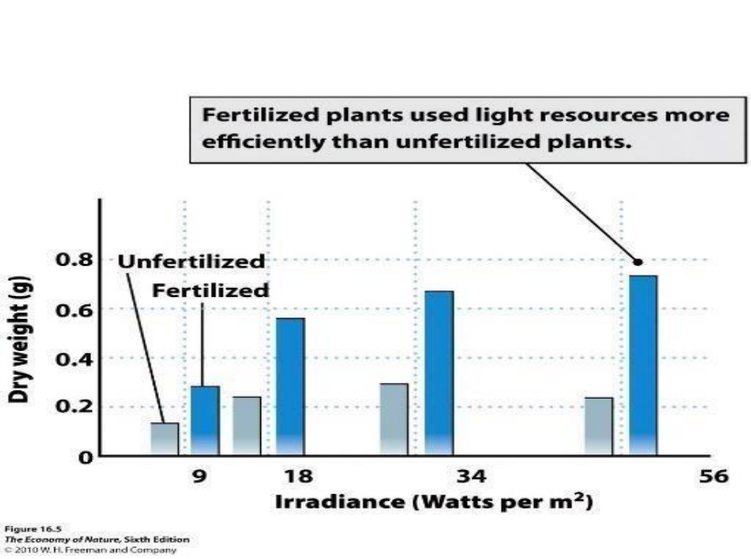


Figure 16.5
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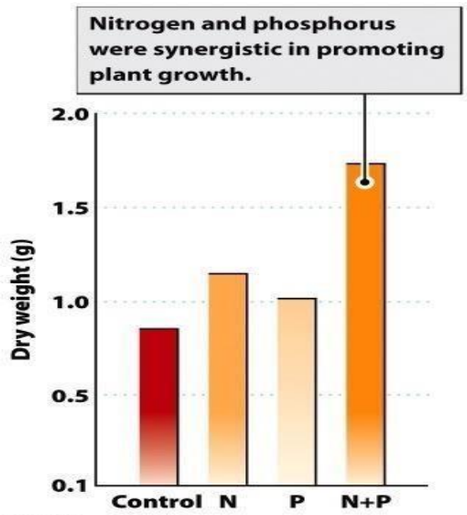

Figure 16.6
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162-Competition 3

13.2 Failure of species to coexist in laboratory cultures led to the competitive exclusion principle

G.F. Gause, Russian biologist, Protist: (bacteria here) P. aurelia and P. caudatum
Same nutrient medium

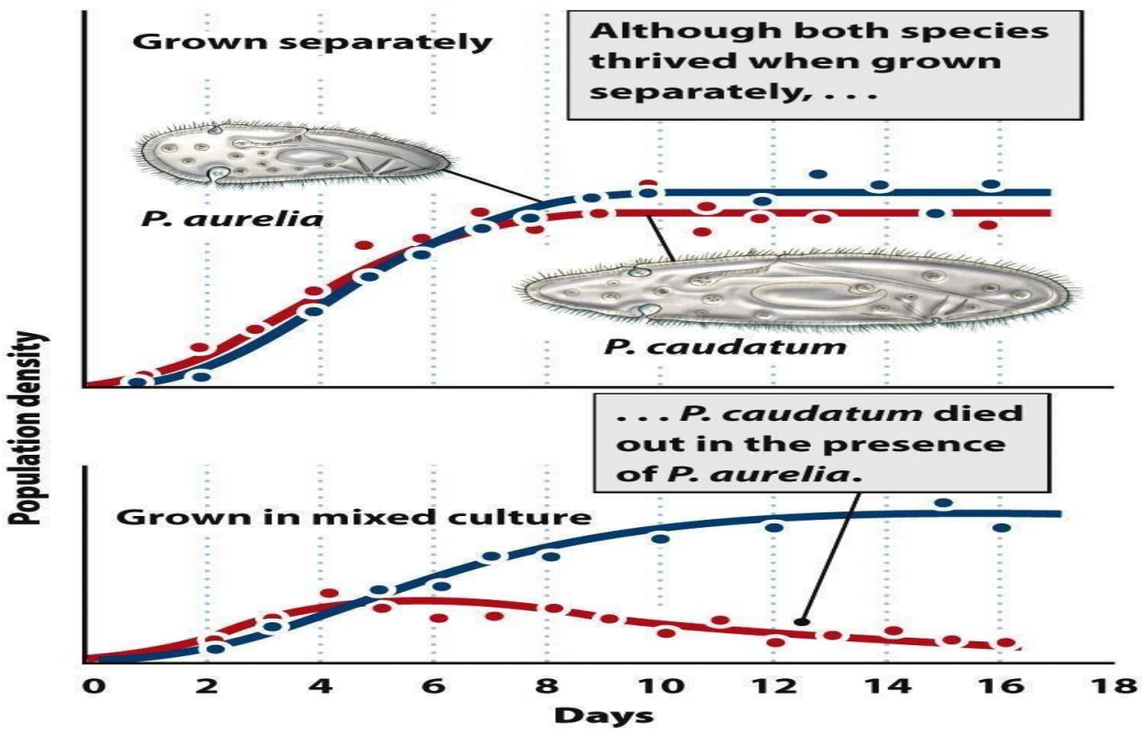

Figure 16.7
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Diatom experiment

David Tilman, University of Minnesota

Asterinella formosa (Af) and Synedra ulna(Su) compete for silica for the formation of cell walls.

Grow well alone

Insufficient silica, Su reduced the silica to a low level and drove Af to extinction

Competitive exclusion principle

■ Principle: Complete competitors can not coexist. One species must go extinction

■ Complete competitors: two species that live in the same place and possess exactly the same ecological requirements.

■ Assumptions:

• Exactly the same resource requirement (no more, no less)

• Environmental conditions remain constant

■ In natural situations, two similar species can coexist, why?

163-Competition 4

13.3 Asymmetric competition can occur when different factors limit the populations of competitors

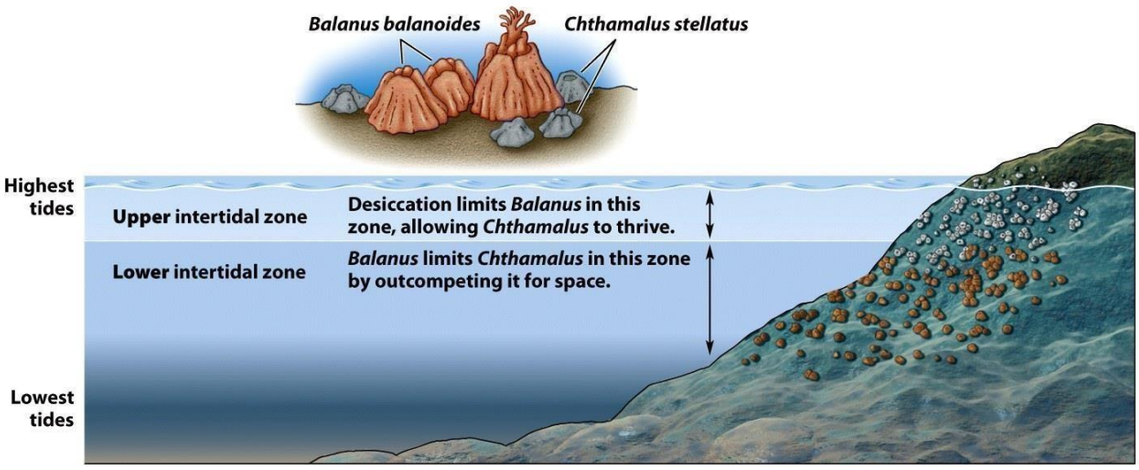

Figure 16.11
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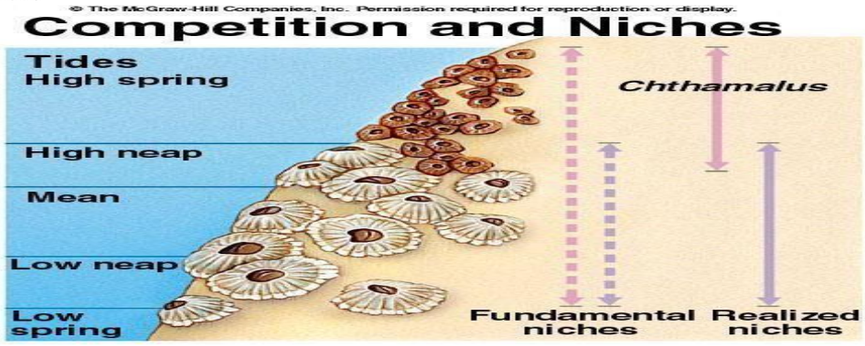
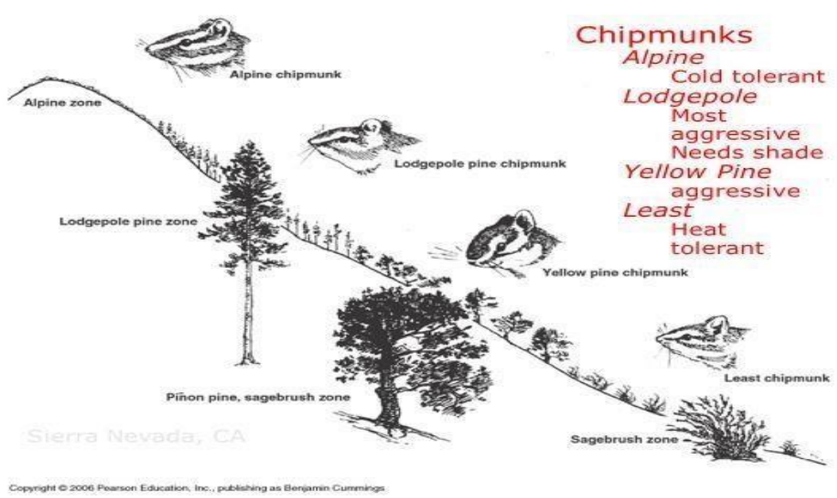




13.4 Habitat productivity can influence competition between plant species

Two hypotheses:

1. Plants compete more intensively when mineral nutrients are less abundant in the soil (By Grubb and Tilman)

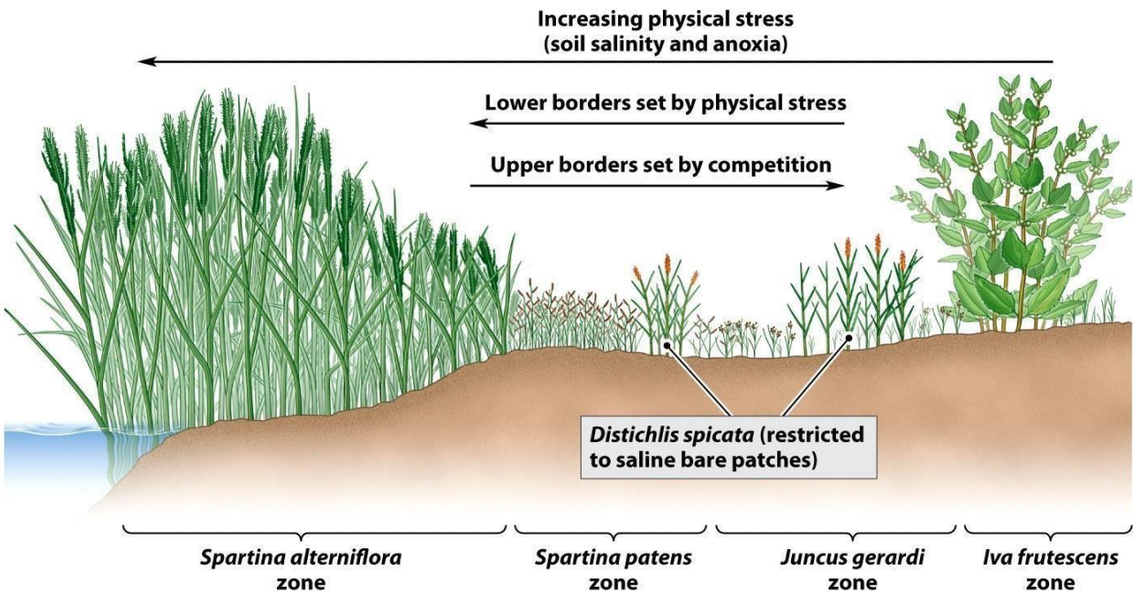
Plants compete more intensively when nutrients are less. High nutrients are less likely to limit plant population; thus the intraspecific competition is weak.

1. Competition is less intense when water and nutrients are less abundant (Grime and Keddy)

Competition for light is more important than competition for nutrients; limit in water and nutrients would limit the population growth to a certain point that individual plants are widely spread and do not compete for light.

Difference between these hypotheses lies in the relative importance placed on belowground and aboveground competition for resources --Light or nutrient. (Debate)

Habitat productivity can influence competition between plant species



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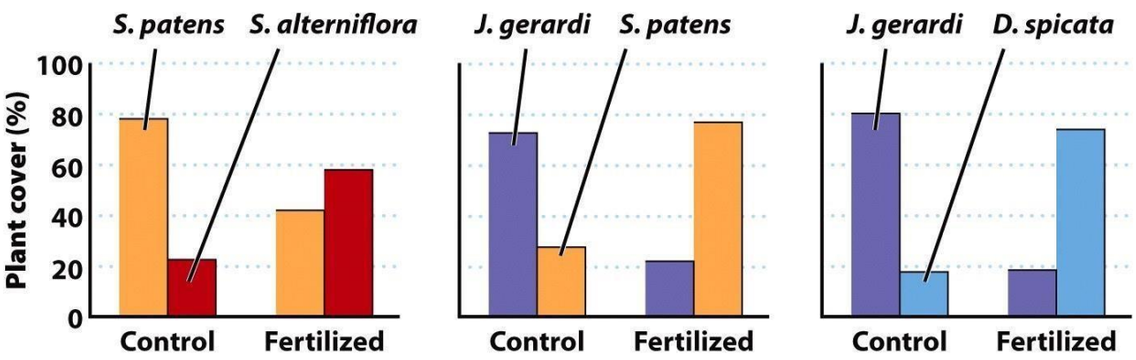

Figure 16.13
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Fertilization alters the outcome of competition by removing nutrient limitation on stress-tolerant plants, expand, away from water.

164-Competition 5

13.3 The theory of competition and coexistence is an extension of logistic growth model (Lokta- Volterra Model)

Derived from logistic growth equation

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

Add influence of another species (a competition component)

$$\frac{dN_1}{dt} = r_1 N_1\left(\frac{K_1 - N_1 - \alpha_{2,1}N_2}{K_1}\right)$$

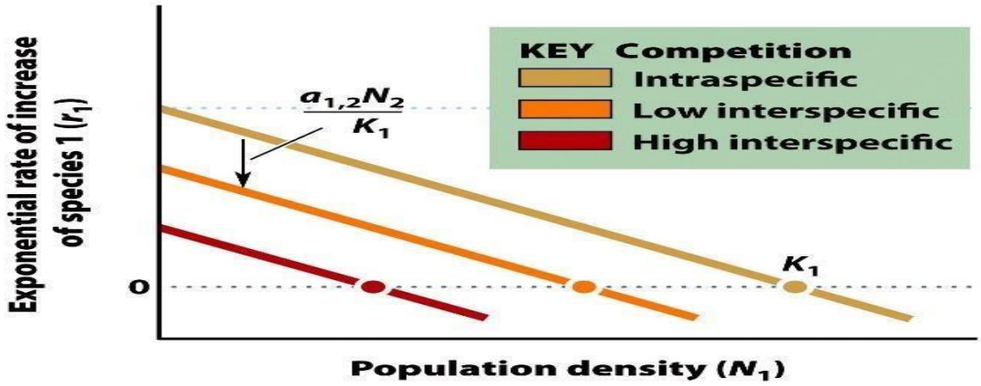
$$\frac{dN_2}{dt} = r_2 N_2\left(\frac{K_2 - N_2 - \alpha_{1,2}N_1}{K_2}\right)$$

Lokta-Volterra Model α2,1N2 and α1,2N1: effect of interspecific competition, where

α2,1 and α1,2 per capita effects of competition

In term of resource use, an individual of species 2 is equal to α2,1 individuals of species 1

Interspecific competition reduces the equilibrium level of a population below the carrying capacity



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If no interspecific competition

■ **Species 1:** dN1/dt = r1N1 ((K1 – N1 – 1,2N2)/K1) • In the absence of interspecific competition, 1,2 = 0 and N2 = 0 → the population of species 1 grows logistically to carrying capacity

■ **Species 2:** dN2/dt = r2N2 ((K2 – N2 – 2,1 N1)/K2) • In the absence of interspecific competition, 2,1 = 0 and N1 = 0 → the population of species 2 grows logistically to carrying capacity

Lokta-Volterra Model

α2,1N2 and α1,2N1: effect of interspecific competition, where α2,1 and α1,2 per capita effects of competition

In term of resource use, an individual of species 2 is equal to α2,1 individuals of species 1

There Are Four Possible Outcomes of Interspecific Competition

■ **Possible outcomes of the Lotka–Volterra equations**

• In two situations, one of the species is the superior competitor and wins out over the other

– In one case, species 1 inhibits the population of species 2 while continuing to increase – In one case, species 2 inhibits the population of species 1 while continuing to increase

There Are Four Possible Outcomes of Interspecific Competition

■ **Possible outcomes of the Lotka–Volterra equations**

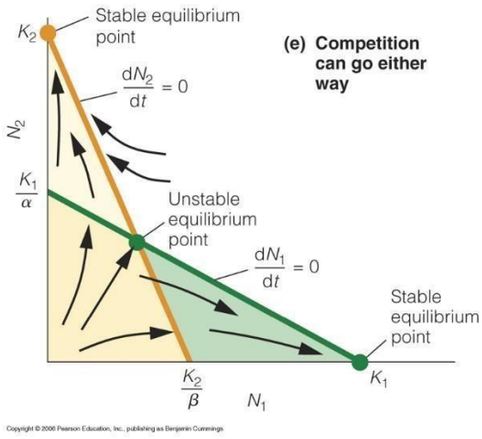
• In a third situation, each species, when abundant, inhibits the growth of the other (more than it inhibits its own growth)

– Eventually one of the two species “wins” • In a fourth situation, neither species eliminates the other resulting in coexistence

– Each species inhibits its own population growth more than that of the other species

(e) Unstable situation, both inhibit in a density dependent manner. Depending on initial density, either can make other extinct

(f) Each species inhibits its own population growth more than competitor. Neither can eliminate competitor



165-Competition 6

13.5 Competition may occur through direct interference

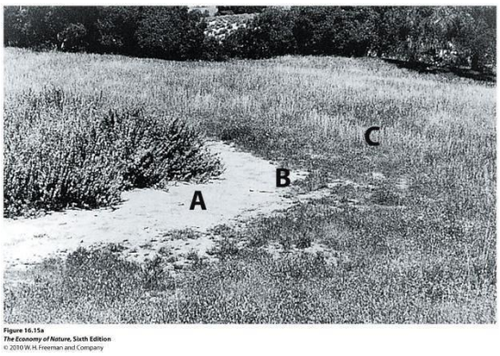
■ Exploitation: indirectly influencing each other by consuming the same resources (eat same grass by zebras , compete for water uptake by trees, indirectly)

■ Interference: direct influencing each other by preventing others to occupy a habit or access resources (birds, bees chase birds and bees, animals release toxic chemicals).

■ Meadow vole (wet) and mountain vole (dry). (Asymmetric

competition also) ■ **Allelopathy (chemical competition)**

Figure 16.14 Some plants (eucalyptus) compete by chemical means.



Clumps of shrubby Salvia plants (mint) are usually surrounded by bare zones separating the sage from neighboring grassy areas (Figure 16.15)

Predator can influence the outcome of prey competition Peter Morin, Rutgers Salamander Frog or toad tadpole (300 each of 3 species)

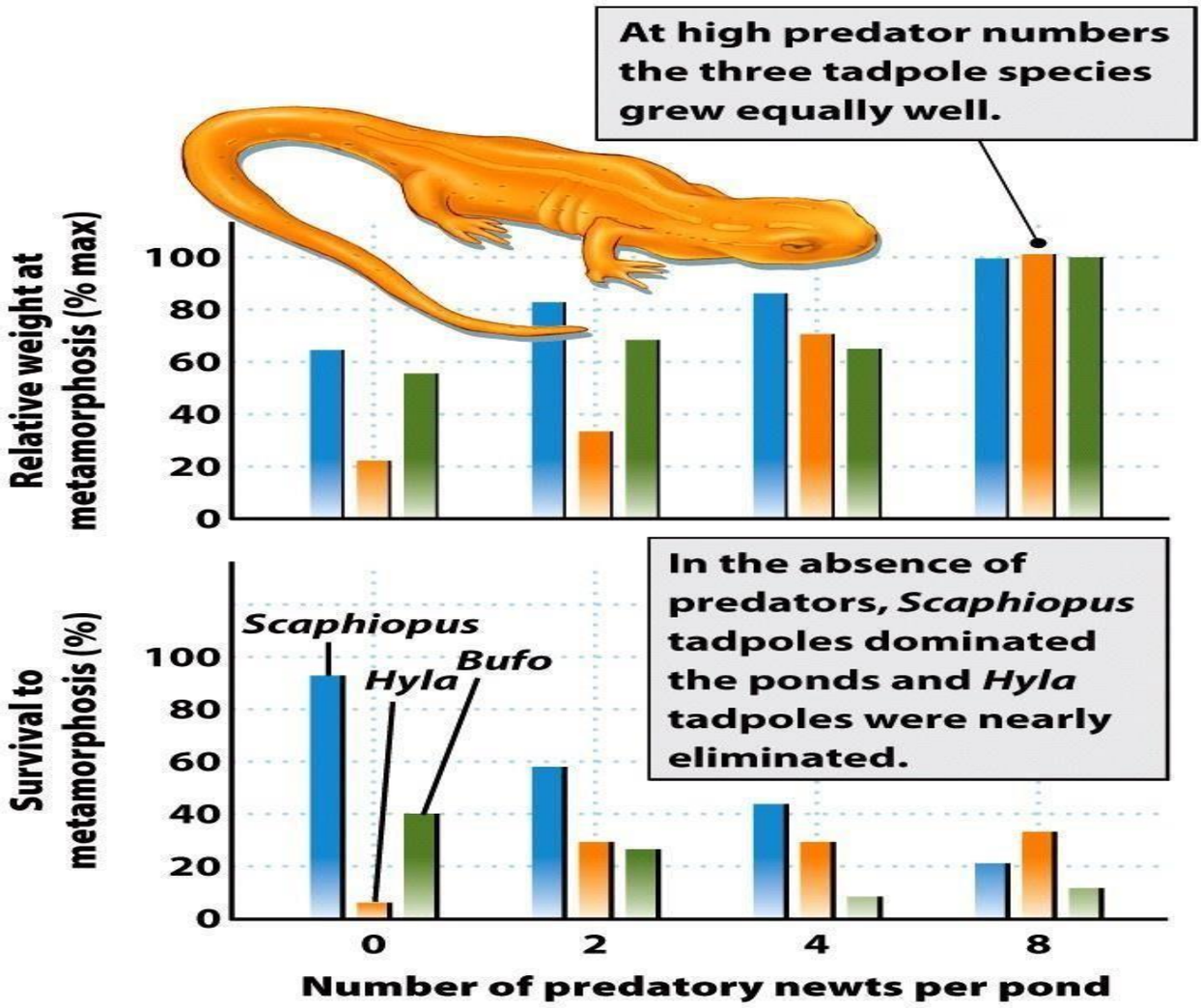


Figure 16.18
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Apparent competition

Combined populations of two prey species support a larger predator population neither can support alone. As a result, two prey populations reduced, gives outward appearance of interspecific competition.

Experimental supports:

Nettle aphid, grass aphid and ladybug beetle (Smith and Smith, page 359)

Brought nettle aphid plants to grass aphid plants together suppressed both population, as a results of larger ladybug beetle population.

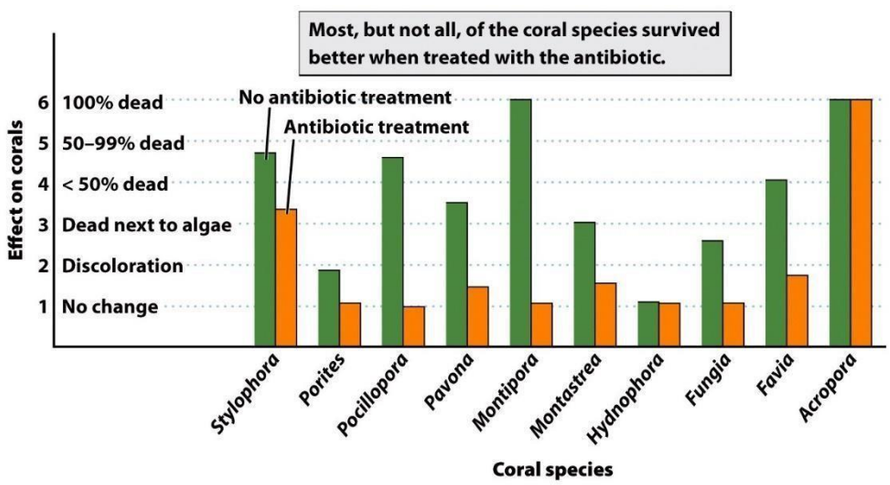

Figure 16.20
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Apparent competition

- In the absence of predator, the population of each prey is regulated by purely intraspecific density-dependent mechanisms
- Neither prey species compete, directly or indirectly, with each other • Predator abundance depends on the total abundance of prey
- Under these conditions, the combined population abundance of two prey species will support a higher predator density

166 -Energy and Nutrient Relations 1

Three main sources of energy

- **Organisms** use one of three main sources of energy:
- **light,**
- **inorganic molecules, or organic molecules**
- Photosynthetic plants and algae CO2 as a source of carbon and light, of wavelengths between 400 and 700 nm, as a source of energy
- Light within this band, which is called photosynthetically active radiation, or PAR, accounts for about 45% of the total energy content of the solar spectrum at sea level.

PAR quantification

- PAR can be quantified as photosynthetic photon flux density, generally reported as µmol per square meter per second
- Among plants, there are three major alternative **photosynthetic pathways,** C3, C4, and CAM. C4 and CAM plants are more efficient in their use of water than are C3plants.

Heterotrophs

- **Heterotrophs** use organic molecules both as a source of carbon and as a source of energy.
- **Herbivores,** carnivores, and detritivores face fundamentally different trophic problems.
- **Herbivores** feed on plant tissues. which often contain a great deal of carbon but little nitrogen.
- Herbivores must also overcome the physical and chemical defences of plants.

167-Energy and Nutrient Relations 2

Detritivores

- **Detritivores** feed on dead plant material, which is even lower in nitrogen than living plant tissues
- **Carnivores** consume prey that are nutritionally rich but very well defended.
- **Chemosynthetic autotrophs**, which consist of a highly diverse group of chemosynthetic bacteria, use inorganic molecules as a source of energy
- **Bacteria** are the most trophically diverse organisms in the biosphere.

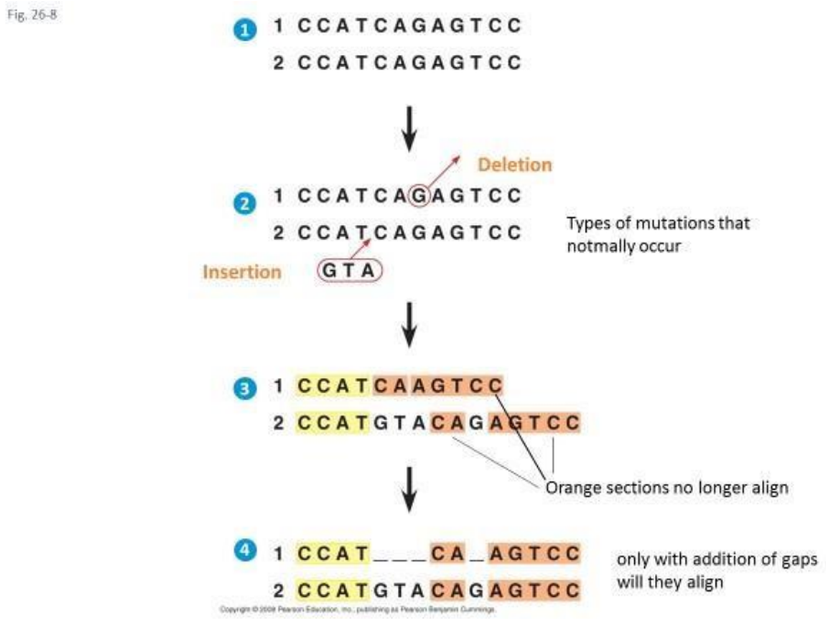
Rate of uptake of energy

- **The rate at which organisms can take in energy is limited**, either by external or internal constraints.
- **The relationship** between photon flux density and plant photosynthetic rate is called photosynthetic response.

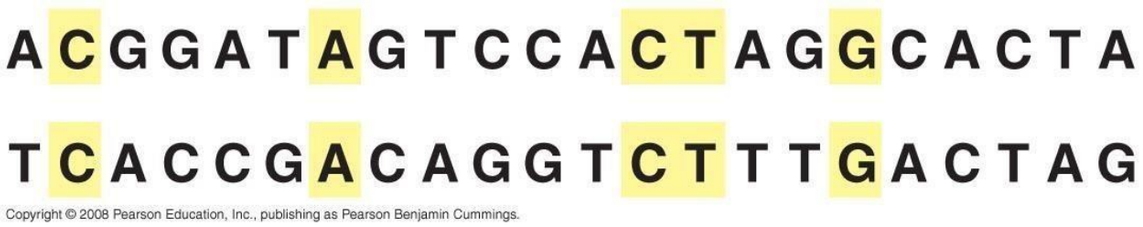
- **Herbs** and short-lived perennial shrubs from sunny habitats have high maximum photosynthetic rates that level on at high light intensities.
- The **lowest** maximum rates of photosynthesis occur among plants from shady environments
- The **relationship** between food density and animal feeding rate is called **the functional response.**
- The shape of the functional response is generally one of three types.
- The forms of photosynthetic response curves and type 2 animal functional responses are remarkably similar
- **Energy** limitation is a fundamental assumption of optimal foraging theory.

168-Evaluating Molecular Homologies

- **Systematists** use computer programs and mathematical tools when analyzing comparable DNA segments from different organisms



- It is also important to distinguish **homology** from **analogy** in molecular similarities
- Mathematical tools help to identify molecular **homoplasies,** or coincidences



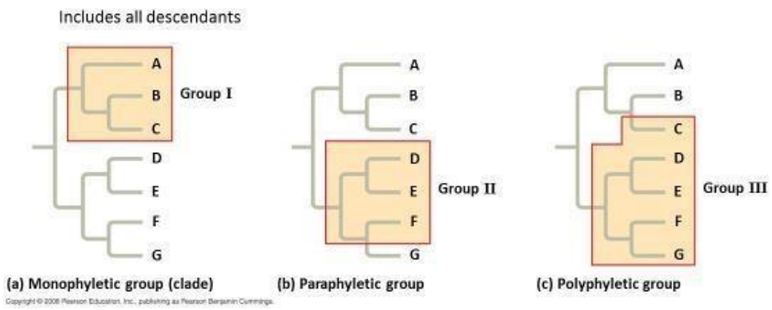
- **Molecular systematics** uses DNA and other molecular data to determine evolutionary relationships

Shared characters are used to construct phylogenetic trees

- **Cladistics** groups organisms by common descent
- A **clade** is a group of species that includes an ancestral species and all its descendants
- A valid clade is **monophyletic**, signifying that it consists of the ancestor species and all its descendants
- A **paraphyletic** grouping consists of an ancestral species and some, but not all, of the descendants

• A **polyphyletic** grouping consists of various species that lack a common ancestor

Fig. 26-10



169-Rate of uptake of energy

• The shape of the functional response is generally one of three types.

• The forms of photosynthetic response curves and type 2 animal functional responses are remarkably similar

• **Energy** limitation is a fundamental assumption of optimal foraging theory.

Optimal foraging theory

• **Optimal foraging theory** attempts to model how organisms feed as an optimizing process.

• **Evolutionary ecologists** predict that if organisms have limited access to energy, natural selection is likely to favour individuals that are more effective at acquiring energy and nutrients.

Optimal foraging theory

• Many animals select food in a way that appears to maximize the rate at which they capture energy

• **Plants** appear to allocate energy to roots versus shoots in a way that increases their rate of intake of the resources that limit their growth.

• Plants in environments with abundant nutrients but little light tend to invest more **energy** in the growth of stems and leaves and less in roots.

• In environments rich in light but poor in nutrients, plants tend to invest more energy in the growth of roots.

Trophic diversity of bacteria

• The **trophic diversity of bacteria,** which is critical to the health of the biosphere, can also be used as a tool to address some of our most challenging waste disposal problems

• **Bacteria** can be used to eliminate the huge quantities of sewage produced by human populations, clean up soils and aquifers polluted by petroleum products such as benzene,

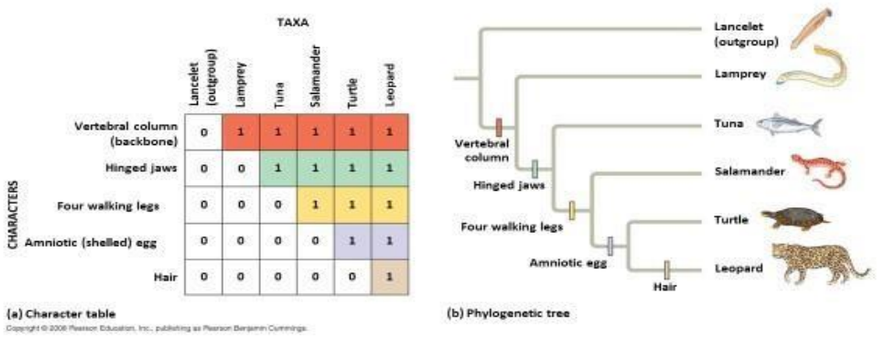
• And eliminate the pollution caused by some kinds of mine waste.

Role of bacteria

- The success of these projects requires that ecologists under- stand the energy and nutrient relations of bacteria.
- Bacteria will likely continue to play a great role as we address some of our most vexing environmental problems.

170-Shared Ancestral and Shared Derived Characters 1

- In comparison with its ancestor, an organism has both shared and different characteristics
- A **shared ancestral character** is a character that originated in an ancestor of the taxon
- A **shared derived character** is an evolutionary novelty unique to a particular clade
- A character can be both ancestral and derived, depending on the context, it is useful to know in which clade a shared derived character first appeared



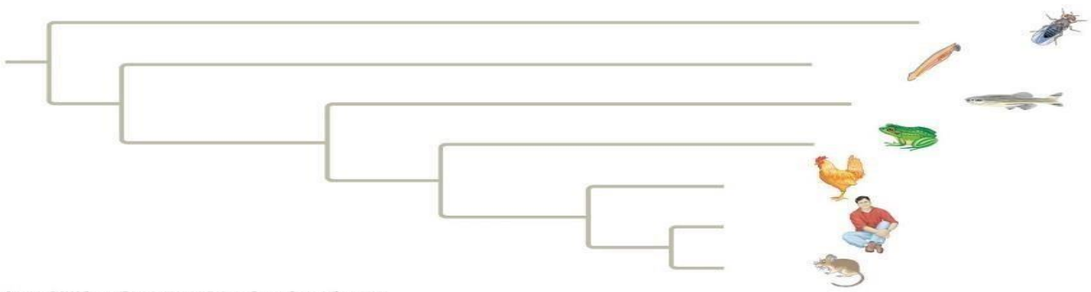
- An **out-group** is a species or group of species that is closely related to the **ingroup,** the various species being studied
- **Systematists** compare each in-group species with the out-group to differentiate between shared derived and shared ancestral characteristics

171-Shared Ancestral and Shared Derived Characters 2

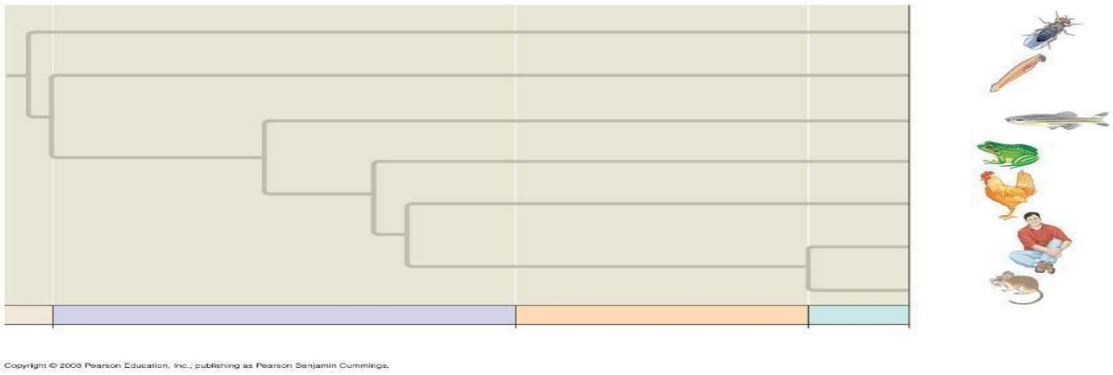
- **Homologies** shared by the out-group and in-group are ancestral characters that predate the divergence of both groups from a common ancestor

Phylogenetic Trees with Proportional Branch Lengths

- In some trees, the length of a branch can reflect the number of genetic changes that have taken place in a particular DNA sequence in that lineage



- In other trees, branch length can represent chronological time, and branching points can be determined from the fossil record

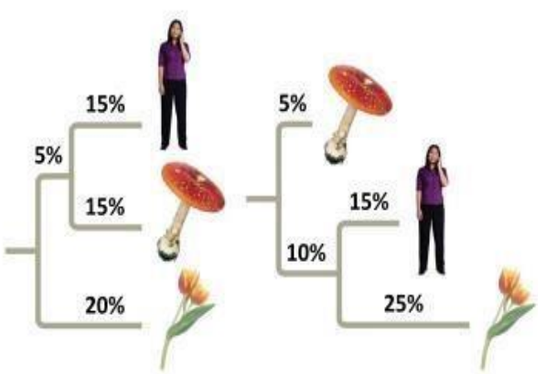


Maximum Parsimony and Maximum Likelihood

- **Systematists** can never be sure of finding the best tree in a large data set
- They narrow possibilities by applying the principles of **maximum parsimony** and **maximum likelihood**
- **Maximum parsimony** assumes that the tree that requires the fewest evolutionary events (appearances of shared derived characters) is the most likely
- The principle of **maximum likelihood** states that, given certain rules about how DNA changes over time, a tree can be found that reflects the most likely sequence of evolutionary events

	Human	Mushroom	Tulip
Human	0	30%	40%
Mushroom		0	40%
Tulip			0

(a) Percentage differences between sequences



(b) Comparison of possible trees

172-Evolution of Definitions of Ecology

- **Ecology** = from the Greek root OIKOS, “at home”, and OLOGY, “the study of” Haeckle (1870):
- “By ecology we mean the body of knowledge concerning the economy of Nature - the investigation of the total relations of the animal to its inorganic and organic environment.”
- **Burdon-Sanderson (1890s):** Elevated Ecology to one of the three natural divisions of Biology: Physiology - Morphology - Ecology
- **Elton (1927):** “Scientific natural history”
- **Andrewartha (1961):** “The scientific study of the distribution and abundance of organisms”

• **Odum (1963):** “The structure and function of Nature”

Our Definition

• **“Ecology** is the scientific study of the processes regulating the distribution and abundance of organisms and the interactions among them, and the study of how these organisms in turn mediate the transport and transformation of energy and matter in the biosphere (i.e., the study of the design of ecosystem structure and function).

• **<u>Beyond Fundamental Ecology Applied Ecology:</u>**

• Using ecological principles to maintain conditions necessary for the continuation of present day life on earth.

Industrial Ecology

• The design of the **industrial infrastructure** such that it consists of a series of interlocking "technological ecosystems" interfacing with global natural ecosystems.

• **Industrial ecology** takes the pattern and processes of natural ecosystems as a design for sustainability. It represents a shift in paradigm from conquering nature to becoming nature.

Ecological Engineering

• Unlike **industrial ecology,** the focus of Ecological Engineering is on the manipulation of natural ecosystems by humans for our purposes, using small amounts of supplemental energy to control systems in which the main energy drives are still coming from non- human sources.

• It is the design of new ecosystems for human purposes, using the selforganizing principles of natural ecosystems

173-Ecological Economics

• Integrating ecology and economics in such a way that economic and environmental policies are reinforcing rather than mutually destructive. **Urban ecology**

• For ecologists, urban ecology is the study of ecology in urban areas, specifically the relationships, interactions, types and numbers of species found in urban habitats. • Also, the design of sustainable cities, urban design programs that incorporate political, infrastructure and economic considerations.

Conservation Biology

• The application of diverse fields and disciplines to the conservation of biological diversity

• Restoration Biology: Application of ecosystem ecology to the restoration of deteriorated landscapes in an attempt to bring it back to its original state as much as possible. Example, prarie grass.

Landscape Ecology

• “Landscape ecology is concerned with spatial patterns in the landscape and how they develop, with an emphasis on the role of disturbance, including human impacts” (Smith and Smith).

• It is a relatively new branch of ecology, that employs Global Information Systems.

• The goal is to predict the responses of different organisms to changes in landscape, to ultimately facilitate ecosystem management.

Organizing principles

• All these disciplines require an understanding of the "organizing principles" of ecosystems, i.e., their ecology. This involves the detailed study of the structure and function of ecosystems in their undisturbed state, and using their designs to:

- **Determine** the resilience of ecosystem functions to human activities.
- **Design ecosystems** which function in the service of human beings with minimal fossil energy input (ideally none) and minimal waste.
- **Design the industrial infrastructure**. integrate the value of "goods and services" of natural ecosystems into the global economic system.

What is "Sustainability"?

- There are many definitions of this one, depending on your perspective.
- Here's ours: Sustainability is a property of a human society in which ecosystems (including humans) are managed such that the conditions supporting present day life on Earth can continue.

174-Foundation and keystone species

- Some species have unusually strong impacts on **community structure**, preserving the balance of the community or even making its existence possible.
- These "special" species include foundation and keystone species.
- **A foundation species** plays a unique, essential role in creating and defining a community. Often, foundation species act by modifying the environment so that it can support the other organisms that form the community
- **Kelp (brown algae)** is a foundation species that forms the basis of the kelp forests off the coast of california. Kelps create environments that allow the survival of other organisms that make up the kelp forest community.
- The **corals of a coral reef** are another foundation species.
- The exoskeletons of living and dead coral make up most of the reef structure, which protects other species from waves and ocean currents. Beavers, which modify their environment by building dams, can also be seen as a foundation species.

Keystone species

- A **keystone species** is a species that has a disproportionately large effect on community structure relative to its biomass or abundance.
- **Keystone species** differ from foundation species in two main ways: they are more likely to belong to higher trophic levels (to be top predators), and they act in more diverse ways than foundation species, which tend to modify their environment.
- Different sources use different definitions for keystone and foundation species. In some sources, foundation species are viewed as a subcategory of keystone species.

175-Reactions in Exon Splicing

Reactions in Exon Splicing

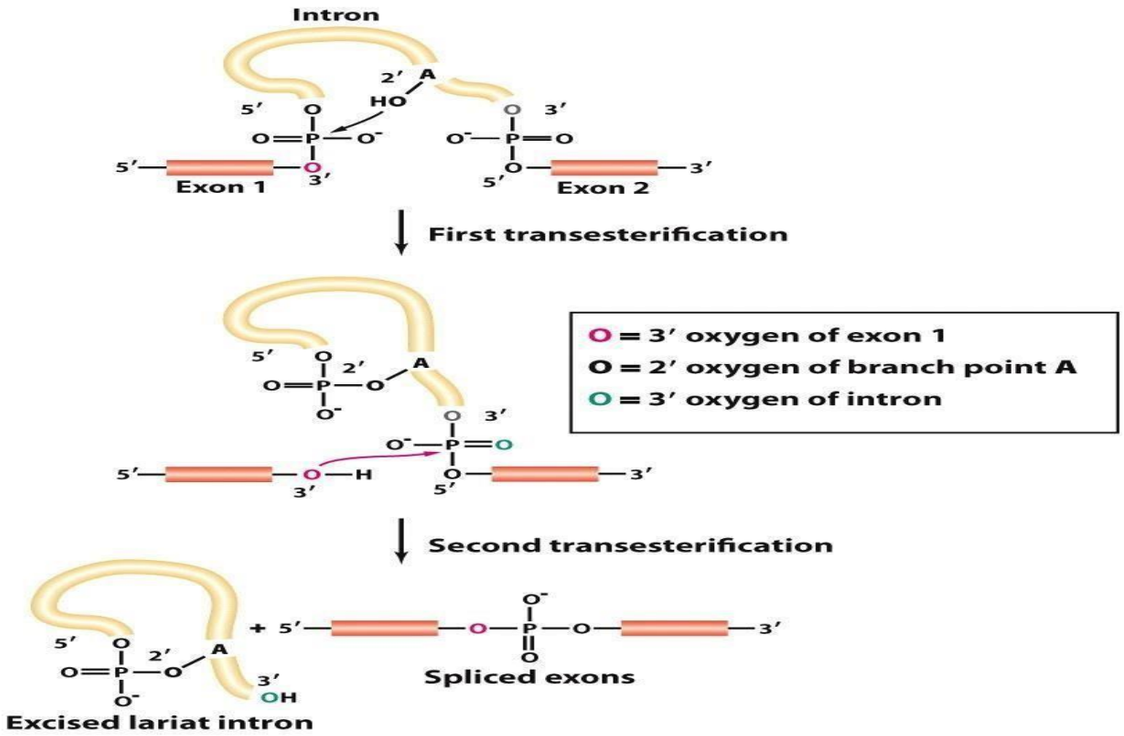


Figure 8-17
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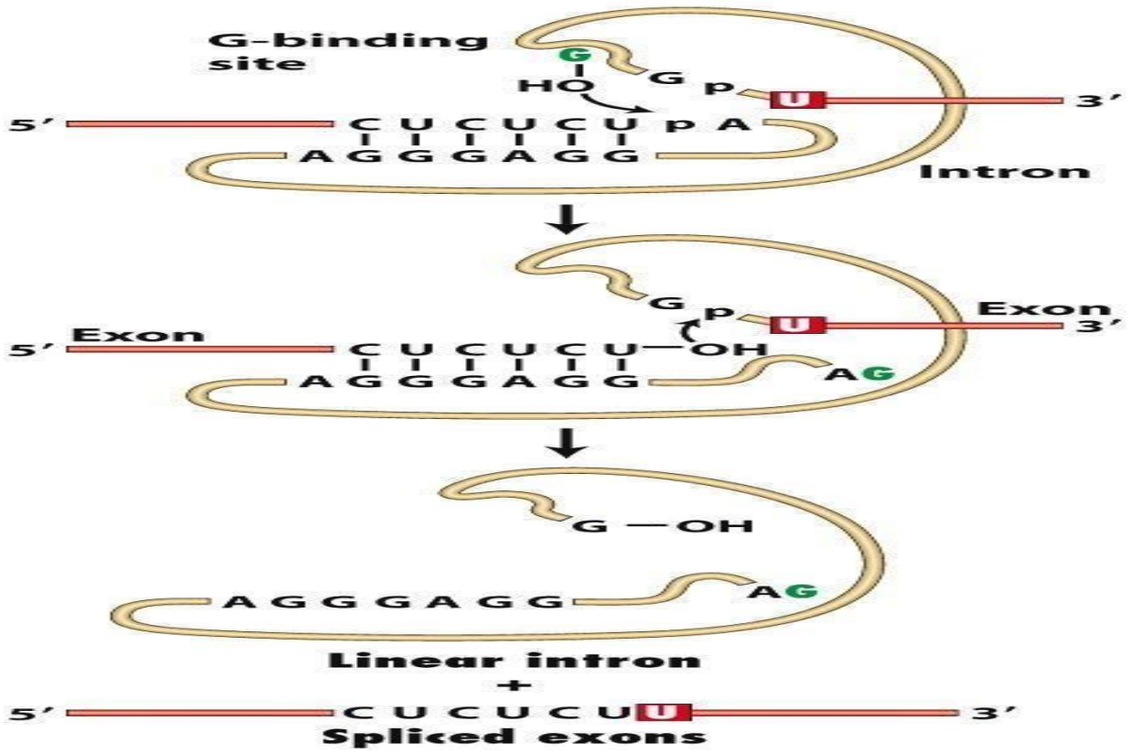
RNA molecules can act somewhat like enzymes (ribozymes).

In the protozoan Tetrahymena, the primary transcript of an rRNA can excise a 413nucleotide intron from itself.

These self-splicing introns are an example of RNA that can catalyze a reaction.



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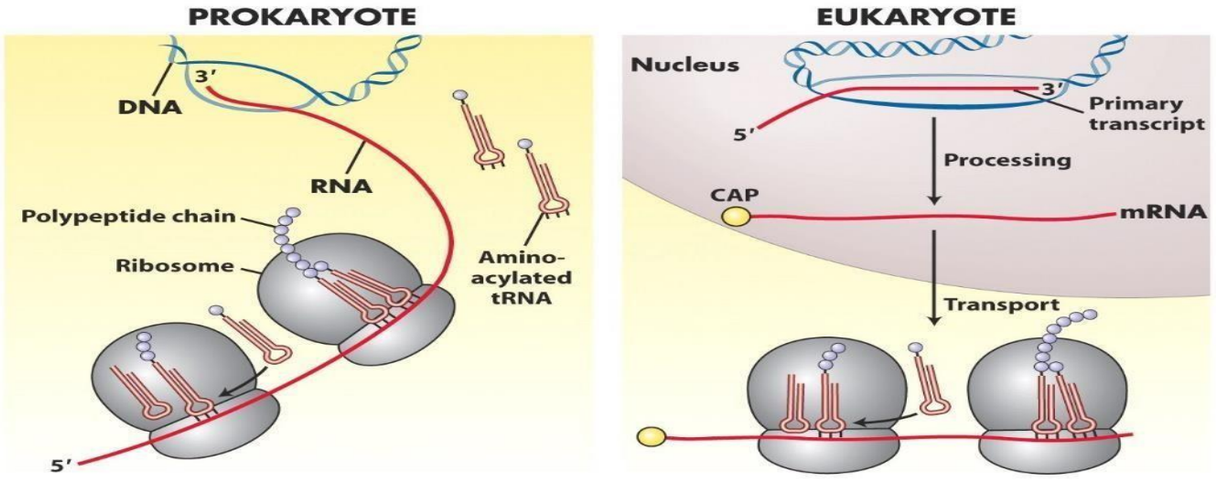
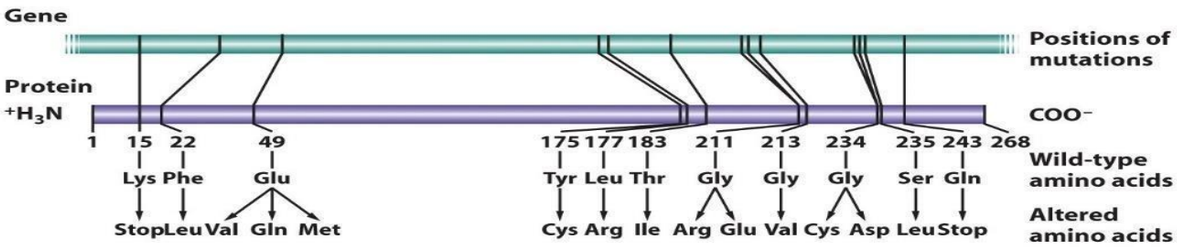
Transfer of Information in Prokaryotes and Eukaryotes



What are the similarities? What are the differences?



"The linear sequence of nucleotides in a gene determines the linear sequence of amino acids in a protein."

Mutant alleles of trpA gene differed in the position of the mutation at the DNA level, which corresponded to position of amino acid substitution in the gene product.

Colinearity of mutations and altered amino acids in a subunit of tryptophan synthetase from E. coli

C. Yanofsky, 1967. Scientific American

176-Genetic Diversity in Ecosystem Management

What is genetic diversity?

- **Genetic diversity** is the variation at the level of
- ***individual genes,***
- *In a population,*
- **Genetic diversity**, means that the population contains most of the possible alleles for each particular gene locus.
- Provides a **mechanism** for populations to adapt to their changing environment.
- The more variation, the better the chance that at least some of the individuals will have an allelic variant that is suited for the new environment, and will produce offspring with the variant that will in turn reproduce and continue the population into subsequent generations. Why study genetics in Ecosystem Management?
- Loss **of genetic diversity** can imply lack of evolution and premature extinction.
- Fitness decreases with reduced **genetic variation.**
- Populations of endangered species are small and tend to lose genetic diversity.
- When genetic variation disappears the **basis for life** on earth becomes impoverished

Some useful definitions

- **Locus:** physical location of a gene.
- **Allele**: one of the genes at a particular locus.
- **Homozygous**: two of the same alleles at a given locus.
- **Heterozygous**: two different alleles at a given locus.
- **Fitness**: contribution of an individual's genotype to the next generation

177-Levels of genetic diversity

1. **Within individuals,**
2. **Among individuals within the same population,**
3. **Among populations**

- **Within individuals,**
- Every diploid organism has duplicated genetic information (from its mother and father, It is the same type of information (locus) but the specific forms may differ (alleles)
- **Among individuals within a population,**
- Different individuals carry different genetic information, The sum of the variation of an interbreeding population is called Gene pool

Among populations,

- Different gene pools among populations.
- Isolation is and important factor responsible for among population genetic diversity (natural or man made barriers).
- Can lead to

local adaptation,

- Natural local adaptation: Example of mistletoe species in Argentina and Chile,

• Ultimate effect of among population variability: Speciation

Heterozygosity

• In an individual organism, is the state of possessing different alleles at a given locus in regard to a given character,

At the population level: "The fraction of individuals in a population that are heterozygous for a specific locus",

• Often **positively correlated** with fitness,

• Often positively correlated with population size (declines in small populations),

• When an organism is referred to as a heterozygote, or being heterozygous for a specific gene, it means that the organism carries two different versions of that gene on the two corresponding chromosomes.

Heterozygosity refers to both the state of being a heterozygote, but more commonly in population genetics to the fraction of individuals in a population that are heterozygous for that locus.

Loss of genetic diversity
Two ways of losing it

• Loss of genetic diversity in small populations,

• Changes in **the natural distribution** of genetic diversity among populations (artificial isolation and mixing)

• **Population size critical factor,**

• Census population size (Nc) vs. Effective population size (Ne), Usually Ne is much smaller that Nc (10 to 30%)

178-Factors responsible for genetic diversity loss

Four factors responsible for genetic diversity loss in small populations :

2. Genetic drift,
3. Founder effect,
4. Demographic bottleneck,
5. Inbreeding

• **Genetic drift**

• " Random change in gene frequency within a population" (Meffe et al.),

• Not necessarily adaptive, Stronger in small populations

• **Founder effect,**

• "The establishment of a new population by a few original founders which carry only a small fraction of the total genetic variation of the parental population." (Ernst Mayr), Alleles may be lost, Differentiation from the parental population, Example: Irish Potato Famine

Four factors responsible for genetic diversity loss in small populations

• **Demographic bottleneck,**

• Population suffers reduction in size and then recovers, Random losses of genetic diversity,

• Usually associated with catastrophic events or diseases,

• Genetic variation doesn't rebound from a decrease as quickly as population size.

• **Inbreeding**

- Inbreeding is breeding between close relatives,
- Leads to a reduction in genetic diversity (inbreeding depression: reduced health and fitness),
- The primary problem with inbreeding is that two closely related individuals are likely to have very similar genomes, and if one individual has a gene for a given negative trait, then the other is likely to have it as well., Inbreeding increases homozygosity (therefore decreases heterozygosity)

The other way to loss genetic diversity:

- **Changes** in the natural distribution of genetic diversity among populations
- Related with the geographical distribution of the species and therefore with landscape management issues
- **Artificial isolation**
- Avoids genetic flux among populations due to barriers such as highways, dams, etc
- **Artificial mixing** Enhances genetic flux among populations where that flux was not possible due to natural barriers (examples: bridges, tunnels)

Allelic richness

- Allelic richness Is the number of alleles in a sample (population),
- **Rare alleles** are important during extreme environmental events,
- Loss of allelic richness is perhaps more serious than loss of quantitative variation because alleles are lots forever while quantitative variation can be recovered,
- Rare alleles are more important that their frequency in the population
- Example: Peppered moth and pollution in Manchester, Small sized populations are more prone to lose allelic richness

Usefulness of Ecosystem Management and Genetics in Conservation

Ecosystem Management and Genetics in Conservation Useful in;

- Endangered small populations,
- Captive breeding,
- Translocation of individuals,
- Determining dispersal patterns,
- Recognize limitations and scale of application, I
- It's easy to lose the sight of the larger picture and try to apply a genetics approach when it is not appropriate to do so.

179-Geographic ecology

- **Geographic ecology** focuses on large-scale patterns of distribution and diversity of organisms, such as island biogeography, latitudinal patterns of species diversity, and the influences of large-scale regional and historical processes on biological diversity.

Isolation

- **On islands and habitat patches on continents, species richness increases with area and decreases with isolation.**
- Larger oceanic islands support more species of most groups of organisms than small islands. Isolated oceanic islands generally contain fewer species than islands near mainland areas.
- Many habitats on continents are so isolated that they can be considered as islands.

Species richness on habitat islands

- Species richness on habitat islands, such as mountain islands in the American Southwest, increases with area and decreases with isolation.
- Lakes can also be considered as habitat islands. They are aquatic environments isolated from other aquatic environments by land.
- Fish species richness generally increases with lake area.
- Species richness is usually negatively correlated with island isolation. However, because organisms differ substantially in dispersal rates, an island that is very isolated for one group of organisms may be completely accessible to another group.

Models of Species richness on islands

- Species richness on islands can be modelled as a dynamic balance between immigration and extinction of species. The equilibrium model of island biogeography proposes that the difference between rates of immigration and extinction determines the species richness on islands.

The equilibrium model of island biogeography

- The equilibrium model of island biogeography assumes that rates of species immigration to islands are mainly determined by distance from sources of immigrants. The model assumes that rates of extinction on islands are determined mainly by island size.