Lecture 01

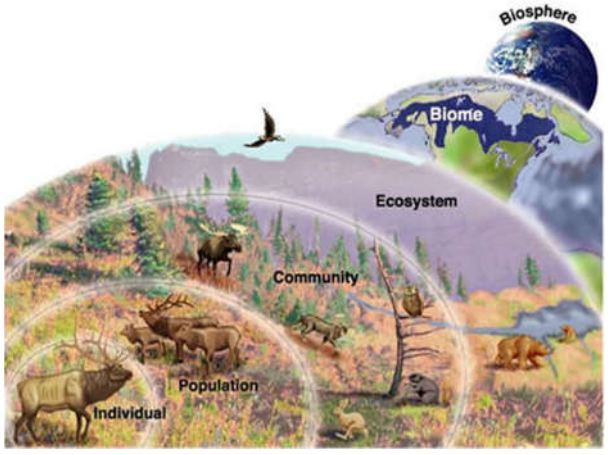
Introduction to Ecology:

The word 'ecology' was first used by **Ernest Haeckel** in 1869.

Ecology is the scientific study of the interactions that determine the distribution and abundance of organisms in an environment.

All organisms have to interact with both living & non living things that surround them.

Both these living & non living factors contribute to the whole environment of organisms in which they live.



> Ecology is a complex and an amazing field of biology that describes the richness of the biosphere.

The basic concept of ecology is that, "all organisms in an environment are interdependent".

So environment is a main part of the relationship that occurs between organism and their natural and manmade environment.

Sub fields of ecology

- Organismal ecology
- Population ecology
- Community ecology
- Ecosystem ecology
- Landscape ecology
- Global ecology



Major components of ecology are

- Species
- Population
- Community
- Ecosystem
- Biome
- Biosphere



Lecture 02

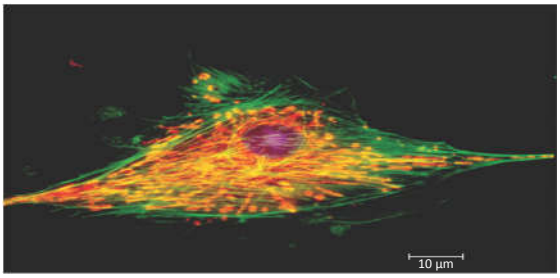
Level of organization: Cell

Cell is the basic structural and functional unit of life.

All organisms are composed of cells which is the basic concept of cell theory.

Organisms may consist of single cell (unicellular) or many cells (multicellular).

The cell is the simplest collection of matter that can live. Cell structure is correlated to cellular function.

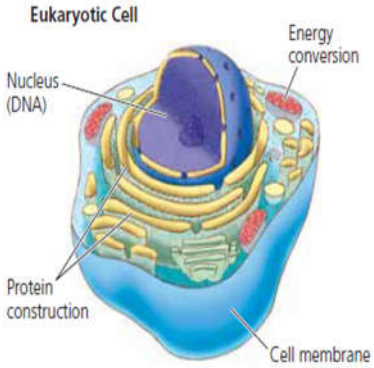


Organisms are divided into two types on the basis of their cell structure.

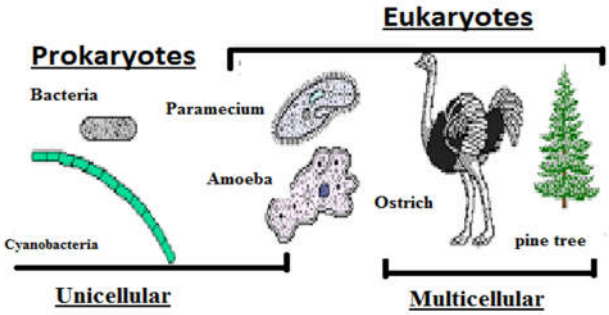
- ❖Prokaryotes
- ❖Eukaryotes

Eukaryotes

They have well defined nucleus and also have Membrane Bound organelles.

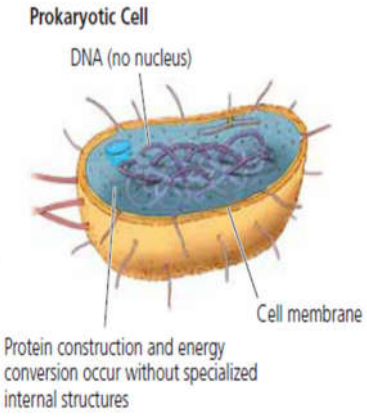


Prokaryotes consist of only unicellular organisms while Eukaryotes consist of both unicellular and multicellular organisms.



Prokaryotes:

They lack well defined nucleus and also membran bound organelles.



Lecture 03

Species:

A group of sexually reproducing organisms, that can mate and produce fertile offspring. This is the biological concept of species.

Every organism is a member of a particular species with specific traits.

The species is the largest unit of population in which gene flow is possible.

It is defined by reproductive isolation from other species in natural environments.

Four basic concepts about species are

1. Biological species concept
2. Ecological species concept
3. Morphological species concept
4. Phylogenetic species concept

1. Biological concept of species:

Defines species on the base of their interbreeding potential not on similarity or appearance.

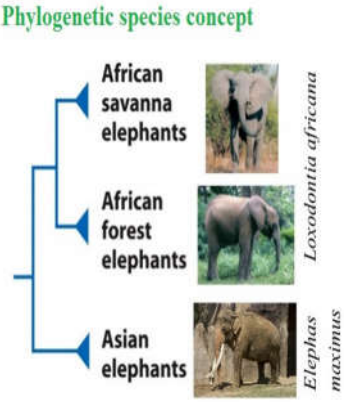
For example, Western meadowlarks (*Sturnella neglecta*) and Eastern meadowlarks (*Sturnella magna*) look almost identical to one another, yet do not interbreed to each other thus, they are separate species according to this definition.



The Western meadowlark (left) and the Eastern meadowlark (right) appear to be identical, and their ranges overlap, but their distinct songs prevent interbreeding.

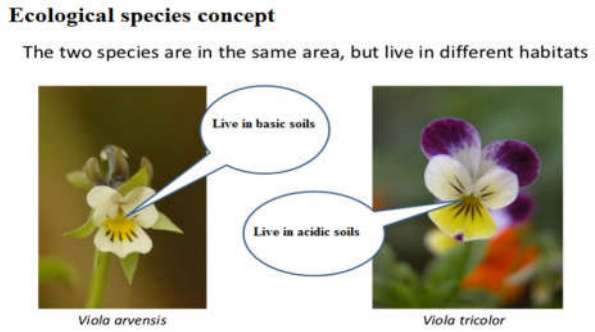
4. Phylogenetic species concept:

Defines species as the smallest group of individuals on a phylogenetic tree.



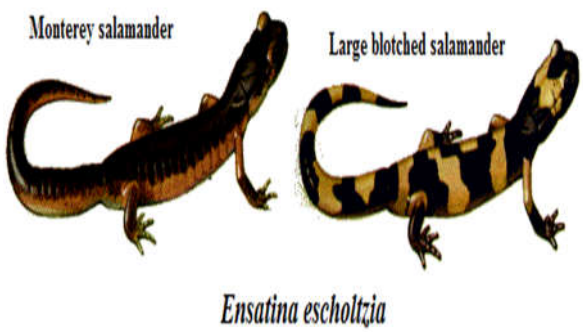
2. Ecological species concept

Defines species in terms of its ecological niche.



3. Morphological species concept

Defines species by structural features.



Lecture 04

Population:

A group of same species located at the same place and same time is called as a population. Population biologists study groups in a specific area.

A group of ducks would not be a population if there were mallard and wood ducks combined.

It means that there are two populations existing in the same area.



Every population has particular characteristics:

- Population size
- Population growth
- Population distribution
- Population density

Organisms are born & the population size increases.

Other factors that will increase the size of a population are:

- Reproductive fitness
- Good weather
- Medicine
- Geographic isolation
- No predators

Organisms will also die of old age and the population will decrease.

Populations can also decrease when there are more **predators** around, after a natural disaster, when **competition** is too great or when some of the organisms just leave the area (**migration**).

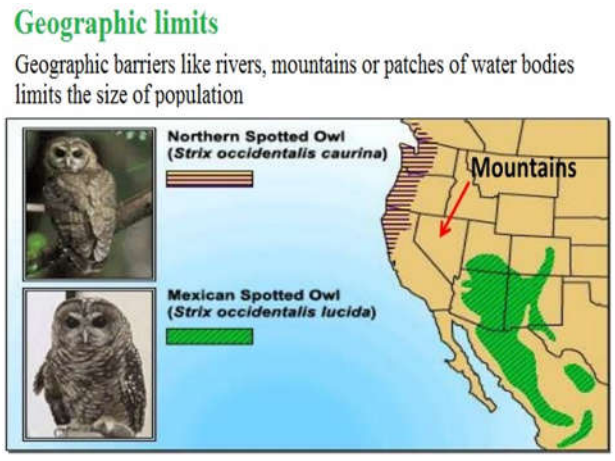
Physical limits:

There are some **physical limits** for a population. Sometimes other environments are just bad places to live for a population. They may be too hot, too cold, or too dangerous.

Geographic limits:

Geographic limits are also a main constraints that decreases the size of a population.

These above mentioned factors (Physical limits and geographic limits) are very important to address because they limit the population expansion.



Lecture 05

Community:

Community or biological community is the group of population of different species located in a particular area or place.

Communities are not only a random composition of species but they also have a unique organization.

A community is made up of many populations that interact in an area.

For example, a catfish species in a pond usually shares the pond with other fish species, & with plants, insects, ducks, & many other species that make up the community.

Many of the organisms in a community interact with one another in feeding and other relationship.



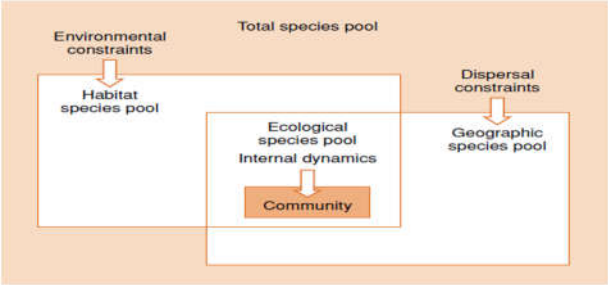
Communities, like all biological entities, require matter for their construction and energy for their activities.

The community is an assemblage of species populations that occur together in space and time.

Community assembly

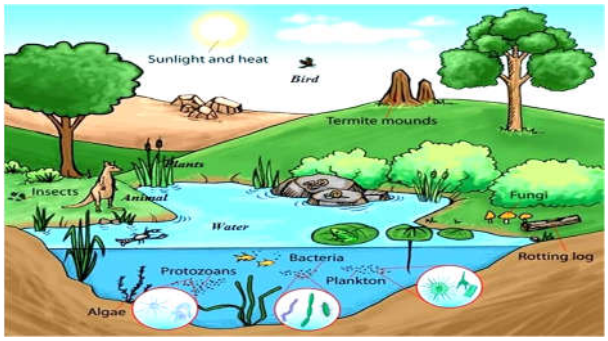
The species that assemble to make up a community are determined by:

- Dispersal constraints
- Environmental constraints
- Internal dynamics



The relationships among five types of species pools: the total pool of species in a region, the geographic pool (species able to arrive at a site), the habitat pool (species able to persist under the abiotic conditions of the site), the ecological pool (the overlapping set of species that can both arrive and persist) and the community (the pool that remains in the face of biotic interactions).

If there is more species diversity then structure of ecosystem will be more complex and less energy will be needed to maintain the structure of ecosystem.



Lecture 06

Ecosystem:

The word ecosystem was coined by **Tansley in 1935.**

An ecosystem is a community of different species interacting with one another and with their nonliving environment of soil, water, other forms of matter, and energy, mostly from the sun.

Ecosystems can be natural or artificial (human created). Examples of artificial ecosystems are crop fields, tree farms, and reservoirs.

Ecosystems do not have clear boundaries and are not isolated from one another. Matter and energy move from one ecosystem to another.

For example, soil can wash from a grassland or crop field into a nearby river or lake. Water flows from forests into nearby rivers and crop fields.

Birds and various other species migrate from one ecosystem to another. Winds can blow pollen from a forest into a grassland.

Ecosystem is a basic structural and functional unit of ecology.

Structure of an ecosystem depends on **species diversity** as well as the energy that is required to maintain it.

An ecosystem consists of two major components

1. Biotic components
2. Abiotic components

The interactions between both these components constitutes an ecosystem.

Biotic components

Living components of an ecosystem

1. Producers : Green plants
2. Consumers: Animals
3. Decomposers: Bacteria and fungi

Abiotic components:

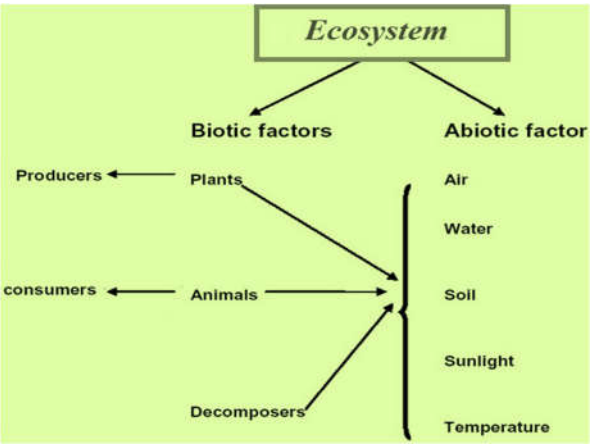
Non living components of an ecosystem

Physical components:

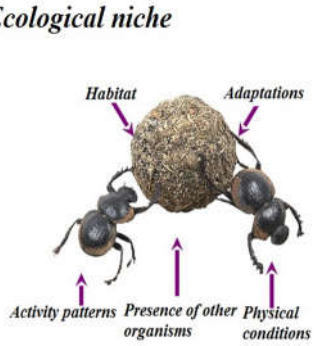
1. Water
2. light
3. Temperature
4. Wind
5. Air
6. soil

Chemical components:

1. Oxygen
2. Carbon
3. Nitrogen
4. Phosphorus
5. Sulphur.



Bacteria from the genus Pseudomonas can grow in a broad variety of niches, which range from natural environments to human-associated ecosystems.



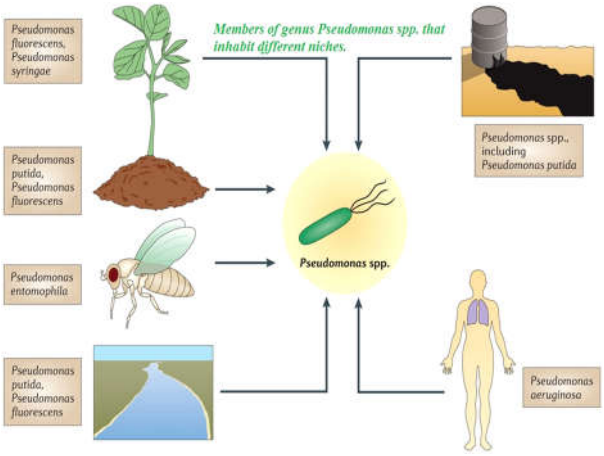
Lecture 07

The ecological niche:

The **ecological niche** is an important concept of community structure.

An important principle of ecology is that each species has a distinct role to play in the ecosystems where it is found.

So ecological niche is defined as the role that a species plays in its environment including behaviour and influence.
It is a species' way of life in a community and includes everything that affects its survival and reproduction, such as how much water and sunlight it needs, how much space it requires, and the temperatures it can tolerate.

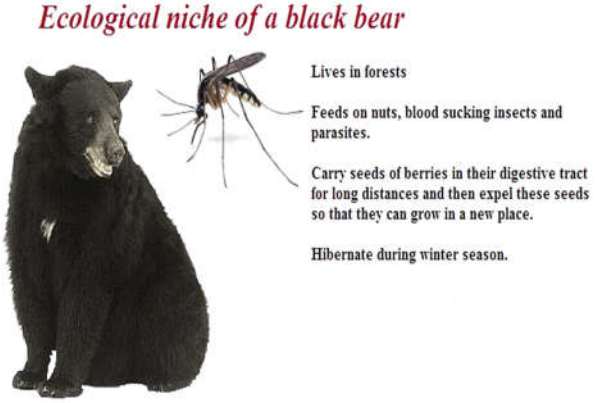


A species' niche should not be confused with its habitat, which is the place where it lives. Niche is simply a pattern of living of species.

The ecological niche basically highlights the functional position of a species in its environment.

A typical niche describes;

1. The habitat which is the actual place of living of an organisms.
2. The activity pattern of an organism that is a time period in which an organism remains active.
3. The resources that an organism gains from the surrounding environment.



Lecture 08

Generalist species

Those species that have broad range of niches are known as generalist species.

They can live in many different places, eat a variety of foods, and often tolerate a wide range of environmental conditions.

Flies, cockroaches, mice, rats, white-tailed deer, raccoons, and humans are Generalist species.

Cockroaches: Nature's Ultimate Survivors

Cockroaches are present on earth since **350 million years**.



One of brilliant example of evolution's great success because they are generalists.

There are **3500 cockroach species**. They can eat almost anything, including algae, dead insects, fingernail, glue, Paper soap. They can also live and breed almost anywhere except in polar regions.

- Some cockroach species can go for a month Without food, survive for a month on a drop of water from a dishrag, and withstand massive doses of radiation.
- One species can survive being frozen for **48 hours.**

- They have high reproductive rates.
- In only a year, a single Asian cockroach and its offspring can add about 10 million new cockroaches to the world.
- Their high reproductive rate also helps them to quickly develop genetic resistance to almost any poison we throw at them.
- About **25 species** of cockroach live in homes and can carry viruses and bacteria that cause diseases.
- On the other hand, cockroaches play a role in nature's food webs. They make a tasty meal for birds and lizards.

Lecture 09

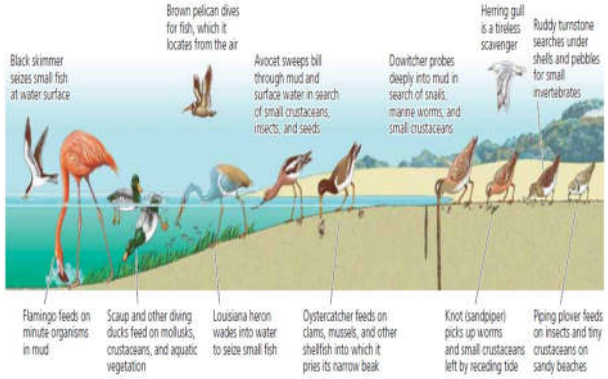
Specialist species:

Those species that occupy narrow range of niches are known as specialist species.

- They may be able to live in only one type of habitat, use one or a few types of food, or tolerate a narrow range of climatic and other environmental conditions.
- This makes specialists more prone to extinction when environmental conditions change.

For example, tiger salamanders breed only in fishless ponds where their larvae will not be eaten. Some shorebirds occupy specialized niches, feeding on crustaceans, insects, and other organisms on sandy beaches and their adjoining coastal wetlands.

Specialized feeding niches of various bird species in a coastal wetland. This specialization Reduces competition and allows sharing of limited resources.



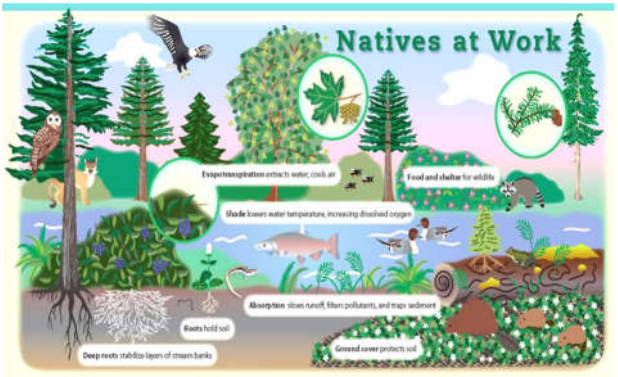
Is it better to be a generalist or a specialist?

It depends on environmental conditions. When environmental conditions are fairly constant, as in a tropical rain forest, specialists have an advantage because they have fewer competitors. But under rapidly changing environmental conditions, the generalist usually is better off than the specialist.

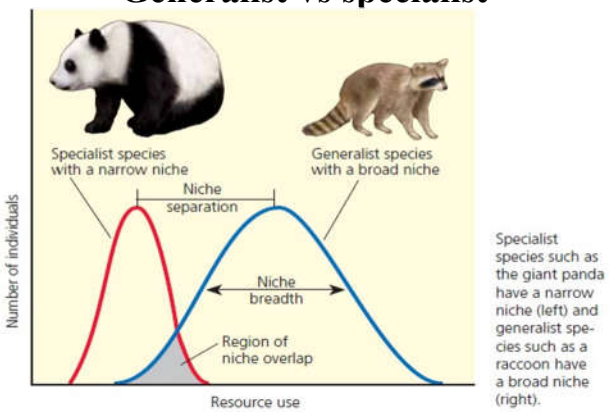
China's giant panda is highly endangered because of a combination of habitat loss, low birth rate, and its specialized diet consisting mostly of bamboo.



2. Indigenous species: These are found within the region & elsewhere in the world also.



Generalist vs specialist



Specialist species such as the giant panda have a narrow niche (left) and generalist species such as a raccoon have a broad niche (right).

Endemic species:

Blind Indus dolphin is only found in Indus river of Pakistan.



Lecture 10

Native species:

Native species are those species that normally live and thrive in a particular ecosystem because of its soil, isolation and climatic conditions.

Native species occurs naturally within a region. They either evolve in that region or arrive and become established in that region without human assistance.

Native species can be either endemic or indigenous.

1. Endemic species:

These species are found within a specific part of world only.

Red kangaroo is endemic to Australia only in the World.



Indigenous species

Snow leopard is found in Pakistan, Nepal, India, Russia and in some other countries of central Asia.



In fact, most introduced and domesticated species of crops and animals, such as chickens, cattle, and fish from around the world, are beneficial to us.

Grass carp was introduced in Pakistan from china. It controls the growth of pond weeds as well as a great protein source.

However, some non-native species can threaten a community's native species & cause unintended & unexpected consequences.



Lecture 11

Non-native species:

Species that are non native to their environment and are deliberately or accidentally introduced into an ecosystem are called **non-native species.**

These are also named as invasive, alien, or exotic species.

An introduced species is occasionally successful in the new environment. Introduction of non native species is a major cause of species loss.

Species are introduced in the new Environment by two ways intentional or Unintentional.

In 1957, for example, Brazil imported wild African bees to help increase honey production.

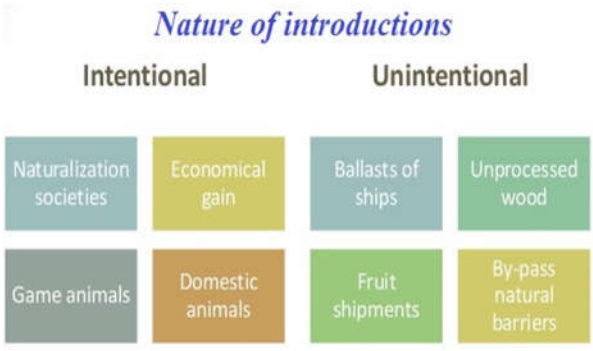
Instead, the bees displaced domestic honeybees and reduced the honey supply.



Impact of non native species:

➢Non-native species can spread rapidly if they find a new more favourable niche.

➢In their new niches, these species often do not face the predators and diseases they faced before.



Non native species that have a potential to cause economic or environmental harm to humans are termed as invasive species.

➢They may be able to out-compete some native species in their new niches.

➢Causes habitat loss and ecosystem disturbance.

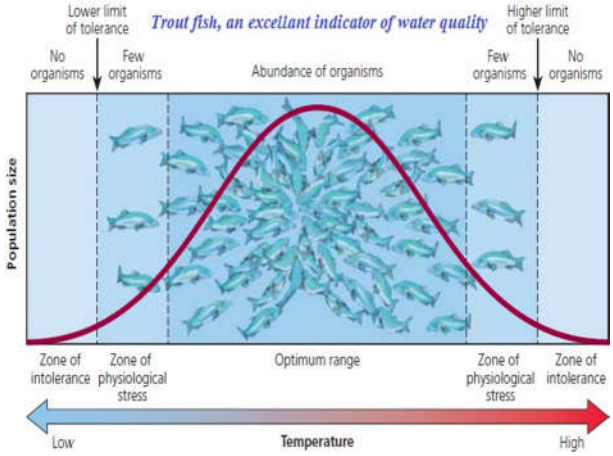


Lecture 12

Indicator species:

Species that provide early warnings of damage to a community or an ecosystem are called **indicator species.**

For example, the presence or absence of trout species in water at temperatures within their range of tolerance is an indicator of water quality because trout need clean water with high levels of dissolved oxygen.



Birds are excellent biological indicators because they are found almost everywhere and are affected quickly by environmental changes such as loss or fragmentation of their habitats and introduction of chemical pesticides. The populations of many bird species are declining.

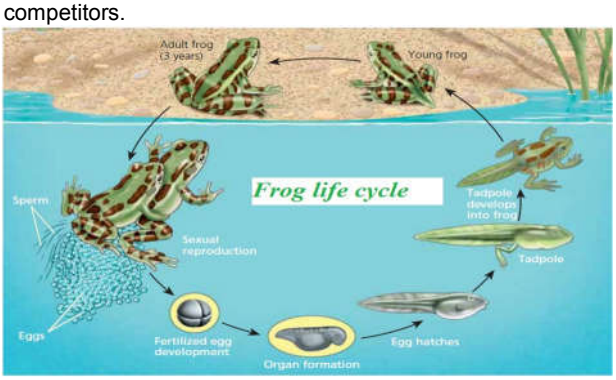
Butterflies are also good indicator species because their association with various plant species makes them vulnerable to habitat loss and fragmentation.

During early 1900s, coal miners took caged canaries (songbirds) into mines to detect early-warning signals. These birds sing loudly and often. If they quit singing for a long period and appeared to be distressed, miners took this as an indicator of the presence of poisonous or explosive gases and got out of the mine.

Some amphibians are also classified as indicator Species.

Amphibians (frogs, toads, and salamanders) live part of their lives in water and part on land. Populations of various frog species can decline because of the effects of harmful factors at different points in their life cycle.

Such factors include habitat loss, drought, pollution, increased ultraviolet radiation, parasitism, disease, overhunting by humans, & non native predators & competitors.



Lecture 13

Keystone species:

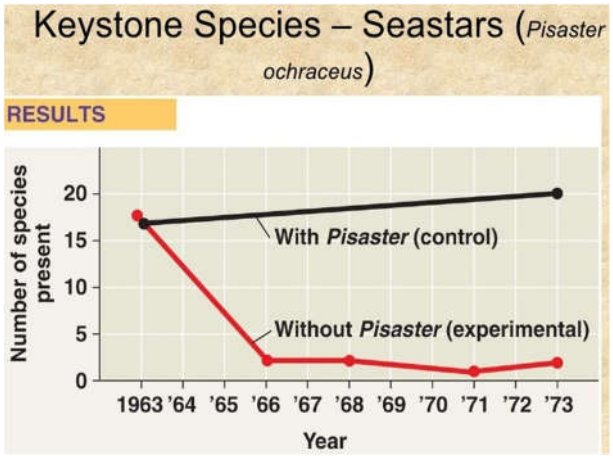
Some species play a key and crucial role in maintaining the structure of a biological community. They are called Keystone species because they have a large effect on the types and abundances of other species in an ecosystem.

The effects that keystone species have in their ecosystems is often much larger than their numbers and because of their relatively limited numbers, some keystone species are more vulnerable to extinction than others.

Keystone species can play several critical roles in helping to sustain an ecosystem. One such role is pollination of flowering plant species by bees, butterflies , hummingbirds, bats, and other species.



The monarch butterfly, which feeds on pollen in a flower and other insects pollinate flowering plants that serve as food for many plant eaters.



In addition, top predator keystone species feed on and help regulate the populations of other species. e.g; are the alligator, wolf, leopard, lion, & some shark species.

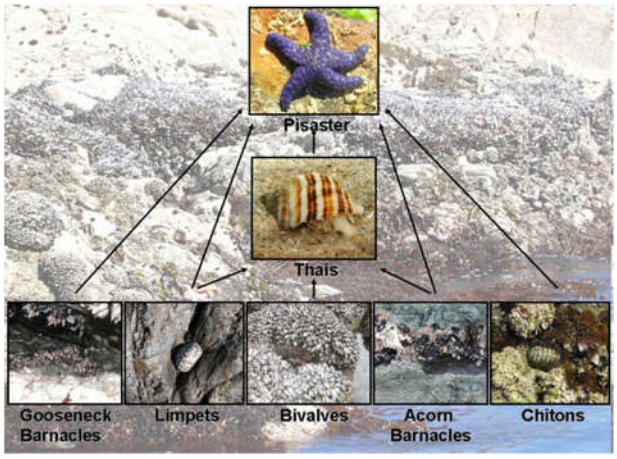
Ecologist Robert Paine studied the keystone role of the top-predator sea star *Pisaster ochraceus* in an intertidal zone community.

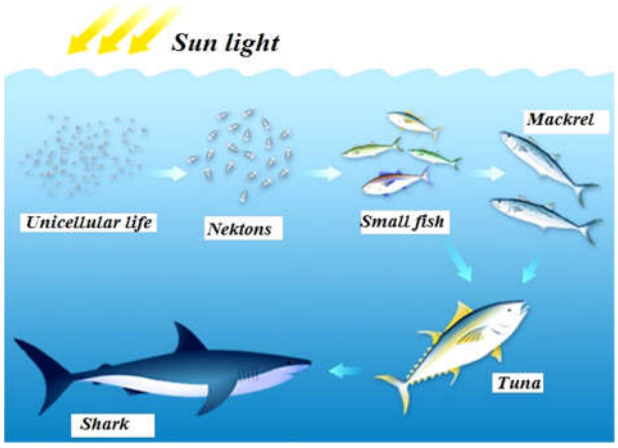
Paine removed the mussel-eating Pisaster sea stars from one rocky shoreline community but not from an adjacent community, which served as a control group. Mussels took over & crowded out most other species in the community without the Piaster sea stars.

Sharks are also a keystone species because they remove injured and sick animals from the ocean, and thus play an important ecological role.

Without the services provided by these keystone species, the oceans would be filled with dead & dying fish.

The loss of a keystone species can lead to **population crashes** and **extinctions** of other species in a community that depends on it for certain services. This explains why it so important for scientists to identify and protect keystone species.





Lecture 14

Foundation species:

Foundation species, plays a major role in shaping communities.

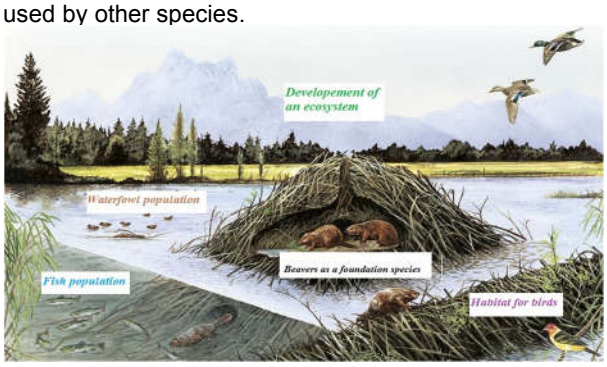
They create & Enhance the habitats in ways that provides benefits to other species. They facilitate the survival & reproduction of other species in the community.

For example, elephants push over, break, or uproot trees, creating

forest openings in the grasslands and woodlands of Africa.



Beavers are another good example of a foundation species. Acting as "ecological engineers," they build dams in streams to create ponds and other wetlands used by other species.



Some bat and bird foundation species help to regenerate deforested areas.

They spread fruit plants by depositing plant seeds in their droppings.

Foundation vs keystone species:

A foundation species creates or provide a foundation of an ecosystem while keystone species regulates and maintains that ecosystem.

Lecture 15

Ecological pyramids:

An ecological pyramid is a graphical relationship among different trophic structures or levels in an ecosystem.

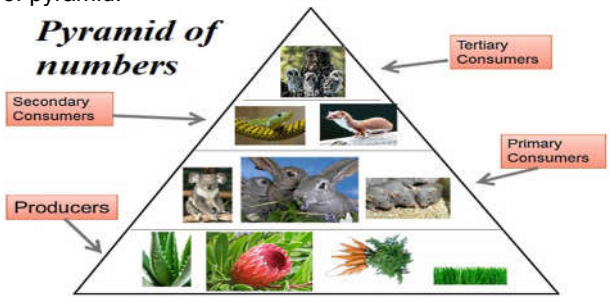
Trophic structure means the different feeding levels of organisms.

An ecological pyramid is further classified into 3 main types,

1. **Pyramid of number**
2. **Pyramid of biomass**
3. **Pyramid of energy**

1. Pyramid of number

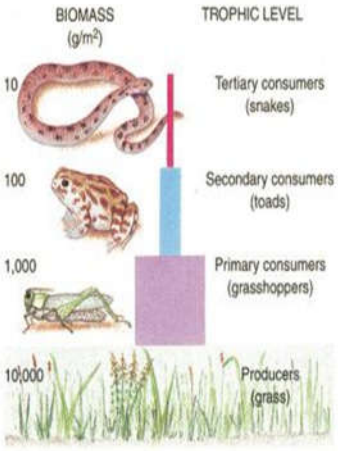
It represents the number of individuals at each trophic level of an ecosystem. More number of individuals at base while a gradual decrease in number towards top of pyramid.

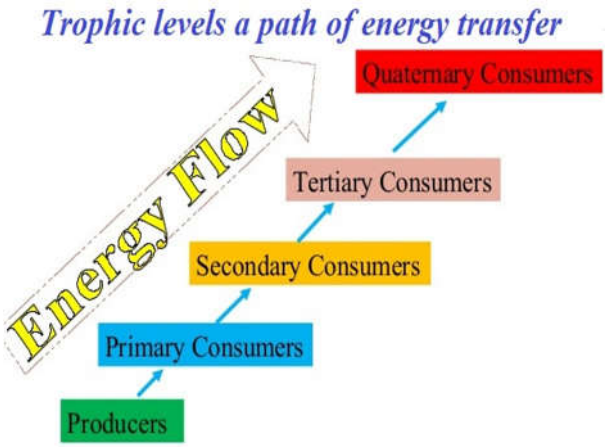


2. Pyramid of biomass

It indicates mass of living matter at each trophic level of food chain.

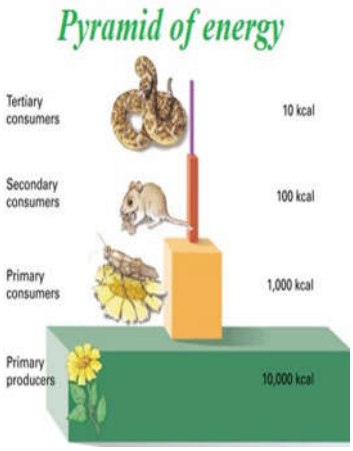
High biomass at the base while lower at top of the pyramid.





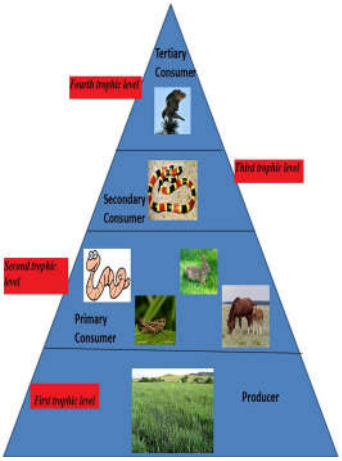
3. Pyramid of energy

Determines the flow of energy through each trophic level in a food chain.



A food pyramid is basically consists of producers and consumers that belongs to different life forms. Energy in the form of food is transferred from one organism to other through different trophic levels.

A simple food pyramid showing the interconnection of different trophic levels.



Lecture 16

Food pyramids:

Energy supports the activities of all organisms in the ecosystem. It usually enters the ecosystem in the form of sunlight. It is incorporated into the chemical bonds of molecules within living and decaying tissues, and is eventually lost as heat.

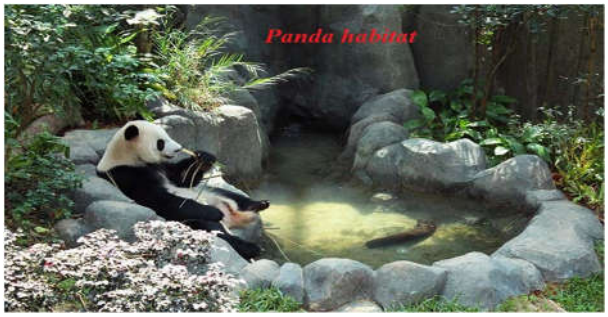
A food pyramid is a graphical representation of flow of energy through different trophic levels of an ecosystem.

The highest level an organism occupies on a food chain is termed as trophic level.

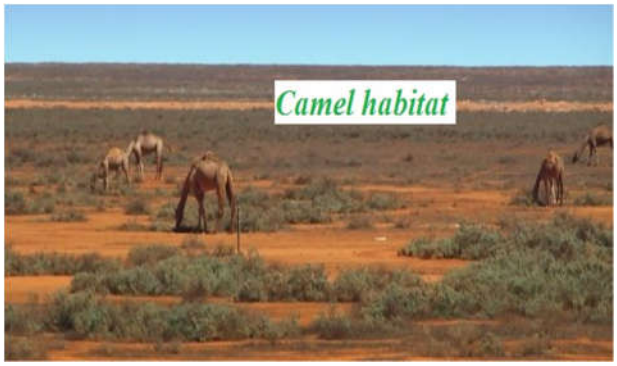
Lecture 17

Organisms and environment:

Actual place of an organism where it lives is called its habitat or environment.



An animal's habitat (environment) includes all living (biotic) and non-living (abiotic) characteristics of the area in which the animal lives.



Taxis

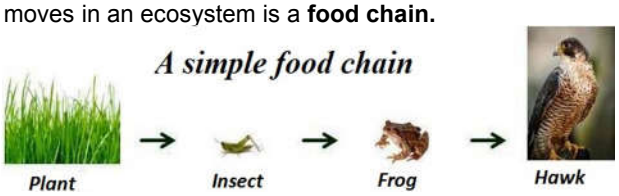
Response of an organism towards any abiotic factor is known as taxis. Basically organisms orient themselves to that response.

For example, a response of organism to light is called phototaxis.

Lecture 18

Food chain:

The sequence of organisms through which energy moves in an ecosystem is a **food chain.**



Animals always live within a certain range of values, called the **tolerance range,** for any environmental factor.

At either limit of the tolerance range, one or more essential functions cease.

Range of optimum defines the conditions at which organisms are most successful in survival.

Organisms can performed their life activities well under these optimum conditions.

Decomposers and detritus feeders consume the leaf, caterpillar, frog, and hawk after they die and return their nutrients to the soil for reuse by producers.

The chemical energy stored as nutrients in the bodies and wastes of organisms flows through ecosystems from one trophic (feeding) level to another.

A food chain determines how chemical energy & nutrients move from one organism to another through the trophic levels in an ecosystem.

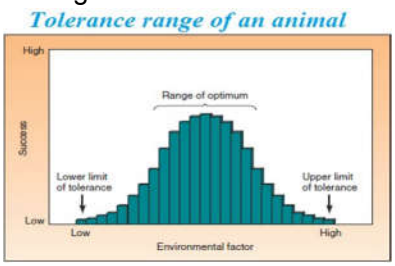
A certain range of values within the tolerance range is called the range of optimum.

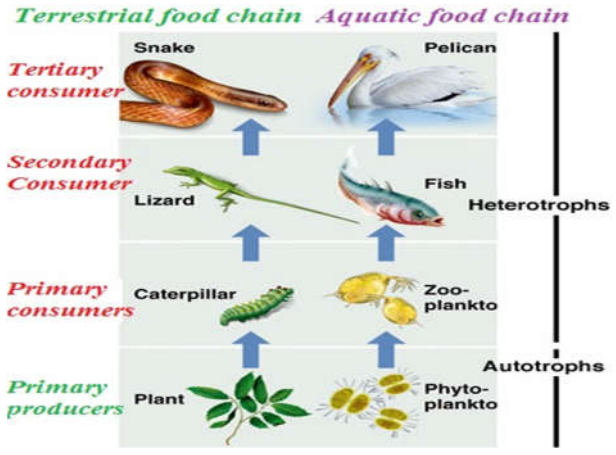
Limiting factor

When an abiotic factor becomes out of an organism tolerance range then it is said to be a limiting factor.

For example

- Oxygen
- Water
- Food





Lecture 19

Food web:

In natural ecosystems, most consumers feed on more than one type of organism, and most organisms are eaten or decomposed by more than one type of consumer.

Because of this, organisms in most ecosystems form a complex network of interconnected food chains called a **food web**.

Food chains and webs show how producers, consumers, and decomposers are connected to one another as energy flows through trophic levels in an ecosystem.

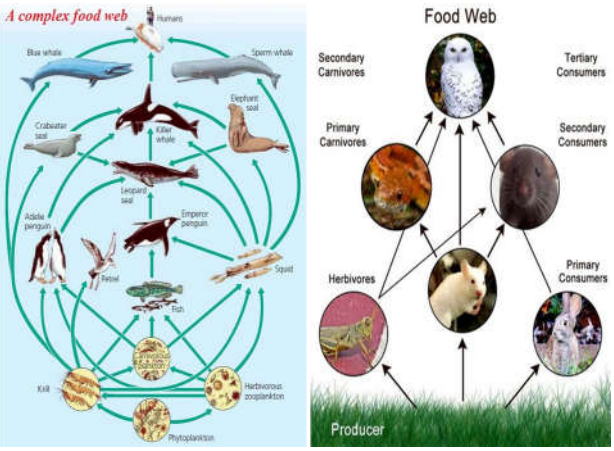
Provide stability to ecosystem.

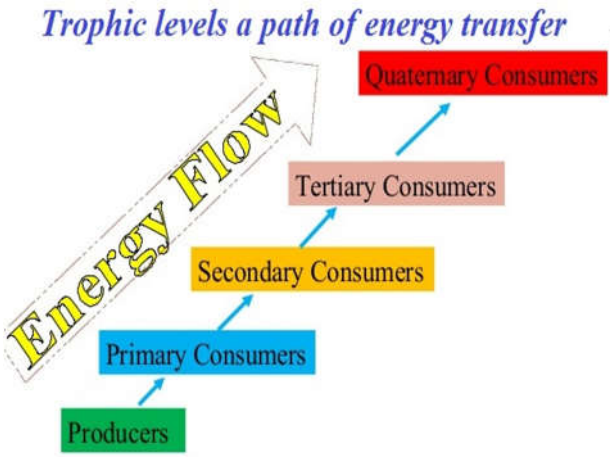
Other trophic levels are made up of consumers (heterotrophs).

- Consumers eat other organisms to obtain energy.
- Herbivores (primary consumers) eat producers.
- Some carnivores (secondary consumers) eat herbivores, and other carnivores (tertiary consumers) eat the carnivores that ate the herbivores.

Consumers also include scavengers that feed on large chunks of dead and decaying organic matter.

Decomposers break down dead organisms and feces by digesting organic matter extracellularly and absorbing the products of digestion.





Lecture 20

Trophic levels:

Because food webs are complex, so it is easy to group organisms according to the form of energy used. These groupings are called **trophic levels.**

Energy flows through these trophic levels in a food chain.

Producers (autotrophs) obtain nutrition (complex organic compounds) from inorganic materials as an energy source.

They form the first trophic level of an ecosystem. The most familiar producers are green plants.

Lecture 21

Producers:

Producers or autotrophs (self feeders),make the nutrients they need from compounds and energy obtained from their environment.

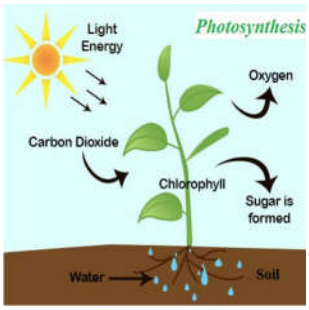
They can generate their own food and present the first trophic level of a food chain.

Autotrophs are divided in to two types

- **Photoautotrophs**
- **Chemoautotrophs**

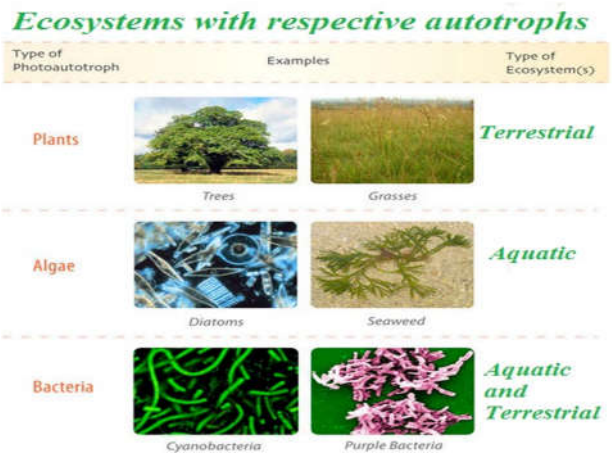
Photoautotrophs

Most producers capture sunlight to produce energy rich Carbohydrates (such as glucose) By **photosynthesis,** which is the way energy enters most ecosystems.

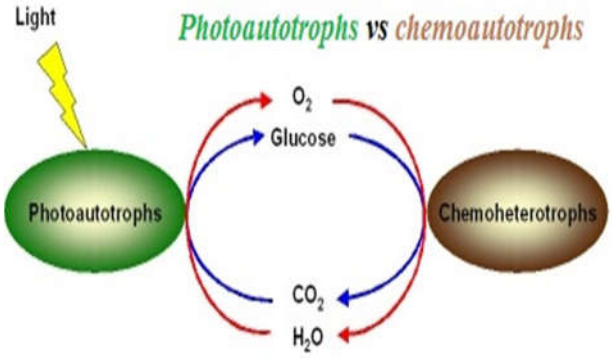


Chemoautotrophs:

Bacteria, can convert simple inorganic compounds from their environment into more complex nutrient compounds by using hydrogen sulphide instead of sunlight through a process called **chemosynthesis.**



Nitrifying bacteria (Nitosomonas and Nitrobacter) are chemosynthetic in nature.



Lecture 22

Terrestrial producers:

On land, most producers are green plants, which generally capture about 1% of the solar energy that falls on their leaves and convert it to chemical energy stored in organic molecules such as carbohydrates.

Terrestrial plants are self supportive plants, so they are strong and stiff in nature. They experience **Gravity** as a main environmental force while **Wind** as an external mechanical force.

Plants are the major habitat-structuring feature in terrestrial ecosystems. Their physical structure governs the patterns of physical environment, organism feeding and activity, and ecosystem processes.

Lecture 23

Aquatic producers

Organisms that manufacture food in aquatic environment.

In freshwater and marine ecosystems, algae and aquatic plants are the major producers. In open water, the dominant producers are *phytoplankton.*

Phytoplankton

Microscopic organisms that float or drift in the water.

Phytoplankton, a great source of food for a wide range of aquatic creatures including whales, shrimp, snails, and jellyfish.

Phytoplankton are of two types

- ❖ Diatoms
- ❖ Dinoflagellates

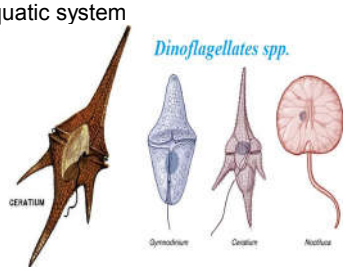


Diatoms

- ○ Unicellular algae
- ○ Shells having interlocking parts.
- ○ Major producers of an aquatic system

Dinoflagellates

- ○ Unicellular
- ○ Double flagella
- ○ 2nd important producers of aquatic systems



Eutrophication

Too much nutrients causes harmful algal blooms (HABs) which are extremely toxic to living creatures (fish, shellfish, birds and mammals).



Red tide

The harmful and toxic blooms of red Dinoflagellates causes the colour of sea water to become red.



Lecture 24

Photosynthesis:

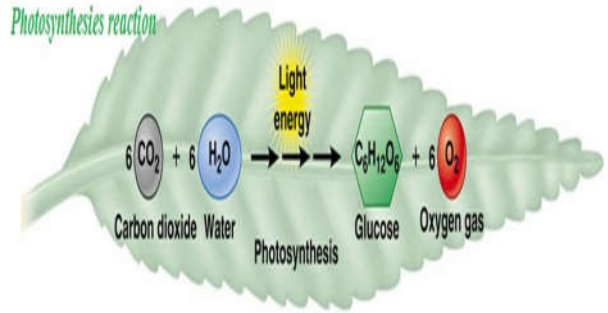
Photosynthesis is the vital process by which producers manufacture food for organisms in an ecosystem.

Infact photosynthesis is a process that starts an ecological food web.

Chlorophyll is the plant pigment that capture light energy directly from sun. It is converted into chemical energy , glucose.

Glucose is then used as a basic energy source by the primary consumers that feeds on plants.

Although hundreds of chemical changes take place during photosynthesis, the overall reaction can be summarized as follows:



Lecture 25

Consumers:

Organisms that depends on producers for purpose of food.

Also named heterotrophs because they can not able to manufacture their own food. They get their nutrients directly or indirectly from producers.

Types of consumers:

1. **Herbivores**
2. **Carnivores**
3. **Omnivores**

1. Herbivores

Primary consumers that feeds on plants directly.

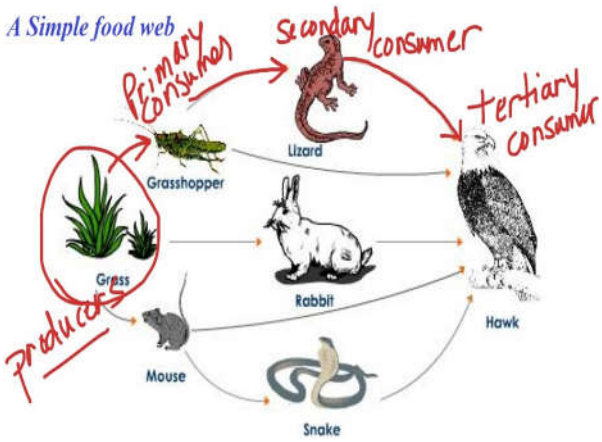
Zooplankton, Cow, zebra, Rabbits, Grasshoppers, Deer etc.



2. Carnivores

Secondary consumers, or carnivores that feeds on meat of herbivores. Spiders, hyenas, birds, frogs, and some zooplankton-eating fish.

Tertiary consumers are carnivores that feed on the flesh of other carnivores. Tigers, wolves, mice-eating snakes, hawks, and killer whales.



Lecture 26

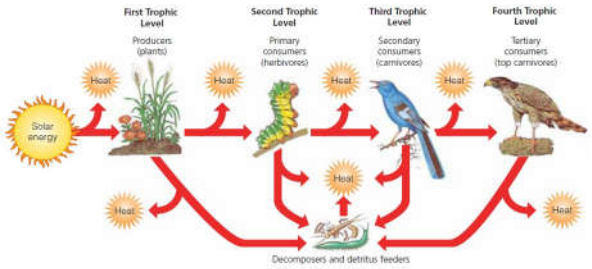
Primary consumer:

A plant-eating animal (an herbivore) that obtains organic molecules by eating producers (autotrophs) or their products.

Herbivores (primary consumers) eat producers (Green Plants)

Primary consumers, or herbivores (plant eaters), are animals such as rabbits, grasshoppers, deer, and zooplankton that eat producers, mostly by feeding on green plants.

- Herbivores are animals that eat only plants.
- They need a lot of energy to stay alive.
- Many have to eat all day long to get enough energy.
- Some herbivores have a special digestive system so they are able to eat/digest grasses.



3. Omnivores

Animals that feeds on both herbivores and carnivores. Humans pigs, foxes, cockroaches, common carp and tilapia.



Few Examples -Manatee

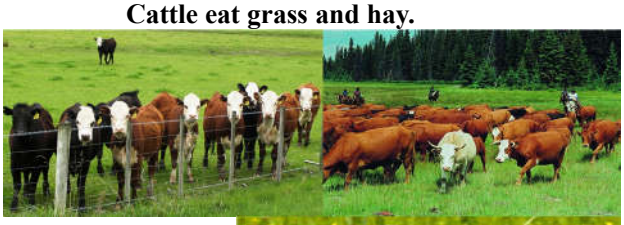
- Aquatic marine
- Herbivorous
- Eat 150 pounds of plants each day!



A rhinoceros eats grass, leaves, twigs and shrubs.



Cattle eat grass and hay.



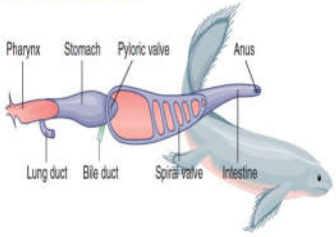
Deer eat corn, twigs, shoots, acorns, fruit, berries, and green plants.



A frog eats insects, earthworms, and spiders.

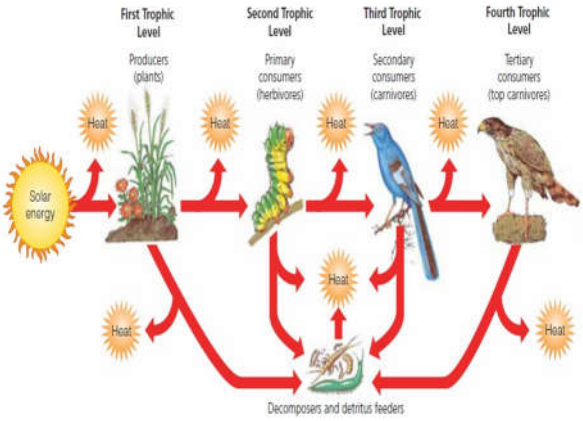


Carnivorous fishes possess long stomach and short intestine.



A giraffe lives in Africa and eats leaves from trees. They especially like the leaves of the Arcadia tree. A giraffe may eat 75 pounds of food each day.





Lecture 27

Secondary consumer:

An animal that preys on and eats a primary consumer. They are also called as **Carnivores** (Meat eaters).

Spiders eat insects.



Lecture 28

Tertiary consumers:

They are third- and higher-level consumers. Tertiary consumers eat the carnivores that ate the herbivores.

Examples

- Tigers
- Wolves
- Mice-eating snakes
- Hawks
- killer whales (orcas)



Lions eat other animals such as gazelles, antelopes, and zebras.



Eagles eat fish, mammals, birds, and snakes. They love fish!



A wolf eats deer, dogs, fish, mice, moose, birds, and other herbivores.

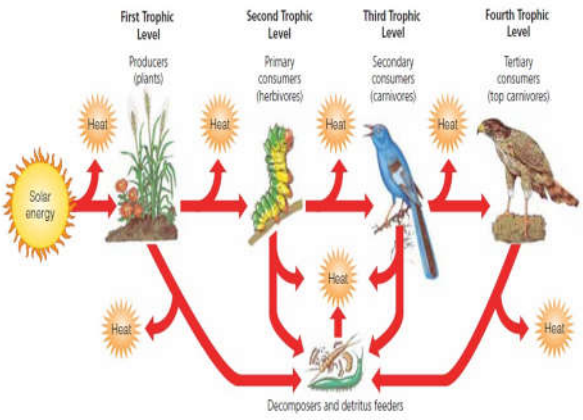
Dentition of Omnivores:

Omnivores have teeth that can perform a number of tasks,

- Tearing
- Ripping
- Chiseling
- Grinding



A pig eats fruit, eggs, corn, and earthworms.



A grizzly bear usually eat things such as grasses, roots, berries, insects, fish, and small or large mammals.



A raccoon eats almost anything including berries, acorns, baby mice, baby birds & eggs, frogs, fish, and even some snakes.



Last but not least – Humans are omnivores!

Lecture 29

Omnivores:

Omnivores (*L. omnius,* all) means animal which eat everything.

Omnivores play dual roles by feeding on both plants and animals. Examples include;

- Pigs
- Foxes
- Cockroaches
- Humans

Lecture 30

Decomposers:

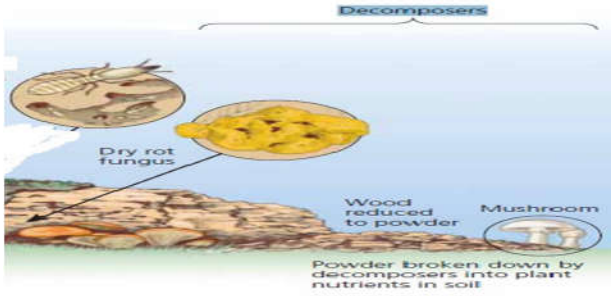
Decomposers break down dead organisms and feces by digesting organic matter extracellularly and absorbing the products of digestion.

Certain types of bacteria and fungi, are Decomposers.

They release nutrients from the dead bodies of plants and animals and return them to the soil, water, and air for reuse by producers.

Decomposers feed by secreting enzymes.

Enzymes speed up the break down of bodies of dead organisms into nutrient compounds such as water, carbon dioxide, minerals, & simpler organic compounds.



Hordes of decomposers & detritus feeders can transform a fallen tree trunk into a powder & finally into simple inorganic molecules that plants can absorb as nutrients.

Conclusion:

- Some organisms produce the nutrients they need.
- Some get their nutrients by consuming other organisms.
- Others recycle the nutrients in the wastes and remains of organisms so that producers can use them again.

Lecture 31

Detritus feeders or **detritivores:**
"di-TRI-tus" meaning debris.

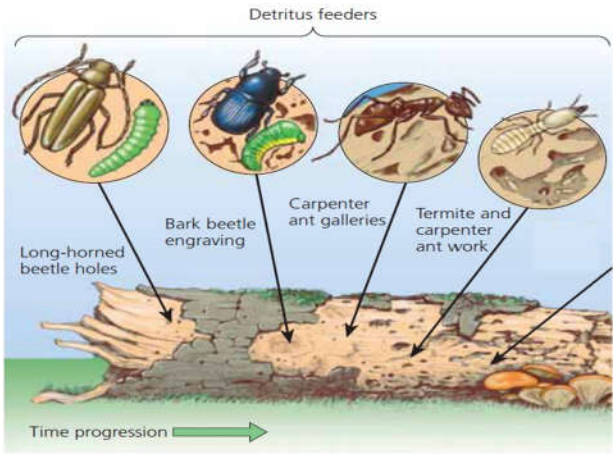
Detritus feeders, or **detritivores,** feed on the wastes or dead bodies of other organisms, which is called as **detritus.**

Examples: **Small organisms such as**

Mites
Earthworms
Some insects
Catfish

Larger scavenger organisms

Vultures.



Lecture 32

Earth's life-support system:

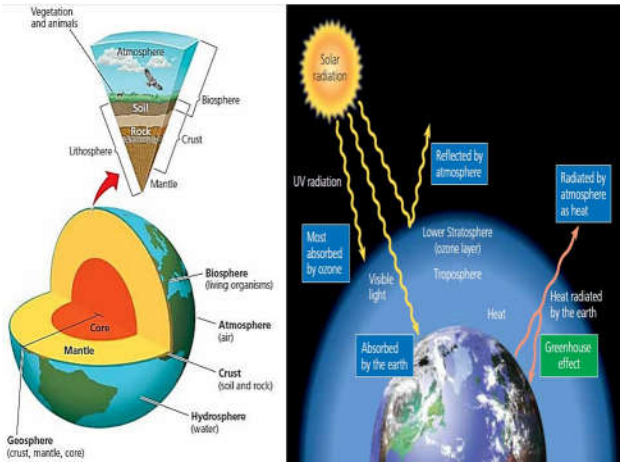
Earth's life-support system consists of four main spherical systems that interact with one another.

1. The atmosphere (air)
2. The hydrosphere (water)
3. The geosphere (rock, soil, sediment)
4. The biosphere (living things)

1. Atmosphere

A thin spherical envelope of gases surrounding the earth's surface.

- Nitrogen (78% of the total volume)
- Oxygen (21%).



2. Hydrosphere

Consists of all of the water on or near the earth's surface. It is found as liquid water (on the surface & underground), ice (polar ice, icebergs, & ice in frozen soil layers called **permafrost**), & water vapor in the atmosphere. Most of this water is in the oceans, which cover about **71%** of the globe.

3. Geosphere: which consists of :

- The earth's intensely hot *core*
- A thick *mantle* composed mostly of rock
- A thin outer *crust.*

4. Biosphere: The biosphere occupies those parts of the atmosphere, hydrosphere, & geosphere where life exists. This thin layer of earth extends from about 9 km (6 miles) above the earth's surface down to the bottom of the ocean.

2. Uniform dispersion: The tendency for populations to be found evenly distributed about their habitat.

This is generally caused by a species ability to survive anywhere in their habitat. They use the resources found immediately around them, & spread out as to use all of the available resources.

3. Random dispersion Distribution of populations in a random fashion through out their habitat.

Generally randomly distributed populations are rare while clumped distribution is common.

Lecture 33

Population Ecology: Dynamics:

Populations differ in factors such as their

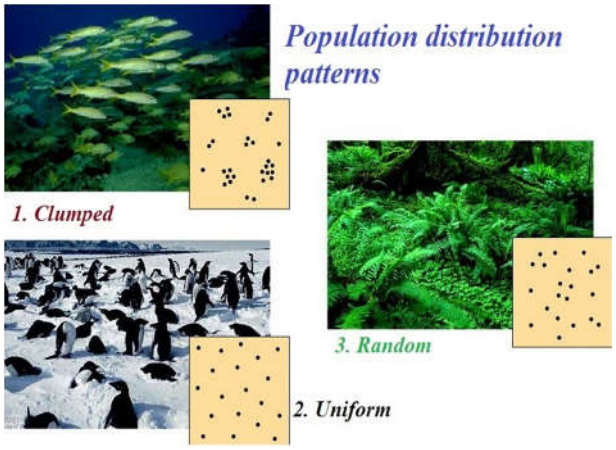
I. Distribution

II. Numbers

III. Age structure

IV. Density

Population dynamics is a study of how these characteristics of populations change in response to changes in environmental conditions.



Such environmental conditions are

- Temperature
- Presence of disease organisms or harmful chemicals
- Resource availability
- Arrival or disappearance of competing species.

General patterns of population distribution or dispersion

1. Clumping
2. Uniform dispersion
3. Random dispersion

1. Clumping

Individuals are found in form of groups or clusters due to uneven distribution of resources.



Lecture 34

Population growth:

Animal populations change over time as a result of

- Birth
- Death
- Dispersal

Biotic potential

Ability of a population to grow under ideal conditions.

Low biotic potential

Large individuals, such as elephants and blue whales.

High biotic potential

Small individuals, such as bacteria and insects.

Intrinsic rate of increase (*r*)

The rate at which the population of a species would grow if it had unlimited resources. Individuals in populations with a high intrinsic rate of growth typically,

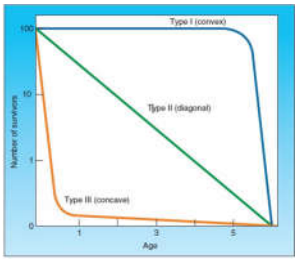
- Reproduce early in life
- Short generation times (the time b/w successive generations)
- Reproduce many times
- Have many offspring each time they reproduce

Environmental resistance

The constraints that climate, food, space, and other environmental factors place on a population is called **environmental resistance.**

It is the combination of all factors that act to limit the growth of a population. Together, biotic potential and environmental resistance determine the **carrying capacity (*K*).**

Survivorship curves are a plot of number of survivors (usually a logarithmic plot) versus age.



Type I curves apply to populations in which individuals are likely to live out their potential life span.

Type II curves apply to populations in which mortality rates are constant throughout age classes.

Type III curves apply to populations in which mortality rates are highest for the youngest cohorts (Group of individuals having same characters).

A population increases by **birth and immigration** (arrival of individuals from outside the population) and decreases by **death and emigration** (departure of individuals from the population).

A population's age structure has a strong effect on population growth. Age structure of a population is usually discussed as

- The **pre-reproductive age**: Not mature enough to reproduce
- The **reproductive stage**: Those capable of reproduction
- The **post-reproductive stage**: Those too old to reproduce

The size of a population will likely increase if it is made up mostly of individuals in their **reproductive stage or soon to enter this stage**. In contrast, a population dominated by individuals past their reproductive stage will tend to decrease over time.

Lecture 35

Carrying capacity:

Carrying capacity (*K*)

The maximum population of a given species that a particular habitat can sustain without being degraded.

The carrying capacity of an area or volume is not fixed.

Factors that influence carrying capacity are,

- Food availability
- Water
- Space
- Environmental conditions

The growth rate of a population decreases as its size comes near the carrying capacity of its environment because resources such as food, water, and space begin to decrease.

A drought can decrease the amount of vegetation growing in an area supporting deer & other herbivores, & this would decrease the normal carrying capacity for those species.

Carrying capacity plays a vital role in sustainability and protection of an environment.

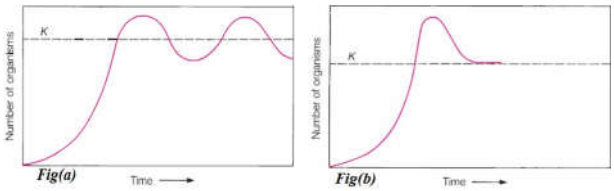
when a population exceeds the carrying capacity of an area, it causes damage that reduces the area's carrying capacity.

Lecture 36

Exponential growth

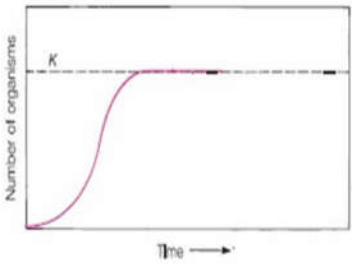
A rapid increase in number of individuals of a population at a constant rate of growth. ***Exponential* or *geometric growth*** starts slowly but then accelerates as the population increases, because the base size of the population is increasing.

During its exponential growth phase, a population may overshoot carrying capacity because demand on resources may lag behind population growth. When that happens, numbers may cycle on either side of *K fig(a),* or form a J-shaped curve fig*(b)*.



Reproductive potential
Ability of individuals to reproduce under ideal or optimum conditions. Exponential growth cannot occur indefinitely.

Logistic growth curves reflect limited resources placing an upper limit on population size.



At carrying capacity *(K),* population growth levels off, creating an S-shaped curve.

Factors influencing reproductive potential

- Number of offspring produced
- The likelihood of survival to reproductive age
- Duration of the reproductive period
- Length of time it takes to reach maturity

Lecture 37

Logistic population growth:

Decrease in growth of rapidly growing populations due to limited resources, until they reach their carrying capacity is termed as logistic population growth.

Logistic growth involves rapid exponential population growth followed by a steady decrease in population growth until the population size levels off.

After leveling off, a population with this type of growth typically fluctuates slightly above & below the carrying capacity.

This slowdown occurs as the population encounters environmental resistance from declining resources and other environmental factors and approaches the carrying capacity of its environment.

Lecture 38

Population regulation:

Demography:

Study of human population and the factors that regulate the growth of population.

Population of any ecosystem is regulated by certain biotic and a biotic factors which are necessary for the growth of population.

Factors regulating population,

- ❖ Birth rate
- ❖ Death rate
- ❖ Food
- ❖ Climate
- ❖ Water
- ❖ Competition
- ❖ Predators
- ❖ Emigration
- ❖ Immigration
- ❖ Disease

Metapopulation:

A group of populations of same species which are separated by space. Individuals can move from one population to other. Extinction and colonization are the main process that regulate the Metapopulation.

Lecture 39

Population density:

Population density is the number of individuals in a population found in a particular area. Population density & population size are the two main factors which are used to study any population in an ecosystem.

Higher population density

▪May help sexually reproducing individuals find mates, but it can also lead to increased competition for mates, food, living space, water, sunlight, and other resources.

▪Help to shield some members from predators, but it can also make large groups such as schools of fish vulnerable to human harvesting methods.

- Close contact among individuals in dense populations can increase the transmission of parasites & infectious diseases.
- Smaller organisms have high population density than larger organisms.

Low population density:

- Less competition for food, living space, water, sunlight, and other resources.
- Individuals with low population density face difficulty in finding mates as compared to individuals with higher population density.
- Less adaptability to environmental changes.

Lecture 40

Density-independent factors:

Factors that influence the No. of animals in a population & their effect is not dependent on the density of the population. So density independent factors exert a strong effect on population size instead of population density of a particular area.

Some of these factors are,

- Weather
- Earthquake
- Floods
- Hurricanes
- Fire
- Pollution
- Habitat destruction
- Climate changes



Weather conditions often limit populations. A severe freeze in late spring can kill many individuals in a plant population or a population of monarch butterflies regardless of their density.

An extremely cold winter with little snow cover may devastate a population of lizards hidden beneath the litter of the forest floor.

Human activities, such as construction and deforestation, often affect animal populations in a similar fashion.

Lecture 41

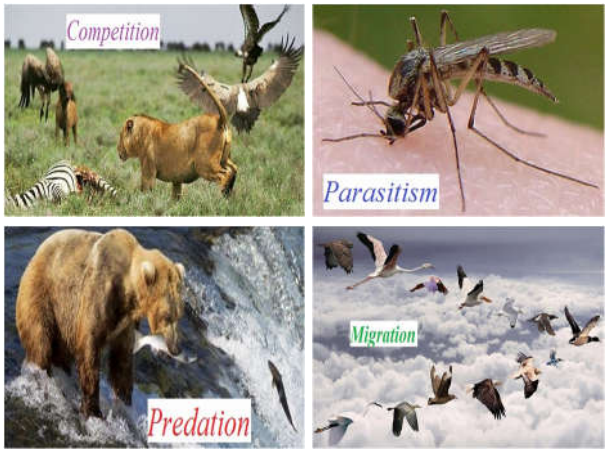
Density-dependent factors:

Factors that influence both, the population size & population density are termed as density dependent factors.

Some factors that limit population growth have a greater effect as a population density increases.

Factors that influence population density are,

- ❖Competition
- ❖Disease
- ❖Predation
- ❖Parasitism
- ❖Food
- ❖Migration



Density-dependent factors tend to regulate a population at a fairly constant size, often near the carrying capacity of its environment.

Density-dependent factors are more severe when population density is high (or sometimes very low) than they are at other densities.

Animals often use territorial behavior, song, & scent marking to tell others to look elsewhere for reproductive space.

These actions become more pronounced as population density increases and are thus density dependent.

Lecture 42

Impact of human population on environment:

Human population is increasing day by day and at present it is about **7.4 billion**.

This increase in human population has increased the demand of natural resources like food, space, water and energy etc. Due to overconsumption, natural resources are decreasing at an alarming rate.

Human population growth has severally affected the environment By putting pressure on thenatural resources.

Human impact on environmental health,



- Habitat destruction
- Habitat fragmentation
- Deforestation
- Pollution
- Soil erosion
- Ozone layer destruction
- Invasive species
- Oil spillage
- Coral reef destruction

Lecture 43

Atmosphere; Its Composition and role in ecosystem:

The mixture of gases that surrounds the solid earth is called the atmosphere.

Although it represents a very small fraction of the weight of the earth, it is very important because it is essential to life and is highly reactive.

Circulates and plays an important role in the evolution of landscapes.

Composition:

- Nitrogen (78% of the total volume of air)
- Oxygen (21%).
- 1% of the air includes water vapor, carbon dioxide, & CH_4, all of which are called greenhouse gases, because they trap heat & thus warm the lower atmosphere.

Nitrogen:

- 78% of the total volume of air
- Relatively inert
- Unavailable to plants directly; therefore it must undergo chemical changes to make it useful to producers (plants).

Oxygen:

Oxygen is chemically reactive and important in the

- Breathing
- Weathering of rocks
- The decay of organic matter
- Combustion.

Carbon dioxide:

Carbon dioxide plays an important role by

- Tapping heat
- Causing the greenhouse effect, which keeps the earth warm and livable, for the most part.
- Raw material for photosynthesis

Water vapor

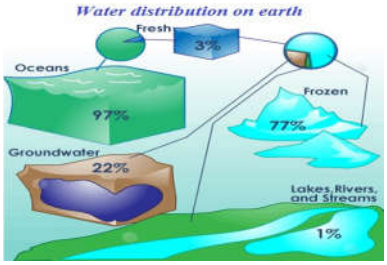
- Water vapor plays an extremely important role in the hydrological cycle.
- Water vapors are highly variable. Air in desert areas may contain only 1 percent vapor by volume; in tropical areas, however, where the air is warm and moist, the content can be as high as 4 percent.

Lecture 44

Water (abiotic factor)

Water is medium of life. Without water life is impossible. About **71%** of earth surface is covered with water. **97%** of this water is saltwater present in oceans while only **3%** is available as freshwater.

The overall distribution of water on the earth surface is depicted by this diagram.



Water importance:

- Photosynthesis
- Irrigation
- Domestic use
- Industrial use for power generation
- Recreational purpose
- Drinking
- Transport of nutrients throughout body
- Removal of waste from body
- Lubricate body tissues
- Maintains the temperature of body
- Essential for proper functioning of body
- Maintenance of pH

Lecture 45

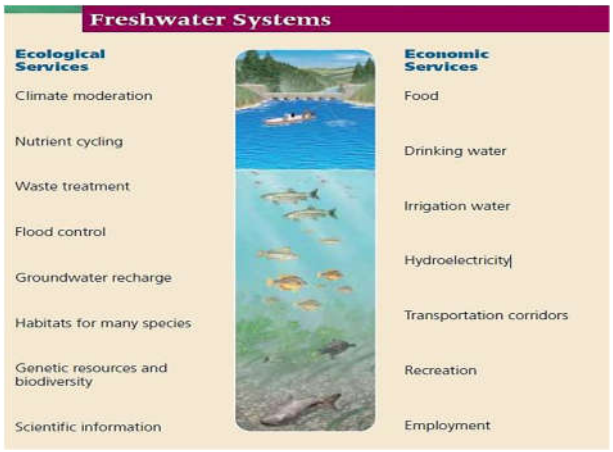
Freshwater ecosystem:

Freshwater Division

Freshwater ecosystem includes

1. **Lentic water bodies or systems**
2. **Lotic water bodies or systems**

- Cover almost about **3%** of the earth's surface.
- They provide a number of important ecological and economic services to humans.
- Possess diverse flora and fauna.



Lecture 46

Lotic water bodies:

The study of freshwater is known as limnology.

Those water bodies that hold running water are termed as lotic water bodies.

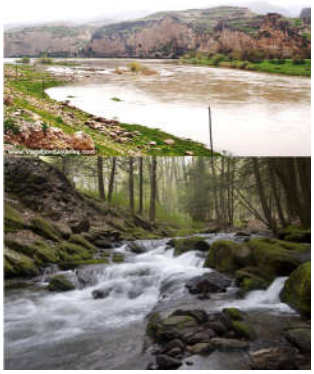
High dissolved oxygen due to continuous flow of water.

Examples of lotic water bodies are

1. Rivers
2. Streams
3. Springs

Lotic water bodies receive water supply from

- Precipitation
- Snow melt
- Springs



Rivers

A deep fast flowing freshwater body with high dissolved oxygen content.

Streams

A shallow fast flowing water body smaller than rivers.

Streams receive nutrients from

- ❖ Falling leaves
- ❖ Animal feces
- ❖ Insects
- ❖ Biomass washed into streams during heavy rainstorms or by melting snow.

Thus, the levels and types of nutrients in a stream depend on what is happening in the stream's watershed.

Springs

A freshwater body in which water flows out of the ground.



Streams receive their water from

- ○ Precipitation
- ○ Melting snow
- ○ Groundwater

They lose water by

- Evaporation
- Sinking into the ground
- Discharge at their terminus or mouth.

The velocity of a stream depends on following factors

i. Volume of water
ii. Stream channel width and depth
iii. Slope or gradient of stream

Lecture 47

Streams:

A small, shallow and fast moving water body that supports variety of aquatic flora and fauna.

A watershed, or drainage basin, is the land area that delivers runoff, sediment, & dissolved substances to a stream.

In many areas, streams begin in mountainous or hilly areas that collect and release water falling to the earth's surface as rain or snow melts during warm seasons. Streams have low depth and narrow banks.

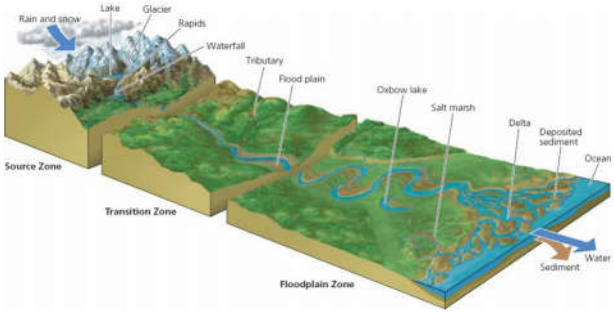
Lecture 48

Rivers:

Small streams join to form rivers, & rivers flow downhill to the ocean. Rivers & streams are powerful transporting agents as they roll & push material on their bed down the channel. The suspended matter give river water a muddy look.

The downward flow of surface water and groundwater from mountain to the sea typically takes place in three zones characterized by different environmental conditions:

- Source zone
- Transition zone
- Floodplain zone



Three zones in the downhill flow of water:

- *Source zone* containing mountain (headwater) streams
- *Transition zone* containing wider, lower-elevation streams
- *Floodplain zone* containing rivers, which empty into the ocean

Lecture 49

Lentic water bodies:

Standing bodies of freshwater that supports variety of life.

Wind action is very vital in these water bodies because it increases the content of dissolve oxygen that is necessary for the aquatic life in these water bodies.

Examples of such water systems are

Ponds

Lakes

Wetlands

These still water bodies possess following zones,

- Littoral zone
- Limnetic zone
- Profundal zone
- Benthic zone

Overturn

The mixing of water from the bottom of the lake with the water close to the surface of lake.

This occurs during spring and fall. Lake overturn enhances the dissolve oxygen content of lake that is necessary for survival of life present in the lake water.

Lecture 50

Lakes:

Lakes are large natural bodies of standing freshwater formed when precipitation, runoff, or groundwater seepage fills depressions in the earth's surface.

Lake formation: Factors that are vital in lake formation are

- Glaciation
- Crustal displacement
- Volcanic activity

Freshwater lakes vary tremendously in

- Size
- Depth
- Nutrient content

Deep lakes normally consist of four distinct zones

1. Littoral
2. Limnetic
3. Profundal
4. Benthic

Littoral zone:

A shallow water area near the shore where maximum light can penetrate.

Littoral zone possess

- High biological diversity
- Ample sunlight
- Inputs of nutrients

Limnetic zone:

Open water area away from shore where still enough light can penetrate.

- Main photosynthetic body
- Produces food and oxygen for consumers
- Most abundant organisms are microscopic phytoplankton and zooplankton

Profundal zone: A deep zone of standing body of water where light can not penetrate.

- No photosynthesis.
- Oxygen levels are often low
- Cool and dark water with fish species is found

Benthic zone: The bottom of the lake Containing organisms called benthos.

- ❖ Decomposers
- ❖ Detritus feeders
- ❖ Invertebrates
- ❖ Some fishes

- Often deep
- Steep banks
- Glaciers and mountain streams supply water
- Little sediment or microscopic life
- Crystal-clear water
- Small populations of phytoplankton and fishes such as smallmouth bass and trout
- Low net primary productivity.



Over time, sediment, organic material, and inorganic nutrients wash into most oligotrophic lakes, and plants grow and decompose to form bottom sediments.

Crater Lake in the U.S. state of Oregon is an example of an *oligotrophic lake* that is low in nutrients. Because of the low density of plankton, its water is quite clear.



Lecture 51

Oligotrophic lakes:

Ecologists classify lakes according to their

1. Nutrient content
2. Primary productivity.

Lakes that have a small supply of plant nutrients are called **oligotrophic lakes.**

Oligotrophic lakes are poorly nourished lakes.

Lecture 52

Eutrophic lake:

A lake with a large supply of nutrients needed by producers is called a **eutrophic lake.**

They are also designated as well-nourished lakes because they receive maximum nutrients.

Eutrophic lake usually have

- ○ Shallow depth
- ○ Murky brown or green water
- ○ High turbidity
- ○ High net primary productivity.

Hypertrophic lake

Lake having excessive amounts of dissolved nutrients.

Mesotrophic lake

Alake having moderate amounts of dissolved nutrients.

A *eutrophic lake* having an excess of plant nutrients. Its surface is covered with mats of algae and cyanobacteria.



Wetlands are important habitats for

- Game fishes
- Muskrats
- Otters
- Beavers
- Migratory waterfowl



Lecture 53

Inland wetlands:

Inland wetlands are lands covered with freshwater all or part of the time (excluding lakes, reservoirs, & streams) & located away from coastal areas.

Some examples of inland wetlands are

- Marshes
- Swamps
- Prairie potholes
- Floodplains

Some wetlands are covered with water year-round.

Some wetlands stay dry for years before water covers them again.

Scientists use the composition of the soil or the presence of certain plants to determine that a particular area is a wetland.

Seasonal wetlands

Remain under water for only a short time each year.

- Prairie potholes
- Floodplain wetlands
- Bottomland hardwood swamps

Lecture 54

Ecological and economic services of a wetland:

Wetlands are vary valuable natural habitats in different areas of world. They provide a number of free ecological and economic services to humans & other living organisms.

Wetland services

- Filtering and degrading toxic wastes and pollutants
- Reducing flooding and erosion
- Helps to replenish stream flows during dry periods
- Helps to recharge groundwater aquifers
- Helps to maintain biodiversity
- Provide habitats for a variety of species
- Supply valuable products such as fishes and shellfish, blueberries, cranberries, wild rice, and timber
- Provide recreation for birdwatchers, nature photographers, boaters, anglers, & waterfowl hunters.

Lecture 55

Brackish water:
Estuary

A semi-enclosed body of mixed water where salt water from the sea mixes with fresh water from the land. That mixture of water is known as **estuarine water or brackish water.**

In an estuary, the amount of water mixing depends on the

- Amount of runoff from the land
- The tidal range
- The wind

Freshwater inflow provides a rich basis for life, making opportunities for commercial and recreational fishing for finfish, molluscs, and crustaceans.

Types of Estuary,

1. Bar built estuary
2. Fjords
3. Tectonic estuary
4. Coastal plain estuary

Fjords

A type of estuary that is formed in river valleys due to the action of valley glaciers. Mostly found in Norway.



Lecture 56

Coastal wetlands:

A productive waterlogged area present between land & open sea is known as **coastal wetland**. These coastal aquatic systems provide important ecological & economic services.

Mangrove forest:

They are some of the earth's most productive ecosystems because of,

- High nutrient inputs from rivers and nearby land
- Rapid circulation of nutrients by tidal flows
- Ample sunlight penetrating the shallow waters



The tangled roots and dense vegetation of mangrove forests act like shock absorbers to reduce damage from storms. They also provide a highly complex habitat for a diversity of invertebrates and fishes.

Sea grass beds:

Another component of coastal marine biodiversity.

- Support at least 60 species of plants that grow underwater.
- Highly productive and physically complex systems that support a variety of marine species.
- Stabilize shorelines and reduce wave impacts.

Importance of coastal wetlands

- Maintain water quality
- Filter toxic pollutants, excess plant nutrients, & sediments,
- They provide food,
- Habitats, & nursery sites for a variety of aquatic & terrestrial species.
- They also reduce storm damage & coastal erosion by absorbing waves .
- Supply timber and fuel wood to coastal communities.

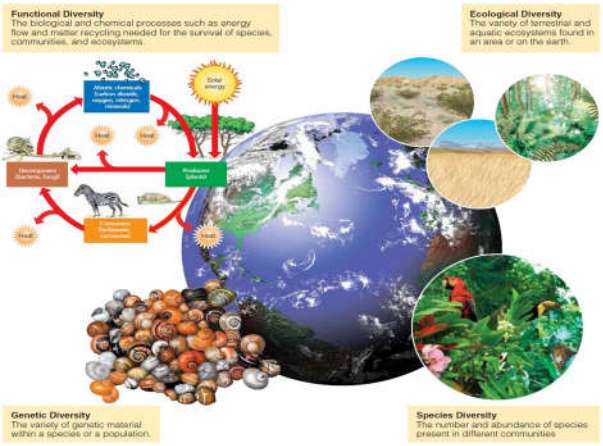
Lecture 57

Marine-water ecosystem

Marine aquatic systems are a great source of biodiversity. They include many different ecosystems, which host a great variety of species, genes, biological & chemical processes that occur in this ecosystem.

Marine water ecosystem sustains four major components of the earth's biodiversity.

1. Ecological diversity
2. Functional diversity
3. Species diversity
4. Genetic diversity



2. Open ocean:

The part of ocean that is deep & away from the coastal zone is termed as open ocean. On the basis of the light penetration open ocean is divided into three vertical zones.

1. Euphotic zone
2. Bathyal zone
3. Abyssal zone

Euphotic zone:

Upper part of open ocean where maximum light can penetrate.

- Phytoplankton carry out about 40% of the world's photosynthetic activity
- High level of dissolve oxygen
- Fish species found in this zone are swordfish, sharks, and bluefin tuna.

Bathyal zone:

Middle part of open ocean that receive a very little amount of sunlight.

-Very little or no photosynthetic activity

-Zooplankton & smaller fishes are the inhabitants of this zone.

Lecture 58

Marine water life zones:

Marine life is found in three major life zones:

1) The coastal zone
2) Open sea
3) Ocean bottom

1. Coastal zone:

- Warm
- Nutrient-rich
- Shallow water
- Makes up less than 10% of the world's ocean
- Contains 90% of all marine species.

Abyssal zone:

The deepest zone of ocean that contains cold & dark water.

-No photosynthetic activity.

-Contains enough nutrients to support large number of species

3. Ocean floor:

The base of an ocean where most organisms of the deep waters get their food from marine snow.

Showers of dead & decaying organisms drifting downward from upper lighted levels of the ocean are known as **marine snow**.

Deposit feeders:

some of organisms found in deep ocean are deposit feeders. These organisms, take mud into their guts & extract nutrients from it. some worms species are deposit feeders.

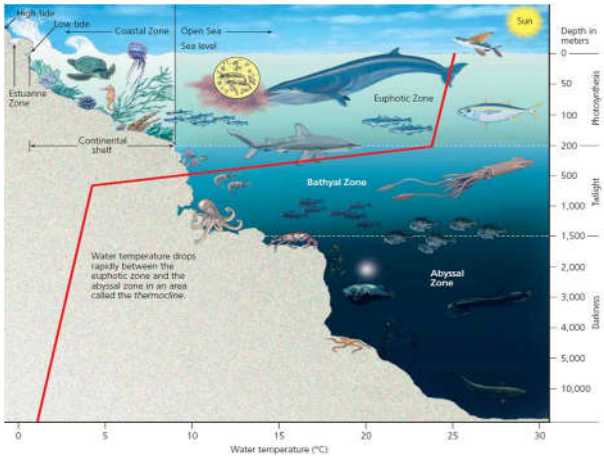
Filter feeders:

Other organisms found in deep oceans are filter feeders. They take in large amount of water into the body and then filter nutrients from it. Organisms like oysters, clams, and sponges are filter feeders.

- Reduced storm impact (mangroves, barrier islands, coastal wetlands)
- Habitats and nursery areas
- Genetic resources and biodiversity
- Scientific information

Economic services:

- Food
- Animal and pet feed
- Pharmaceuticals
- Harbors & transportation routes
- Minerals
- Oil and natural gas
- Building materials
- Coastal habitats for humans
- Recreation
- Employment



Lecture 60

Aquatic life zones:

Saltwater and freshwater life zones possess several major types of organisms. Most Aquatic Species Live in top ,middle, or bottom Layers of Water.

- **Plankton**
- **Nekton**
- **Benthos**
- **Decomposers**

Lecture 59

Importance of marine ecosystems:

About **97%** of total volume of water on earth surface belongs to sea water. Oceans provide valuable ecological and economic services. The overall economic benefit from marine coastal ecosystems is over **$12 trillion** per year.

Ecological services

Climate moderation

CO2 absorption

Nutrient cycling

Waste treatment

Plankton:

A microscopic swimming and free floating organisms in water are termed as planktons.

- Phytoplankton
- Zooplankton
- ultraplankton

Phytoplankton

Microscopic free floating plants are called as phytoplankton. Includes different types of algae that act as a producer and supports most aquatic food webs.

Zooplankton:

A microscopic drifting animals are known as zooplankton.

- Primary consumers (herbivores) that feed on phytoplankton
- Secondary consumers that feed on other zooplankton.
- They range from single-celled protozoa to large invertebrates such as jellyfish.

Ultraplankton:

A very small drifting plankton having size less than 2 micrometer are called as ultraplankton.

Includes small photosynthetic bacteria that carry out 70% of the primary productivity near the ocean surface.

Nekton: This class of organisms include active swimmers that act as a consumers. Important examples of nektons are fish, turtles and whales.

Benthos:

- **Bottom dwellers**
- **Oysters, which anchor themselves to one spot**
- **Clams & worms, which burrow into the sand/mud**
- **Lobsters & crabs, which walk about on the sea floor**

Decomposers: Mainly bacteria & fungi that break down dead & decaying organic matter & release nutrients. These nutrients in turn are used by the primary producers for manufacturing food.

Lecture 61

Coral reefs:

Corals are tiny living animals that belong to group of organisms called Cnidarian.

There are two main types of corals

- Soft corals
- Hard corals

Coral reefs are produced by the large mass of calcium carbonate that is secreted by the corals in marine water.

Coral reefs are an amazing centre of aquatic biodiversity.

Importance of coral reefs:

- Provide natural habitat
- Economic benefits
- Food
- Medicine
- Recreation
- Breeding grounds
- Nursing grounds



A coral reef with a large number of different species.

Lecture 62

Rocky and sandy shores:

The area of shoreline between low & high tides is called the **intertidal zone**. These low & high tides are produced due to gravitational pull of moon & sun. organisms in this zone must be able to survive against the wave impact & changing levels of salinity.

Rocky shores: Rocky shores face a huge impact of waves, so a large number of species occupy different niches in the intertidal zone in response to following changing environmental conditions,

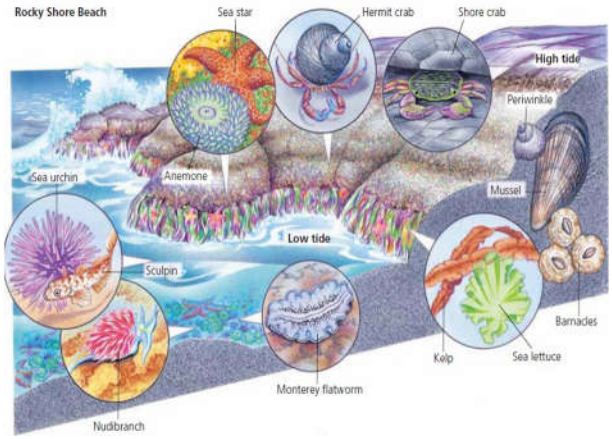
Rocky and sandy shores following changing environmental conditions,

- Temperature
- Water flow
- Salinity

Sandy shore: Sandy beaches & their adjoining coastal wetlands are a home to a variety of shorebirds that feed in specialized niches on crustaceans, insects, and other organisms. Many of these species also live on ***barrier islands***-Low, narrow, sandy islands that form offshore, parallel to some coastlines.

In sandy shore areas organisms can survive by adopting following adaptations,

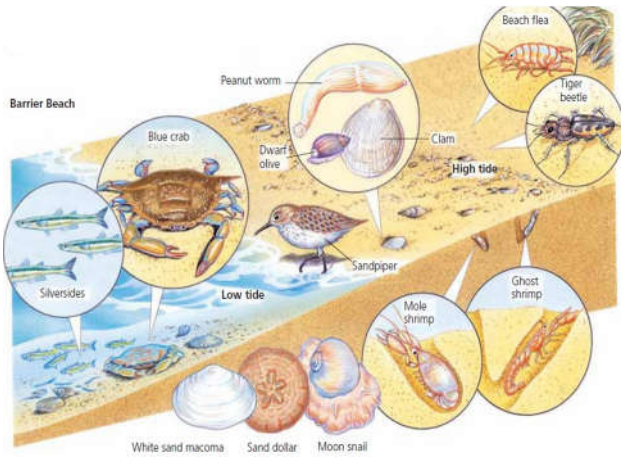
- Burrowing in sand
- Digging in sand
- Tunnelling in sand



- Chemical weathering
- Mechanical weathering
- Biological weathering

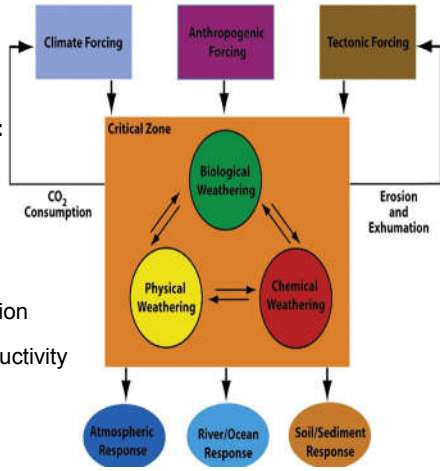
In cold climates mechanical weathering is dominant, while in tropical climates chemical weathering is dominant.

As rocks break down, Lichens are the pioneers to occupy succeeded by mosses & quickly by other plants that take the opportunity to grow in cracks & crevices. As the plants decay they aid in the soil-forming process.



Soil importance:

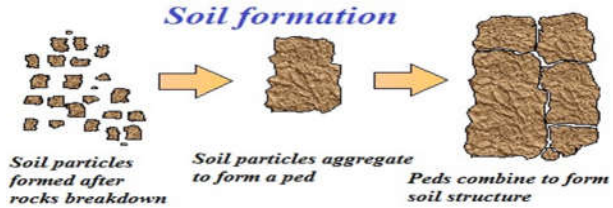
- Nutrients
- Water
- Habitat
- Seed germination
- Biological productivity



Lecture 63

Soil (abiotic factor):

Residual product of the chemical, physical and biological breakdown of rock material that supports plant growth.



Weathering is an important phenomenon in soil forming process. **Weathering** is Process of decomposition & disintegration that causes the rocks to break down in a natural way.

Lecture 64

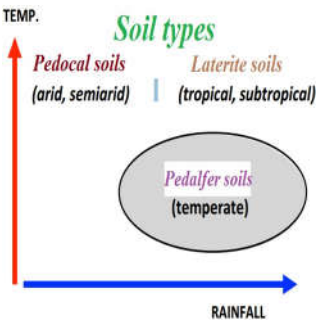
Soil types:

Type of a soil can be determined by,

- Composition of the material
- Topography
- Climate
- Time length

In general soils are classified into 2 main groups on the base of climate,

1. **Pedalfer soils**
2. **Pedocal soils**



1. Pedalfer soils: The term *Pedalfer* is a combination of *ped* (soil), *al* (aluminium), & *fer* (iron).

- Acidic soils formed in temperate (wet) climates.
- Extensive leaching activity.
- Supports growth of deciduous forests and tall grasses.

2. Pedocal soils: *ped* for soil, *cal* for calcium carbonate.

- Soils that are formed in dry (arid & semiarid) climates & are basic in nature.
- Less leaching activity.
- Promotes growth of desert shrubs & small & medium grasses.

O-horizon: Uppermost zone of soil surface where fallen leaves and other plant matter is deposited.

A-horizon: Zone of leaching because percolating rain picks up the soluble materials & transport it downward to B-horizon.

B-horizon: Zone of accumulation because all the leaching materials are accumulated in horizon.

C-horizon: it is composed of broken bedrock material that is merged with underlying solid & hard bedrock material.

Laterite soil:

A special type of Pedocal that is bright red & forms in tropical & subtropical climates with heavy rain & high temperature.

Caliche:

A tough cemented layer developed by the dense mass of calcium carbonate.

Factors that influence these horizons are,

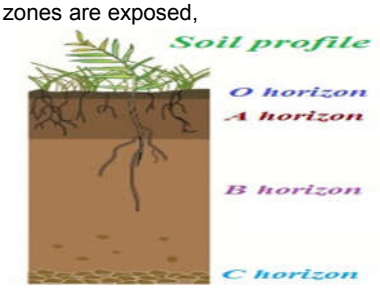
- Erosion
- Wind
- Precipitation
- Human activity
- Topography

Lecture 65

Soil Profile:

A vertical section of soil that tells about various layers of the soils as zones. These zones are named as soil horizons. In a typical soil profile, four zones are exposed,

1. O-horizon
2. A-horizon
3. B-horizon
4. C-horizon



Lecture 66

Temperature (abiotic factor):

Temperature controls metabolic rate as well as overall activity of an individual. For example normal body temperature of humans, goat & birds is, ***98.6°F, 103°F, 105°F*** respectively. Temperature regulates the activity of cold blooded and warm blooded animals.

Warm blooded animals:

Animals that maintain their internal body temperature constant. Also named homeotherms because they are able to stabilize their body temperature. Birds and mammals.



Cold blooded animals:

Animals whose internal body temperature changes with respect to external environmental temperature. Also called Poikilotherms because they are at mercy of environmental temperature. Amphibians, fish and reptiles.



Importance of temperature:

- Metabolism
- Seed germination
- Opening and closing of flowers
- Seasonal falling of tree leaves.

- Growth and development
- Animals migration due to seasonal changes in temperature
- Reproduction
- Temperatures changes in desert ecosystem

(hot day and cool nights)

Lecture 67

Thermoregulation:

Ability of an organism to regulate its body temperature.

Temperature influences many body activities,

- Metabolism
- Growth
- Reproduction

Mechanism of thermoregulation is influenced by

- Availability of food
- Water
- Shelter

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

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

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 68

Ectotherms:

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

Cold blooded animals:

- Fish
- Amphibians
- Reptiles
- Invertebrates



Lecture 69

Endotherms:

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 70

Torpor:

A condition in which the rate of metabolism, circulation and respiration of individuals decreases when they are not feeding. Torpor allows the individual to survive in non feeding period.

Torpor enables these animals to survive in a condition in which they are unable to feed. It is found in bats, hummingbirds, & other animals.



Torpor is generally found in small bird & mammals because they have to expend less energy to return to normal body functions.



Torpor is a mechanism that is under physiological control.

Animals can regain its normal body activities in a short period of time after remaining in a state of torpor.

Lecture 71

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 72

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 73

Aestivation:

Aestivation or summer sleep is a period of inactivity & low metabolic rate in animals in response to high temperature & dry season. Aestivation is common in many invertebrates, reptiles, & 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 74

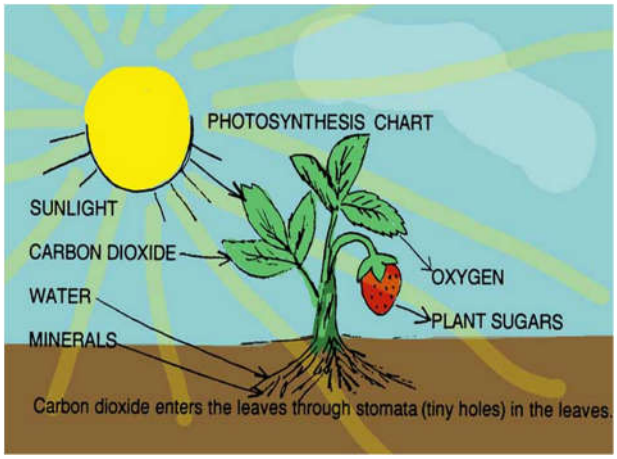
Light (abiotic factor):

Plants receive light energy directly from sun to produce food by the process of photosynthesis. With the help of light energy plants can produce food & also O_2 for all living organisms which are dependent on plants for this purpose.

Photosynthesis

carbon dioxide + water + light energy = glucose + oxygen

Product of photosynthesis are food & oxygen. Both these are valuable for animals survival. Animals take oxygen & expel CO_2 which is turn used by the plants for photosynthesis.



On the base of wavelength there are two types of electromagnetic radiations.

1. Electromagnetic radiations with short wavelength
2. Electromagnetic radiations with long wavelength

1. Electromagnetic radiations with short wavelength

- Gamma rays
- X rays
- (UV) ultraviolet radiation

2. Electromagnetic radiations with long wavelength

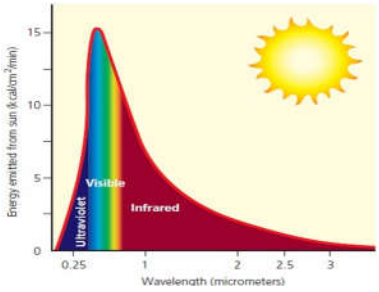
- Visible light
- Infrared radiation (IR)

Light plays a vital role in following life running processes:

- Seed germination
- Transpiration
- Photoperiodism
- Growth
- Reproduction
- Modification in leaf structures
- Migration
- Communication

Electromagnetic radiations of short wavelength have more energy content than the electromagnetic radiations of long wavelength. Visible light makes up most of the spectrum of electromagnetic radiation emitted by the sun.

The spectrum of electromagnetic radiation released by the sun consists mostly of visible light.



Lecture 75

Electromagnetic radiations:

A form of kinetic energy, in which energy travels in the form of a *wave* as a result of changes in electric and magnetic fields. Human eye can detect electromagnetic radiations of wavelength range 380-760nm.

There are many different forms of electromagnetic radiation, each having a different wavelength and energy content. Wavelength is the distance between successive peaks or troughs in the wave of light.

Lecture 76

Energy quality:

It determines the ability of an energy source to do useful work. Energy manifest itself in several forms such as heat, mechanical, electrical, magnetic, kinetic (in motion), potential, etc. Some types of energy are more useful than the others.

Two types of energy on the base of energy Quality,

1. **High quality energy**
2. **Low quality energy**

High quality energy:

High-quality energy is concentrated form of energy and has a high capacity to do useful work.

Examples are,

- Very high-temperature heat
- Nuclear fission
- Concentrated sunlight
- High-velocity wind
- Energy released by burning natural gas, gasoline, or coal.

Low quality energy:

A dispersed form of energy that has a little capacity to do useful work. Heat energy of moving water molecules is of low quality because it is dispersed in water molecules that lowers its temperature.

The total amount of heat stored in the Atlantic ocean is greater than the amount of high quality chemical energy stored in all the oil deposits of Saudi Arabia. But wide dispersion of this ocean's heat energy makes it unable to do useful work.

Lecture 77

Community ecology:

Community ecology determines overall interactions of different populations of a community with one another as well as interaction with the surrounding environment.

Important attributes or characteristics of community ecology are,

- ❖Species composition
- ❖Species richness
- ❖Species diversity and dominance

Vital interactions in community ecology that shape its structure are,

- o Competition
- o Predation
- o Parasitism
- o Mutualism

Lecture 78

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 & 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 & 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 79

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, & 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 & evenness increase, species diversity also increases.

Lecture 80

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 high-dominance 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 81

Succession:

The change in composition & 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 & 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 & their populations become more numerous, while populations of other species decline & may even disappear.

The process of ecological succession occurs due to,

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

Lecture 82

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**.

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.

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

Death, decay, and additional nutrients add to the community. Over thousands of years nutrients accumulate, & 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, & productivity declines in the course of succession.

Types of succession:

Succession is of two types

1. Primary succession
2. Secondary succession

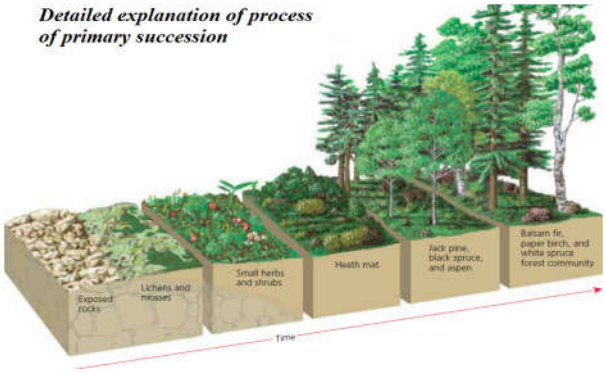
Succession benefits:

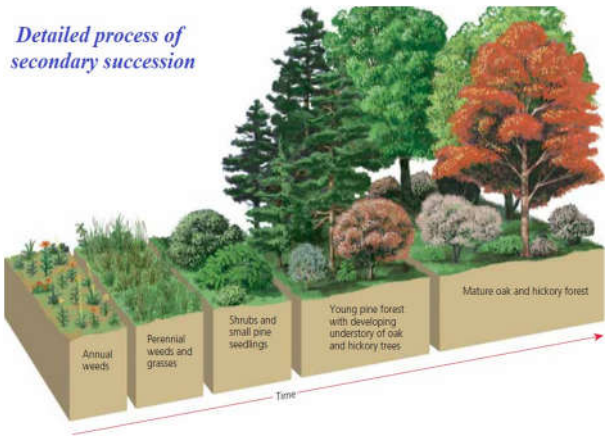
- Development of an ecosystem.
- Sustainability of ecosystem.
- Recovery of ecosystem from damage caused by humans or any other natural disaster.
- Balance of nature.

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 83

Secondary succession:

Development of an ecosystem in an area where previous existing ecosystem was disturbed by climatic & 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 ecosystem has been disturbed, removed,/destroyed, but some soil/bottom sediment remains. This remaining soil provide a framework that initiates the pioneers to grow.

Candidates for secondary succession include

- Abandoned farmland
- Burned or cut forests
- Heavily polluted streams
- 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 84

How Living systems are sustained:

All living systems from a cell to the biosphere are dynamic systems that are constantly changing in response to changing environmental conditions.

The composition of communities and ecosystems changes due to

- Continents movement
- Climate changes
- Natural disturbances
- Succession

Living systems contain complex networks of positive and negative feedback loops that interact to provide some degree of stability, or sustainability, over each system's expected life span.

This stability, or capacity to withstand external stress and disturbance, is maintained only by constant change in response to changing environmental conditions.

A negative, or corrective, feedback loop causes a system to change in the opposite direction from which it is moving. A simple example is a thermostat, a device that controls how often, & how long a heating or cooling system runs.

A positive feedback loop causes a system to change further in the same direction from which it is moving.

For example when vegetation is removed from a stream valley, flowing water from precipitation causes erosion and loss of nutrients, which causes more vegetation to die. With even less vegetation to hold soil in place, flowing water causes even more erosion and nutrient loss, which causes even more plants to die.

It is useful to distinguish among two aspects of stability in living systems.

1. **Inertia, or persistence**
2. **Resilience**

Inertia, or persistence

The ability of a living system, such as a grassland or a forest, to survive in conditions of moderate disturbances.

Resilience

The ability of a living system to be restored through secondary succession after a moderate disturbance.

When members of different species compete for resources, one species may be forced to move or become extinct, or the two species may share the resource and coexist.

Most studies have shown that competing species can coexist.

Coexistence can occur when species utilize resources in slightly different ways.

Robert MacArthur studied five species of warblers that all used the same caterpillar prey.

Warblers partitioned their spruce tree habitats by dividing a tree into preferred regions for foraging. Although foraging regions overlapped, competition was limited, and the five species coexisted.

Robert MacArthur found that five species of warblers *(a–e) coexisted by partitioning spruce trees into preferred* foraging regions (shown in dark green). *(a) Bay-breasted warbler(Dendroica castanea). (b) Cape May warbler (D. tigrina). (c) Blackburnian warbler(D. fusca). (d) Black-throated green warbler (D. virens). (e) Myrtle warbler (D. coronata).*

Lecture 85

Interspecific competition:

All organisms require space and food for their survival.

Requirement of both space & food causes competition b/w the species as well as among the same species.

The competition between different species for purpose of space and food is called **Interspecific competition.**

While competition within the same species is known as **Intraspecific competition.**

