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M.SC ZOOLOGY

ZOO507-Principles-of-Animal-Ecology



HANDOUTS TOPIC NO 1 TO 179

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ZOO507 – Principles Of Animal Ecology

Topic no 1 to 90 mid term and 91 to 179 final term syllabus

Topic_01 The environment is everything around us

It includes all of the living and the nonliving things with which we interact.
And it includes a complex web of relationships that connect us with one another and with the world we live in.
Despite our many scientific and technological advances, we are utterly dependent on the environment for air, water, food, shelter, energy, and everything else we need to stay alive and healthy
As a result, we are part of, and not apart from, the rest of nature.
Environmental science, an interdisciplinary study of how humans interact with the environment of living and nonliving things
It integrates information and ideas from the natural sciences, such as biology, chemistry, and geology, the social sciences, such as geography, economics, political science, and demography, and the humanities, including philosophy and ethics

Topic_02 Environmental Science

Major Fields of Study Related to Environmental Science

Major Fields	Subfields
Biology: study of living things (organisms)	Ecology: study of how organisms interact with one another and with their nonliving environment Botany: study of plants Zoology: study of animals
Chemistry: study of chemicals and their interactions	Biochemistry: study of the chemistry of living things
Earth science: study of the planet as a whole and its nonliving systems	Climatology: study of the earth's atmosphere and climate Geology: study of the earth's origin, history, surface, and interior processes Hydrology: study of the earth's water resources Paleontology: study of fossils and ancient life

Environmental Science

Social sciences: studies of human society	Anthropology: study of human cultures
	Demography: study of the characteristics of human populations
Humanities: study of the aspects of the human condition not covered by the physical and social sciences	Geography: study of the relationships between human populations and the earth's surface features
	Economics: study of the production, distribution, and consumption of goods and services
	Political Science: study of the principles, processes, and structure of government and political institutions
	History: study of information and ideas about humanity's past
	Ethics: study of moral values and concepts concerning right and wrong human behavior and responsibilities
	Philosophy: study of knowledge and wisdom about the nature of reality, values, and human conduct



Environmental science is an interdisciplinary study of connections between the earth’s lifesupport system and human activities.

Topic_03 The goals of environmental science are to learn

How nature works?
 How the environment affects us?
 How we affect the environment? How to deal with environmental problems and live more sustainably?

A key subfield of environmental science is ecology, the biological science that studies how organisms, or living things, interact with their environment and with each other Every organism is a member of a certain species: a group of organisms with distinctive traits and, for sexually reproducing organisms, can mate and produce fertile offspring.

For example, all humans are members of a species that biologists have named *Homo sapiens*. A major focus of ecology is the study of ecosystems

An ecosystem is a set of organisms interacting with one another and with their environment of nonliving matter and energy within a defined area or volume.

Topic_04 Environmental Science

We should not confuse environmental science and ecology with **environmentalism, a social movement** dedicated to protecting the earth’s life-support systems for us and all other forms of life. Environmentalism is practiced more in the political and ethical arenas than in the realm of science.

Environmental Sustainability

Sustainability is the ability of the earth's various natural systems and human cultural systems and economies to survive and adapt to changing environmental conditions indefinitely

Sustainability

A critical component of sustainability is **natural capital**—the **natural resources and natural services that** keep us and other forms of life alive and support our economies.

Environmental Science

Topic_05 Environmental Sustainability

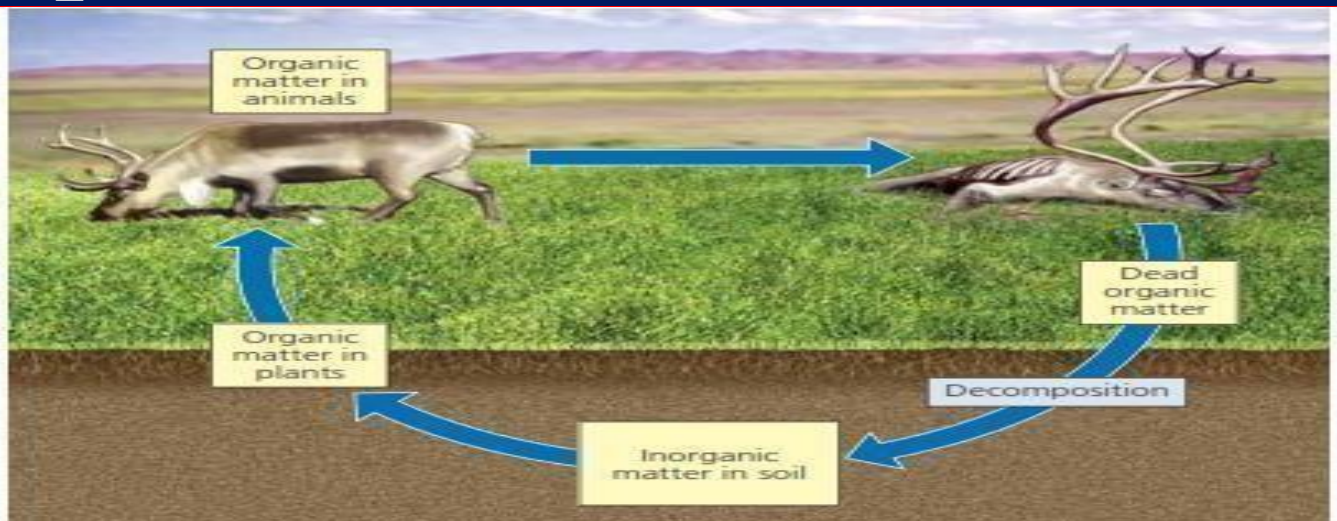
Natural resources are materials and energy in nature that are essential or useful to humans

These resources are often classified as *renewable* (such as air, water, soil, plants, and wind) or *nonrenewable* (such as copper, oil, and coal).

Natural services are functions of nature, such as purification of air and water, which support life and human economies .Ecosystems provide us with these essential services at no cost.

One vital natural service is **nutrient cycling, the** circulation of chemicals necessary for life, from the environment (mostly from soil and water) through organisms and back to the environment

Topic_06 Environmental Science



Nutrient cycling: an important natural service that recycles chemicals needed by organisms from the environment (mostly from soil and water) through organisms and back to the environment. Natural capital is supported by solar capital: energy from the sun Take away solar energy, and all natural capital would collapse

Topic_07 Environmental Science

- Solar energy warms the planet and supports photosynthesis—a complex chemical process that plants use to provide food for themselves and for us and most other animals.

- This direct input of solar energy also produces indirect forms of renewable solar energy such as wind, flowing water, and biofuels made from plants and plant residues.
- For example, *topsoil, the upper layer of the earth's crust*, provides the nutrients that support the plants, animals, and microorganisms that live on land; when they die and decay, they resupply the soil with these nutrients. Without this service, life as we know it could not exist.
- Thus, our lives and economies depend on energy from the sun (solar capital) and natural resources and natural services (natural capital) provided by the earth

Topic_08 Environmental Sustainability

A second component of sustainability is to recognize that many human activities can *degrade natural capital* by using normally renewable resources faster than nature can renew them

For example, in parts of the world, we are clearing mature forests much faster than nature can replenish them

We are also harvesting many species of ocean fish faster than they can replenish themselves This leads us to a third component of sustainability

Environmental scientists search for *solutions to problems* such as the degradation of natural capital

However, their work is limited to finding the scientific solutions, while the political solutions are left to political processes

For example, scientific solutions might be to stop chopping down biologically diverse, mature forests, and to harvest fish no faster than they can replenish themselves

But implementing such solutions could require government laws and regulations

Topic_09 Environmental Sustainability

The search for solutions often involves conflicts

When scientists argue for protecting a diverse natural forest to help prevent the premature extinction of various life forms, for example, the timber company that had planned to harvest trees in that forest might protest.

Dealing with such conflicts often involves making trade-offs, or compromises a fourth component of sustainability

In the case of the timber company, it might be persuaded to plant a tree farm in an area that had already been cleared or degraded, in exchange for preserving the natural forest

Topic_10 Growth of Environmentally Sustainable Societies

Economic growth is an increase in a nation's output of goods and services

It is usually measured by the percentage of change in a country's **gross domestic product (GDP): the annual market value of all goods** and services produced by all firms and organizations, foreign and domestic, operating within a country

Changes in a country's economic growth per person are measured by **per capita GDP: the GDP divided by** the total population at midyear. The value of any country's currency changes when it is used in other countries.

Because of such differences, a basic unit of currency in one country can buy more of a particular thing than the basic unit of currency of another country can buy.

Consumers in the rich country are said to have more purchasing power than consumers in the second country have.

To help compare countries, economists use a tool called purchasing power parity (PPP).

By combining per capita GDP and PPP, for any given country, they arrive at a per capita GDP PPP—a measure of the amount of goods and services that a country's average citizen could buy.

Topic_11 Growth of Environmentally Sustainable Societies

While economic growth provides people with more goods and services, **economic development has the** goal of using economic growth to improve living standards.

The United Nations classifies the world's countries as economically developed or developing based primarily on their degree of industrialization and their per capita GDP PPP.

The **developed countries** (with 1.2 billion people) include the United States, Canada, Japan, Australia, New Zealand, and most countries of Europe.

Most are highly industrialized and have a high per capita GDP PPP.

All other nations (with 5.5 billion people) are classified as developing countries, most of them in Africa, Asia, and Latin America.

Some are middle-income, moderately developed countries such as China, India, Brazil, Turkey, Thailand, and Mexico. Others are low-income, least developed countries where per capita GDP PPP is steadily declining.

Topic_12 Growth of Environmentally Sustainable Societies

- ▶ Some economists call for continuing conventional economic growth, which has helped to increase food supplies, allowed people to live longer, and stimulated mass production of an array of useful goods and services for many people.
- ▶ They also see such growth as a cure for poverty, maintaining that some of the resulting increase in wealth trickles down to countries and people near the bottom of the economic ladder.
- ▶ Other economists put much greater emphasis on environmentally sustainable economic development.

This involves using political and economic systems to discourage environmentally harmful and unsustainable forms of economic growth.

That degrade natural capital, and to encourage environmentally beneficial and sustainable forms of economic development that help sustain natural capital

Topic_13 Affects of Ecological Footprints on the Earth

- ▶ From a human standpoint, a resource is anything obtained from the environment to meet our needs and wants
- ▶ Conservation is the management of natural resources with the goal of minimizing resource waste and sustaining resource supplies for current and future generations
- ▶ Some resources, such as solar energy, fresh air, wind, fresh surface water, fertile soil, and wild edible plants, are directly available for use
- ▶ Other resources such as petroleum, iron, water found underground, and cultivated crops, are not directly available
- ▶ They become useful to us only with some effort and technological ingenuity.
- ▶ For example, petroleum was a mysterious fluid until we learned how to find, extract, and convert (refine) it into gasoline, heating oil, and other products that could be sold

Topic_14 Affects of Ecological Footprints on the Earth

- ▶ Solar energy is called a perpetual resource because it is renewed continuously and is expected to last at least 6 billion years as the sun completes its life cycle
- ▶ On a human time scale, a renewable resource can be replenished fairly quickly (from hours to hundreds of years) through natural processes as long as it is not used up faster than it is renewed
- ▶ Examples include forests, grasslands, fisheries, freshwater, fresh air, and fertile soil
- ▶ The highest rate at which a renewable resource can be used indefinitely without reducing its available supply is called its sustainable yield
- ▶ When we exceed a renewable resource's natural replacement rate, the available supply begins to shrink, a process known as environmental degradation

Topic_15 Overexploitation of Commonly Shared Renewable Resources

- ▶ There are three types of property or resource rights
- ▶ 1- One is private property where individuals or firms own the rights to land, minerals, or other resources
- ▶ 2- Another is common property where the rights to certain resources are held by large groups of individuals
- ▶ 3- A third category consists of *open access renewable re-sources, owned by no one and available for use by anyone* at little or no charge

Many common property and open access renewable resources have been degraded

In 1968, biologist Garrett Hardin (1915–2003) called such degradation the *tragedy of the commons*

- ▶ *It occurs because each user* of a shared common resource or open-access resource reasons, “If I do not use this resource, someone else will
- ▶ The little bit that I use or pollute is not enough to matter, and anyway, it’s a renewable resource.”
- ▶ When the number of users is small, this logic works
- ▶ The cumulative effect of many people trying to exploit a shared resource can exhaust or ruin it
- ▶ Then no one can benefit from it

Topic_16 Overexploitation of Commonly Shared Renewable Resources

- ▶ Such resource degradation results from the push to satisfy the short-term needs and wants of a growing number of people
- ▶ It threatens our ability to ensure the long-term economic and environmental sustainability of open-access resources such as clean air or an open ocean fishery
- ▶ One solution is to use shared resources at rates well below their estimated sustainable yields by reducing use of the resources, regulating access to the resources, or doing both
- ▶ For example, the most common approach is for governments to establish laws and regulations limiting the annual harvests of various types of ocean fish that are being harvested at unsustainable levels in their coastal waters
- ▶ Another approach is for nations to enter into agreements that regulate access to open access renewable resources such as the fish in the open ocean
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Topic_17 Nonrenewable Resources

- ▶ Nonrenewable resources exist in a fixed quantity, or stock, in the earth’s crust

- ▶ On a time scale of millions to billions of years, geological processes can renew such resources

But on the much shorter human time scale of hundreds to thousands of years, these resources can be depleted much faster than they are formed

Such exhaustible resources include energy resources (such as coal and oil), metallic mineral resources (such as copper and aluminum), and nonmetallic mineral resources (such as salt and sand)

- ▶ As such resources are depleted, human ingenuity can often find substitutes
- ▶ For example, during this century, a mix of renewable energy resources such as wind, the sun, flowing water, and the heat in the earth's interior could reduce our dependence on nonrenewable fossil fuels such as oil and coal

Topic_18 Nonrenewable Resources

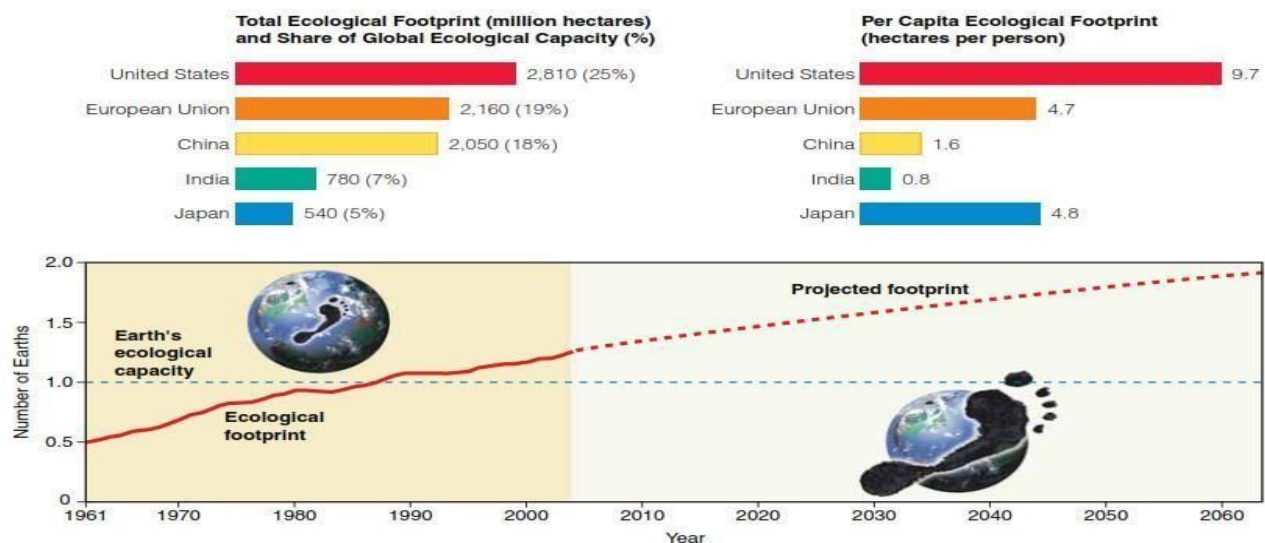
- Also, various types of plastics and composite materials can replace certain metals
- But sometimes there is no acceptable or affordable substitute
- Some nonrenewable resources, such as copper and aluminum, can be recycled or reused to extend supplies
- Reuse is using a resource over and over in the same form
- For example, glass bottles can be collected, washed, and refilled many times
- Recycling involves collecting waste materials and processing them into new materials
- For example, discarded aluminum cans can be crushed and melted to make new aluminum cans or other aluminum products
- But energy resources such as oil and coal cannot be recycled
- Once burned, their energy is no longer available to us

Topic_19 Nonrenewable Resources

- ▶ Recycling nonrenewable metallic resources takes much less energy, water, and other resources and produces much less pollution and environmental degradation than exploiting virgin metallic resources
- ▶ Reusing such resources takes even less energy and other resources and produces less pollution and environmental degradation than recycling does

Our Ecological Footprints Are Growing

- ▶ Many people in developing countries struggle to survive
- ▶ Their individual use of resources and the resulting environmental impact is low and is devoted mostly to meeting their basic needs
- ▶ By contrast, many individuals in more affluent nations consume large amounts of resources way beyond their basic needs



Natural capital use and degradation: total and per capita ecological footprints of selected countries (top). In 2003, humanity total or global ecological footprint was about 25% higher than the earth ecological capacity (bottom) and is projected to be twice the planet ecological capacity by 2050. **Question:** If we are living beyond the earth biological capacity, why do you think the human population and per capita resource consumption are still growing exponentially? (Data from Worldwide Fund for Nature, Global Footprint Network)

Topic_20 Our Ecological Footprints Are Growing

- ▶ Supplying people with resources and dealing with the resulting wastes and pollution can have a large environmental impact
- ▶ We can think of it as an ecological footprint—the amount of biologically productive land and water needed to supply the people in a particular country or area with resources and to absorb and recycle the wastes and pollution produced by such resource use
- ▶ The per capita ecological footprint is the average ecological footprint of an individual in a given country or area.
- ▶ If a country's, or the world's, total ecological footprint is larger than its biological capacity to replenish its renewable resources and absorb the resulting waste products and pollution, it is said to have an ecological deficit.
- ▶ The World Wildlife Fund (WWF) and the Global Footprint Network estimated that in 2003 (the latest data available) humanity's global ecological footprint exceeded the earth's biological capacity by about 25%
- ▶ The per capita ecological footprint is an estimate of how much of the earth's renewable resources an individual consumes
- ▶ After the oil-rich United Arab Emirates, the United States has the world's second largest per capita ecological footprint
- ▶ In 2003, its per capita ecological footprint was about 4.5 times the average global footprint per person, 6 times larger than China's per capita footprint, and 12 times the average per capita footprint in the world's low-income countries like Pakistan

Topic_21 Our Ecological Footprints Are Growing

- ▶ According to William Rees and Mathis Wackernagel, the developers of the ecological footprint concept, it would take the land area of about five more planet earths for the rest of the world to reach current U.S. levels of consumption with existing technology
- ▶ Put another way, if everyone consumed as much as the average American does today, the earth's natural capital could support only about 1.3 billion people—not
- ▶ In other words, we are living unsustainably by depleting and degrading some of the earth's irreplaceable natural capital and the natural renewable income it provides as our ecological footprints grow and spread across the earth's surface

Topic_22 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 and non-living things that surround them.

Both these living and 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. Major components of ecology are

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

Sub fields of ecology

- Organismal ecology

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

Topic_23 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.

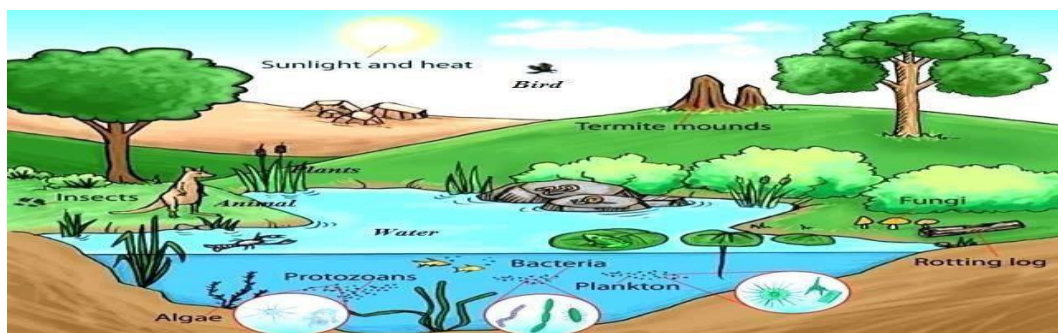
For example, soil can wash from a grassland or crop field into a nearby river or lake. Water flows from forests into nearby rivers and crop fields.

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.

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.



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

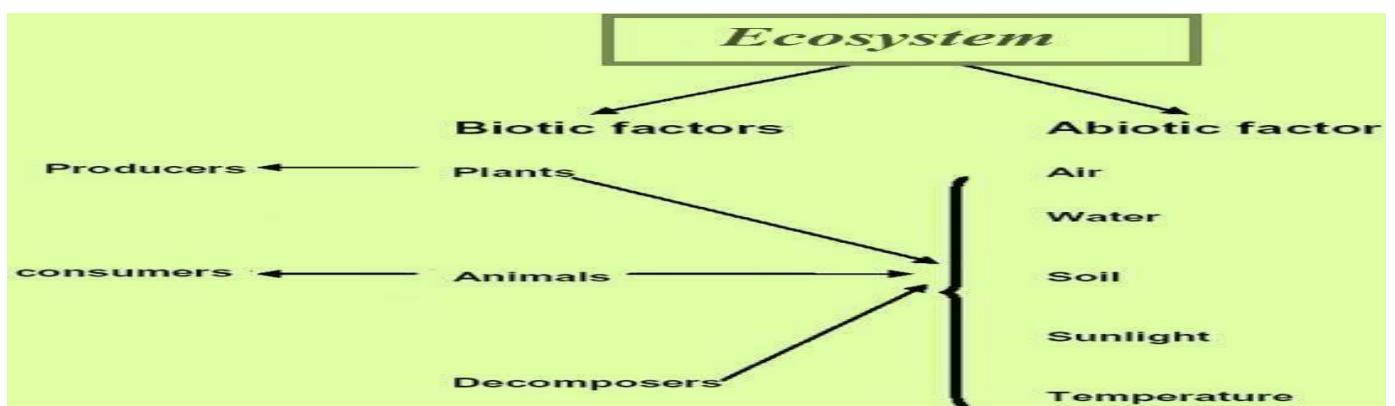
Non-living components of an ecosystem

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.



Topic_24 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 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. **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, and how long a heating or cooling system runs.

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.

Topic_25 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

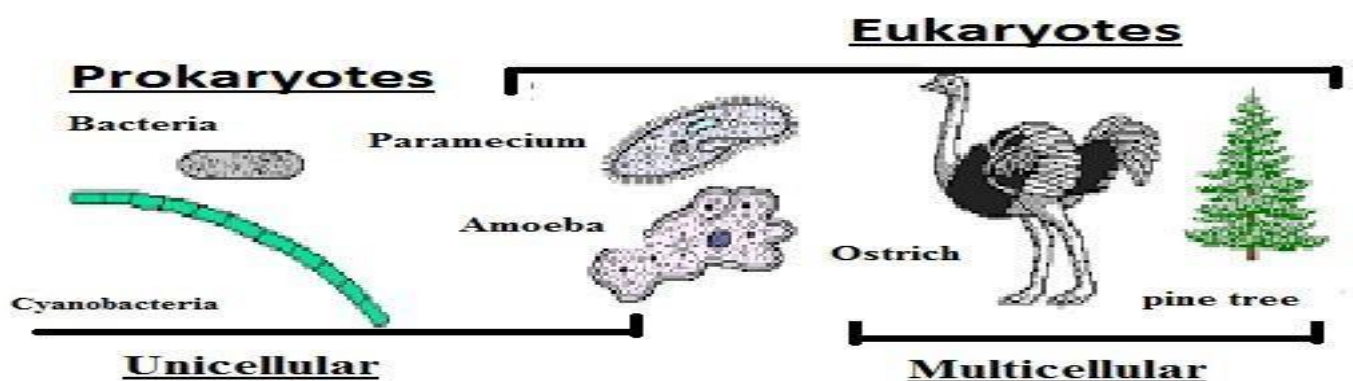
Prokaryotes consist of only unicellular organisms while Eukaryotes consist of both unicellular and multicellular organisms.

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Prokaryotes

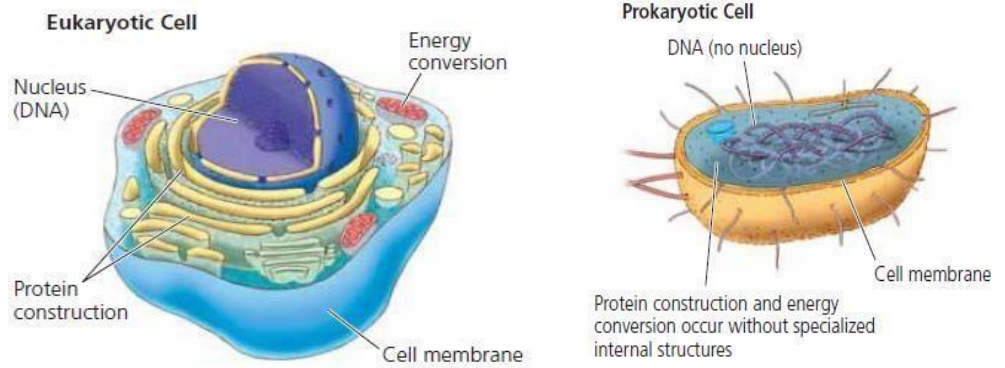
They lack well defined nucleus and also membrane

bound organelles.

They have well defined nucleus and

also have

Membrane Bound organelles.



Topic_26 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 (*Sturnellaneglecta*) and Eastern meadowlarks (*Sturnella magna*) look almost identical to one another, yet do not interbreed with 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.

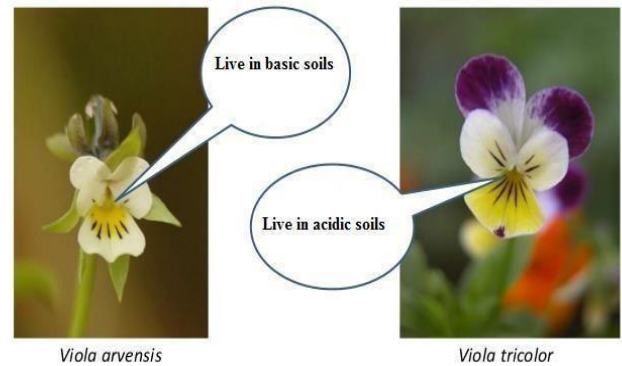
2. Ecological species concept

Defines species in terms of its ecological niche.



Ecological species concept

The two species are in the same area, but live in different habitats



3. Morphological species concept

Defines species by structural features.

4. Phylogenetic species concept

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

Phylogenetic species concept



Topic_27 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.

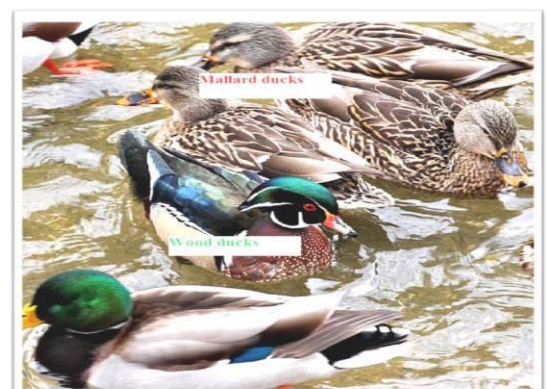
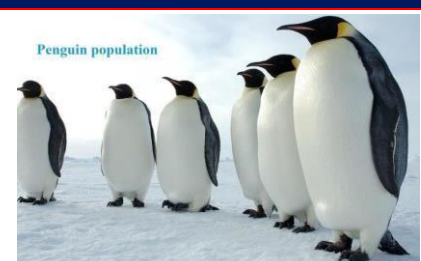
A group of ducks would not be a population if there were mallard and wood ducks combined.

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 and 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.

Geographic limits

Geographic barriers like rivers, mountains or patches of water bodies limits the size of population



Topic_28 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, and with plants, insects, ducks, and 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).

Topic_29 Ecosystem

The word ecosystem was coined by

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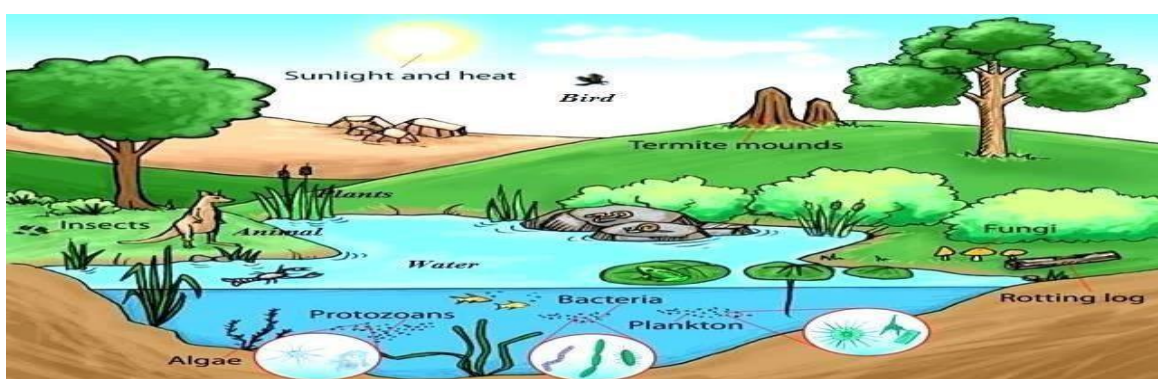
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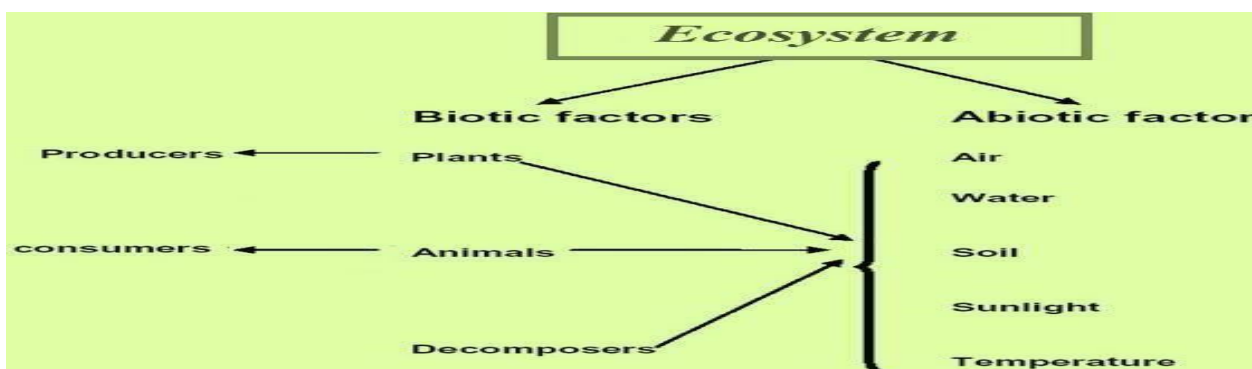
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Topic_30 The ecological niche

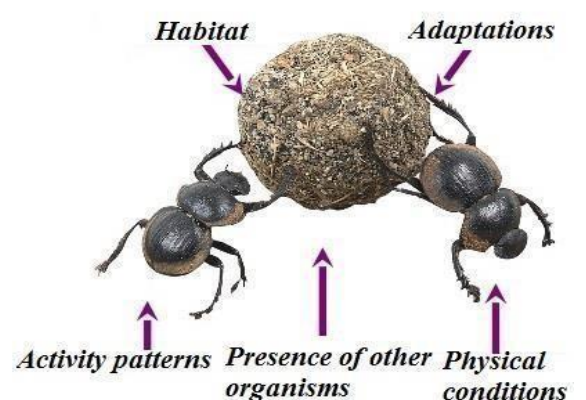
The **ecological niche** is an important concept of community structure.

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

Ecological niche



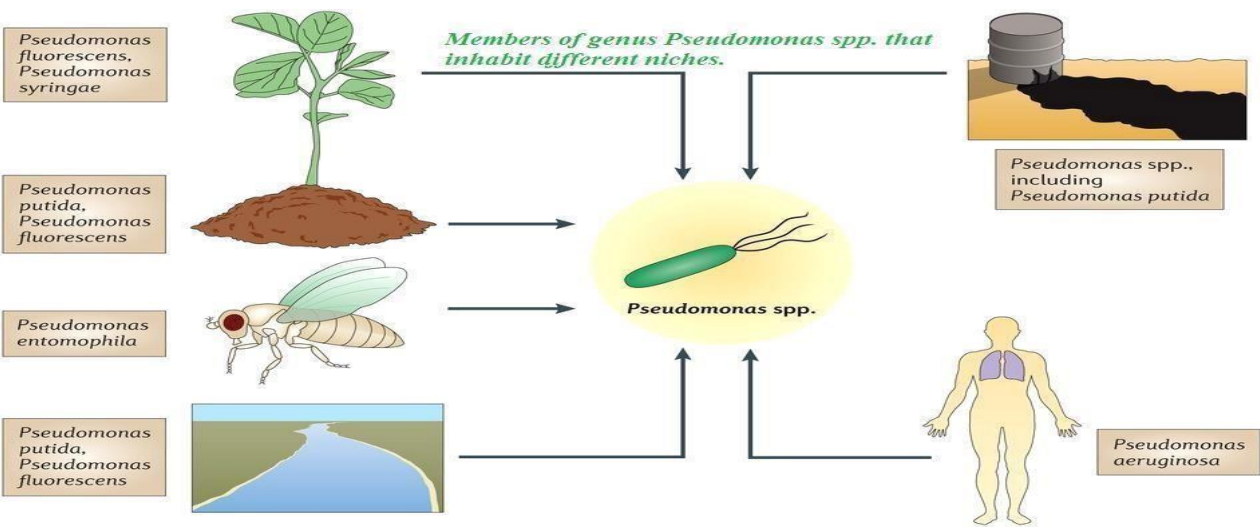
its habitat, which is the place where it lives. Niche is simply a pattern of living of species.

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

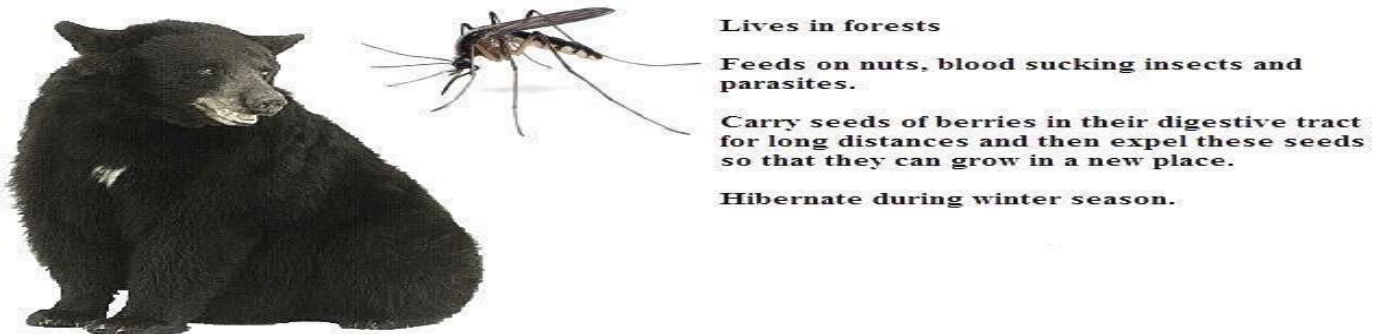
A typical niche describes;

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.

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



Ecological niche of a black bear



Topic_31 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.



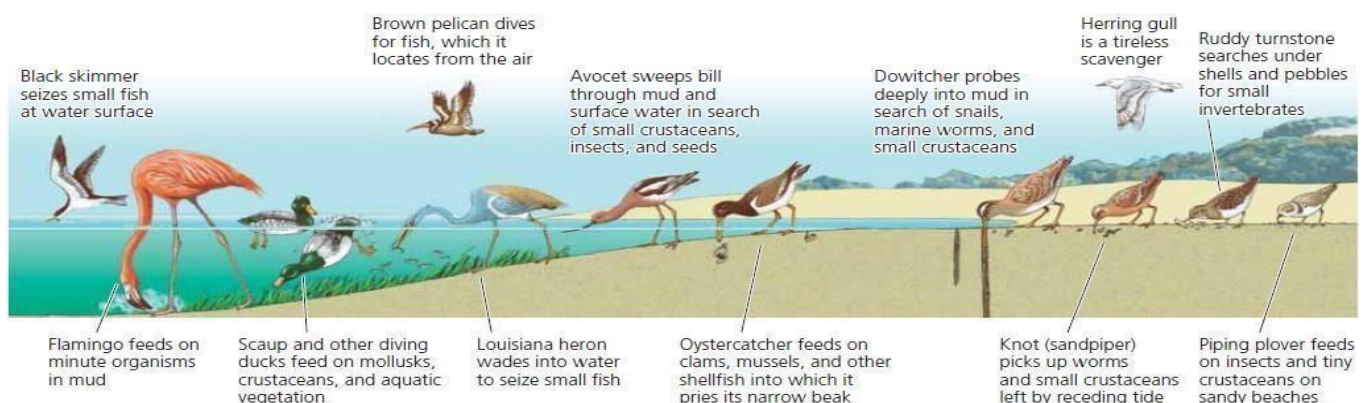
Topic_32 Specialist species

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.

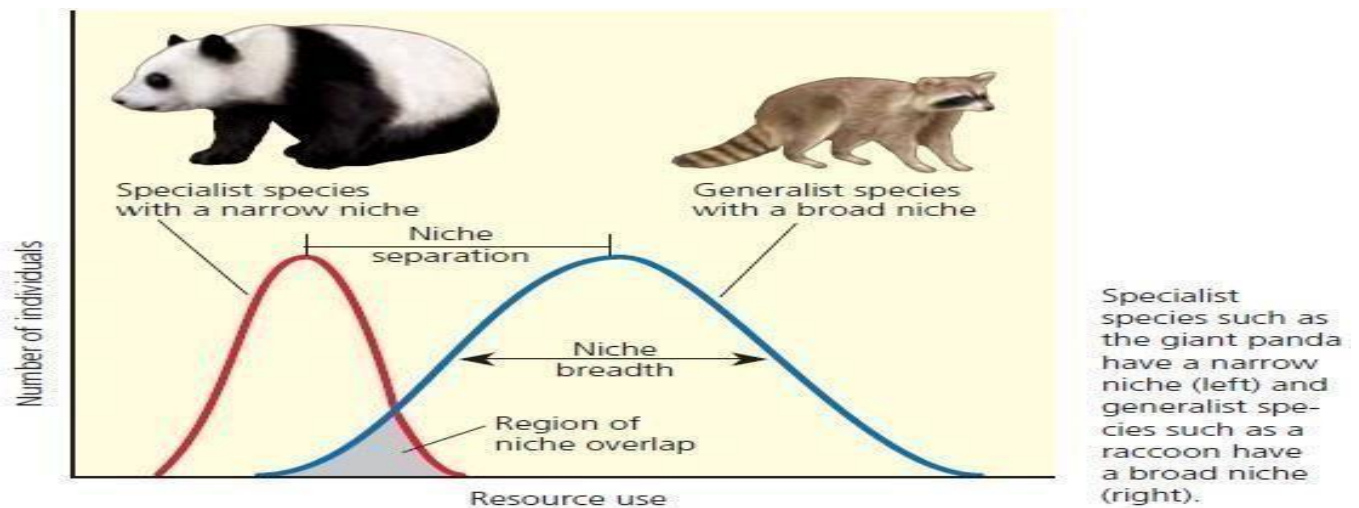
Specialized feeding niches of various bird species in a coastal wetland. This specialization Reduces competition and allows sharing of limited resources.



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.

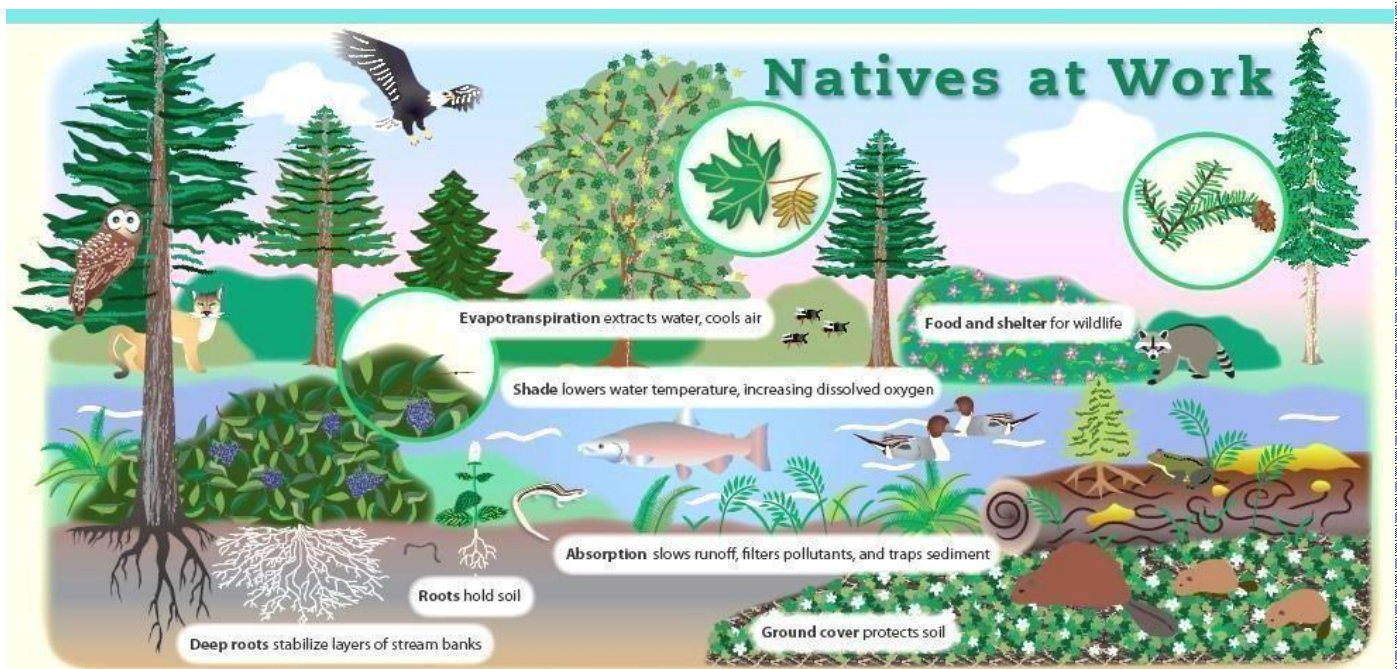
China's giant panda is highly endangered because of a combination of habitat loss, low birth rate, and its specialized diet consisting mostly of bamboo.



Topic_33 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.

2. Indigenous species

These are found within the region and elsewhere in the world also.

Endemic species

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



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.



Topic_34 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 nonnative species is a major cause of species loss.

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



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

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 and cause unintended and unexpected consequences.

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:

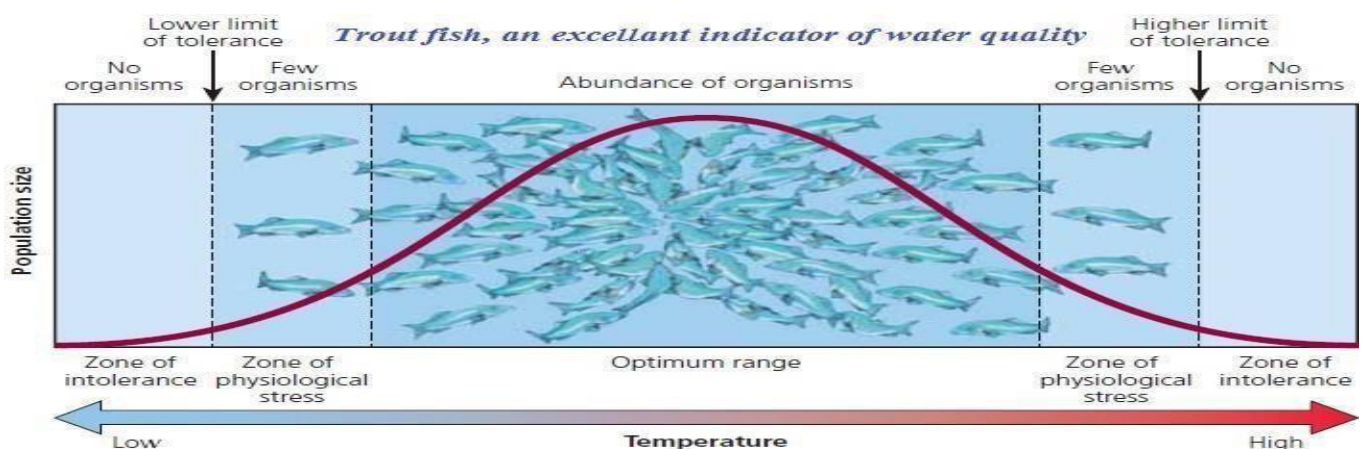
- Non-native species can spread rapidly if they find a new more favourable niche.
- In their new niches, these species often do not face the predators and diseases they faced before.
- They may be able to out-compete some native species in their new niches.
- Causes habitat loss and ecosystem disturbance.



Topic_35 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 earlywarning 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, and non native predators and competitors.



Topic_36 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.

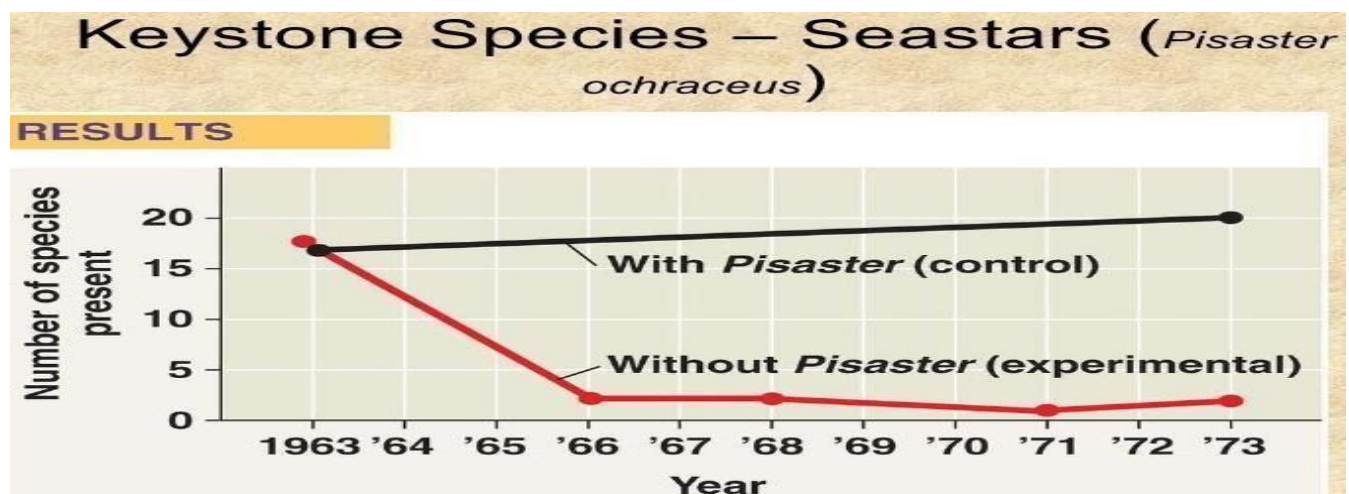
Keystone species can play several critical roles in helping to sustain an ecosystem. One such role is pollination of flowering plant species by bees, butterflies, hummingbirds, bats, and other species.

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. Examples are the alligator, wolf, leopard, lion, and some shark species.

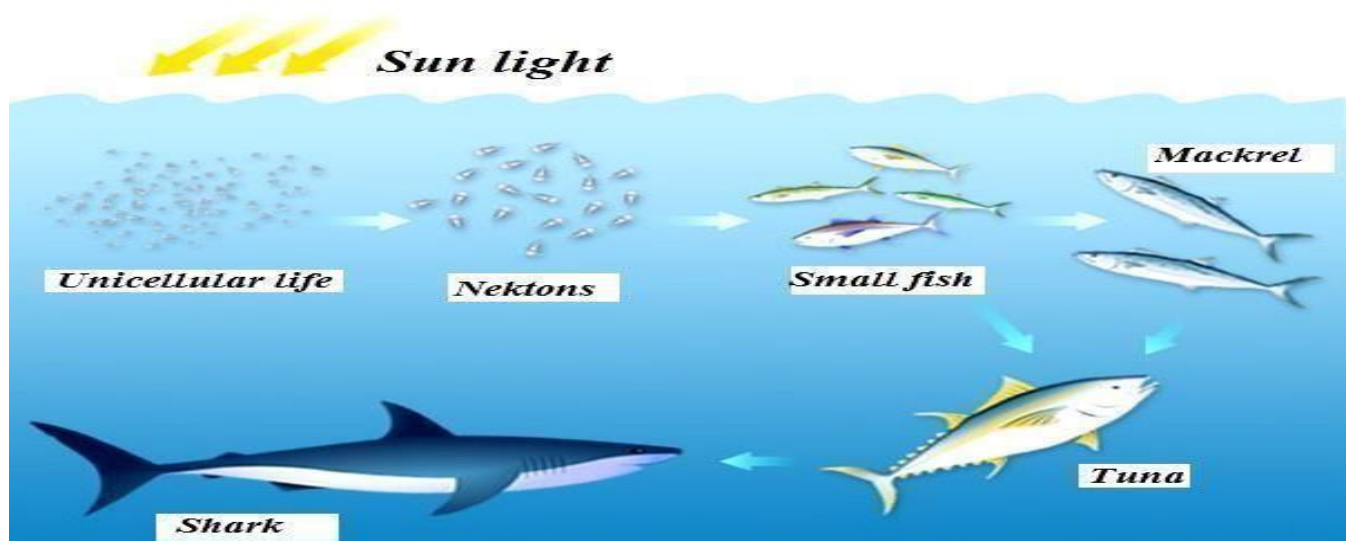
Ecologist Robert Paine studied the keystone role of the top-predator sea star *Pisaster ochraceus* in an intertidal zone community.

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 and crowded out most other species in the community without the *Pisaster* 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 and 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.

Topic_37 Foundation species

Foundation species plays a major role in shaping communities. They create and Enhance the habitats in ways that provides benefits to other species. They facilitate the survival and 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.

Topic_38 Ecological pyramids

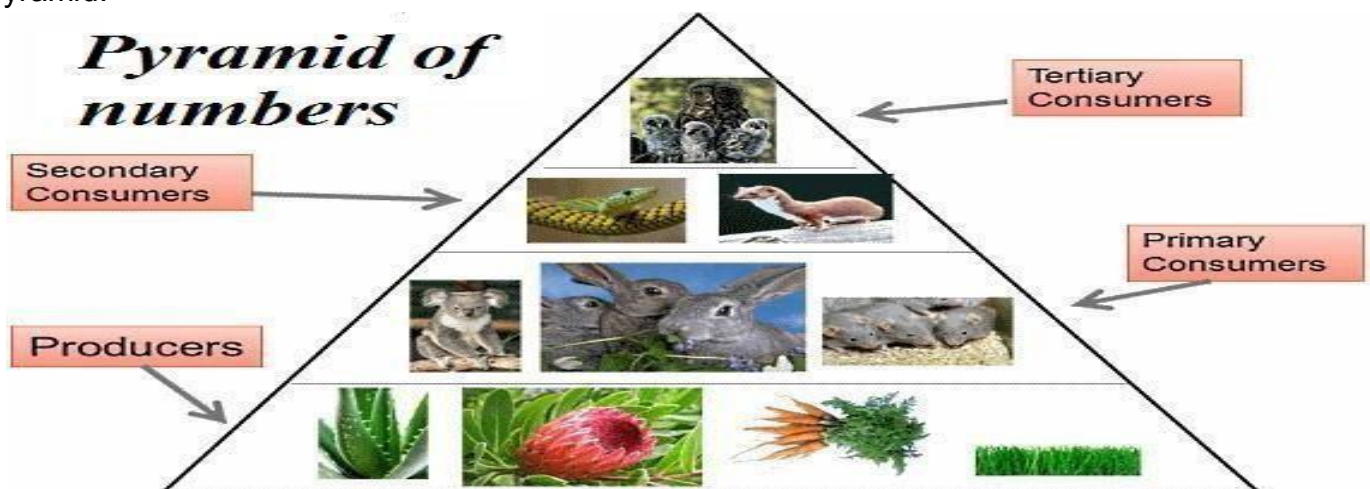
An ecological pyramid is a graphical relationship among different trophic structures or levels in an ecosystem.

Trophic structure means the different feeding levels of organisms. An ecological pyramid is further classified into three main types,

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

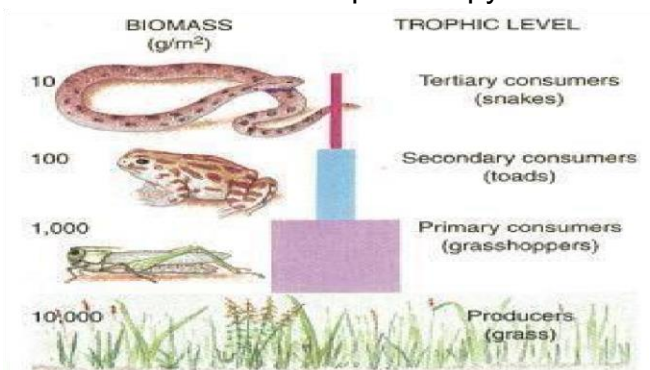
1. Pyramid of number

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.



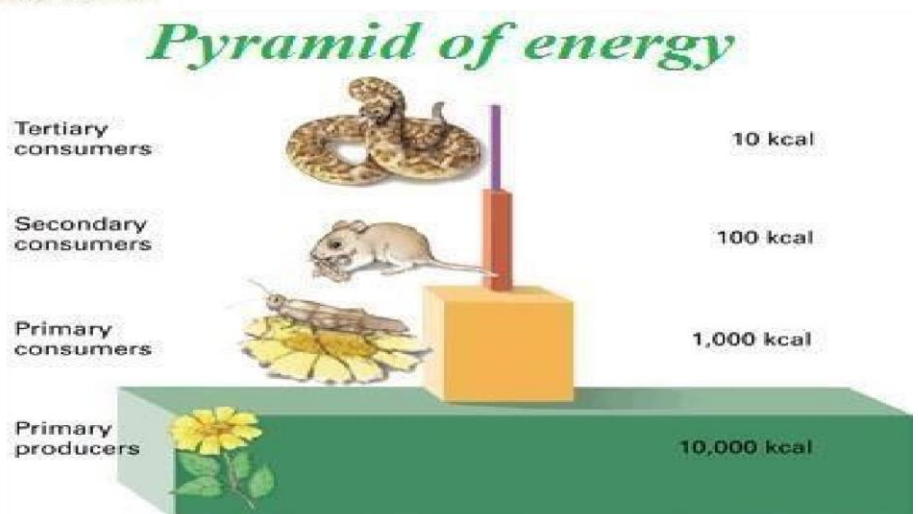
2. Pyramid of biomass

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.



Topic_39 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.



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.

Topic_40 Organisms and environment

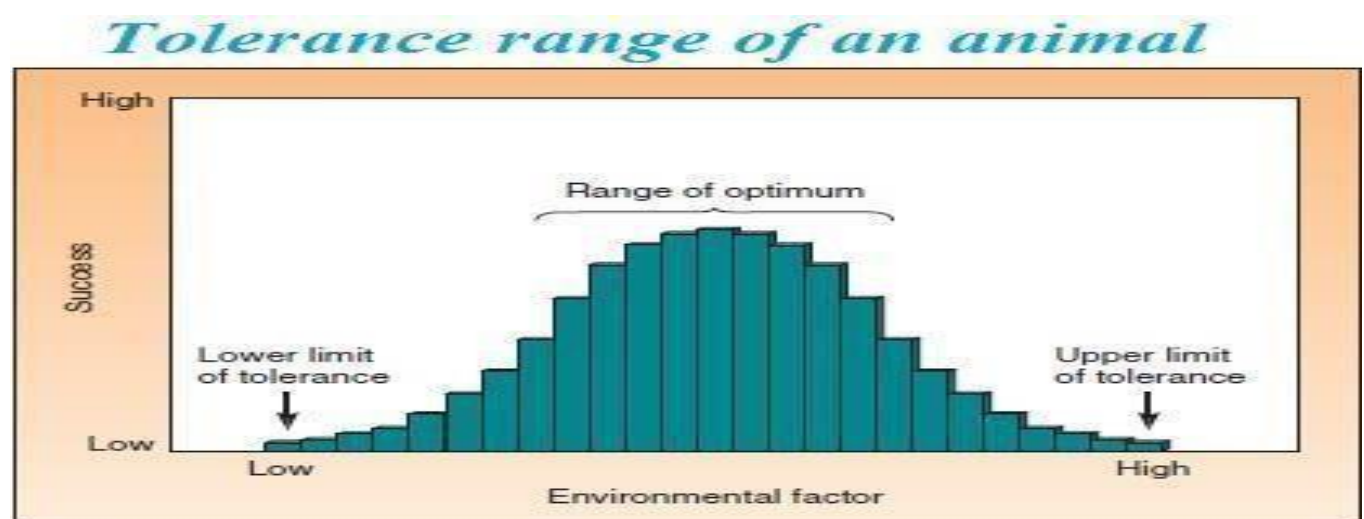
Actual place of an organism where it lives is called its habitat or environment.

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

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.

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



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

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

Limiting factor

When an abiotic factor becomes out of an organism tolerance range then it is said to be a limiting factor. For example o Oxygen o Water o Food

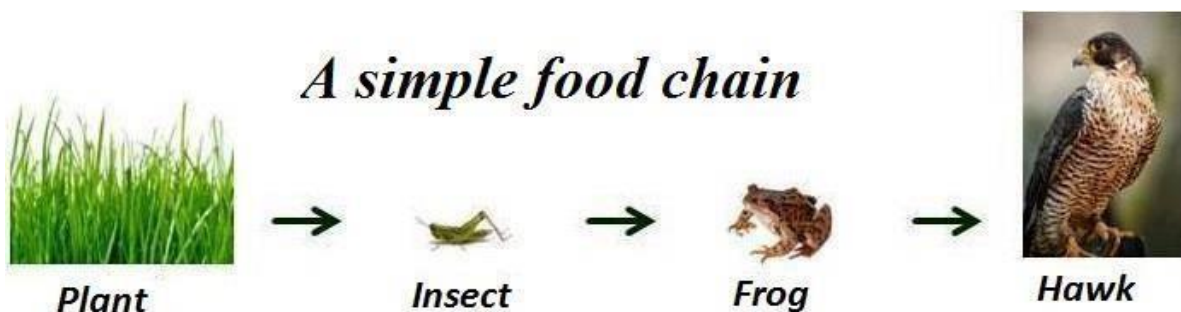
Taxis

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.

Topic_41 Food chain

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



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 and nutrients move from one organism to another through the trophic levels in an ecosystem.

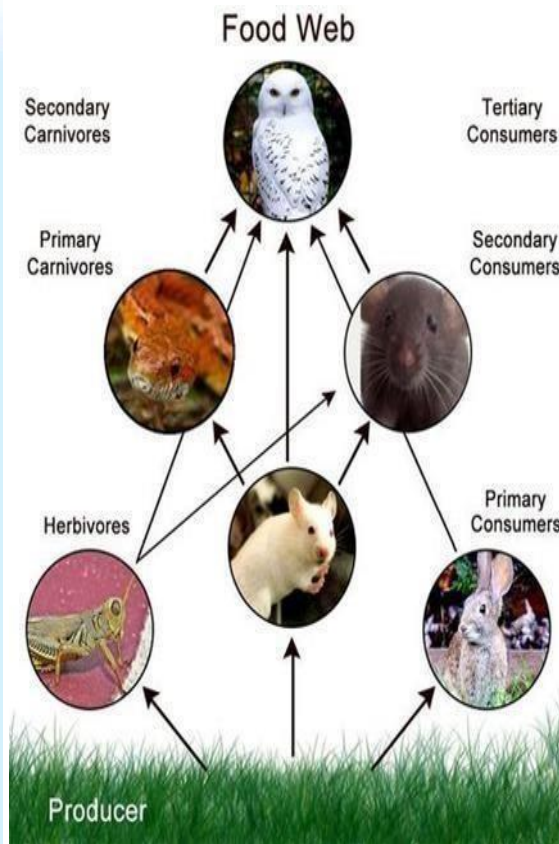
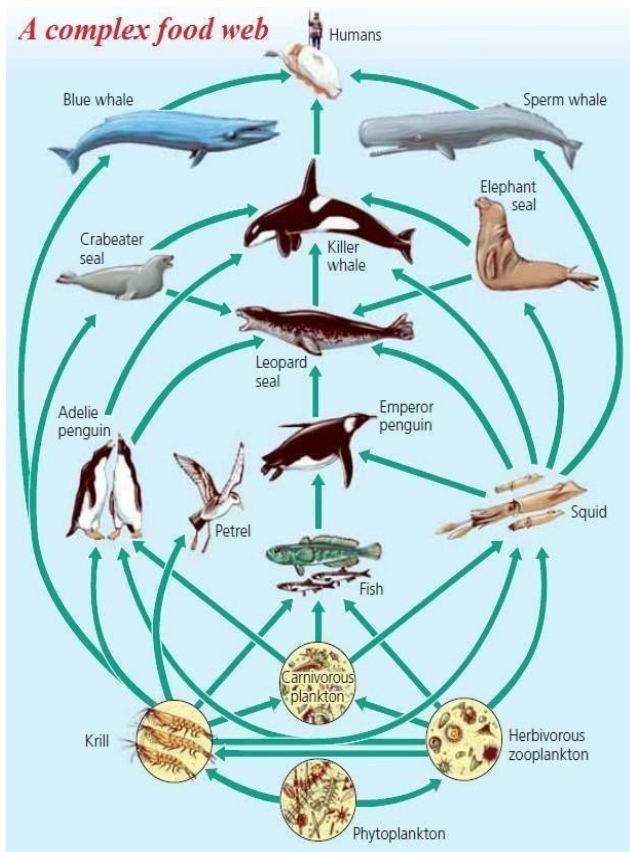
Topic_42 Food web

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.



Topic_43 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.

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.

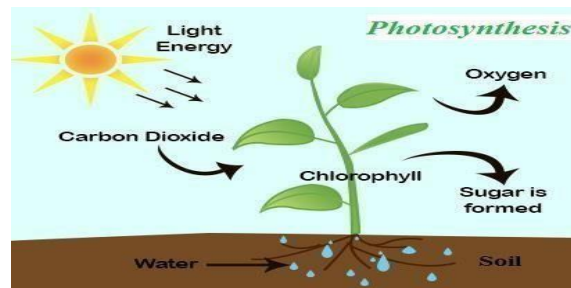
Topic_44 Producers

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 into two types

1. **Photoautotrophs**
2. **Chemoautotrophs**



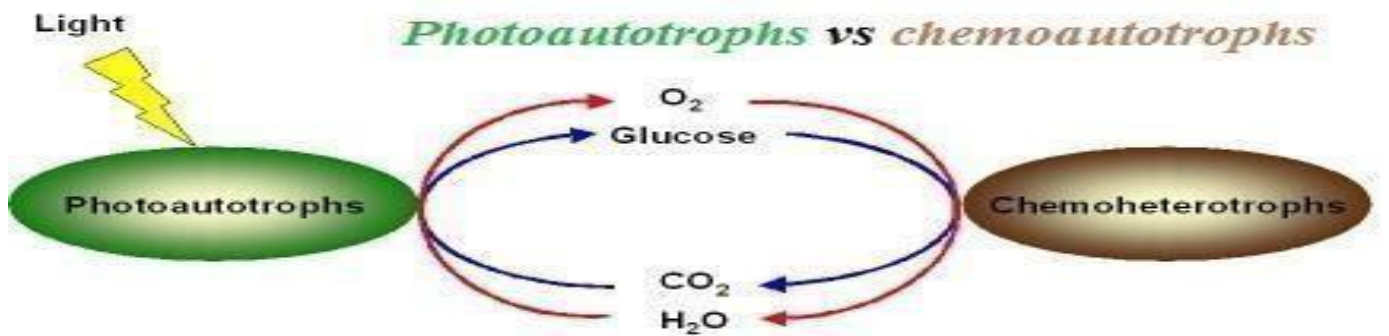
Photoautotrophs

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 (*Nitrosomonas* and *Nitrobacter*) are chemosynthetic in nature.



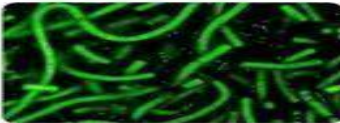
Topic_45 Terrestrial producers

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.

Ecosystems with respective autotrophs

Type of Photoautotroph	Examples		Type of Ecosystem(s)
Plants	 Trees	 Grasses	Terrestrial
Algae	 Diatoms	 Seaweed	Aquatic
Bacteria	 Cyanobacteria	 Purple Bacteria	Aquatic and Terrestrial

Topic_46 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 o Unicellular algae o Shells

having interlocking parts.

- o Major producers of an aquatic system

Dinoflagellates

- o Unicellular
- o Double flagella
- o Second 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.

Topic_47 Photosynthesis

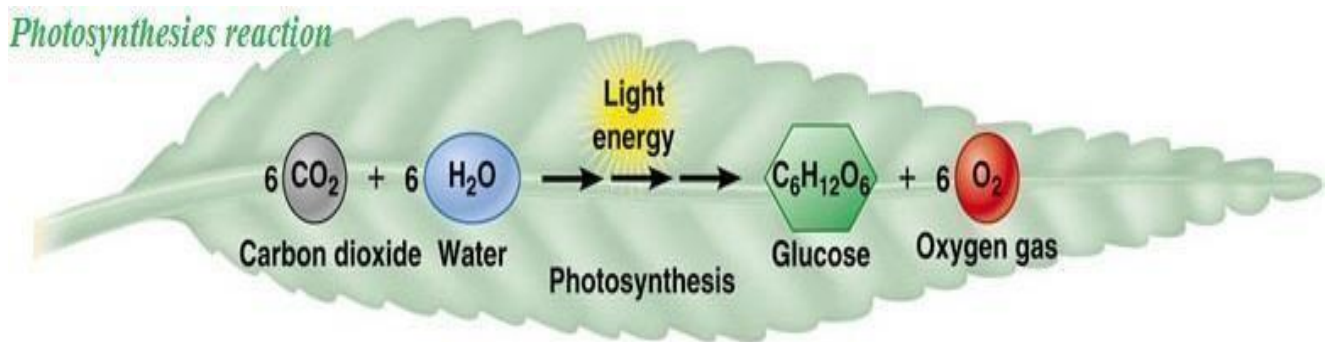
Photosynthesis is the vital process by which producers manufacture food for organisms in an ecosystem.

In fact photosynthesis is a process that starts an ecological food web.

Chlorophyll is the plant pigment that captures 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 feed on plants.

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



Topic_48 Consumers

Organisms that depend 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

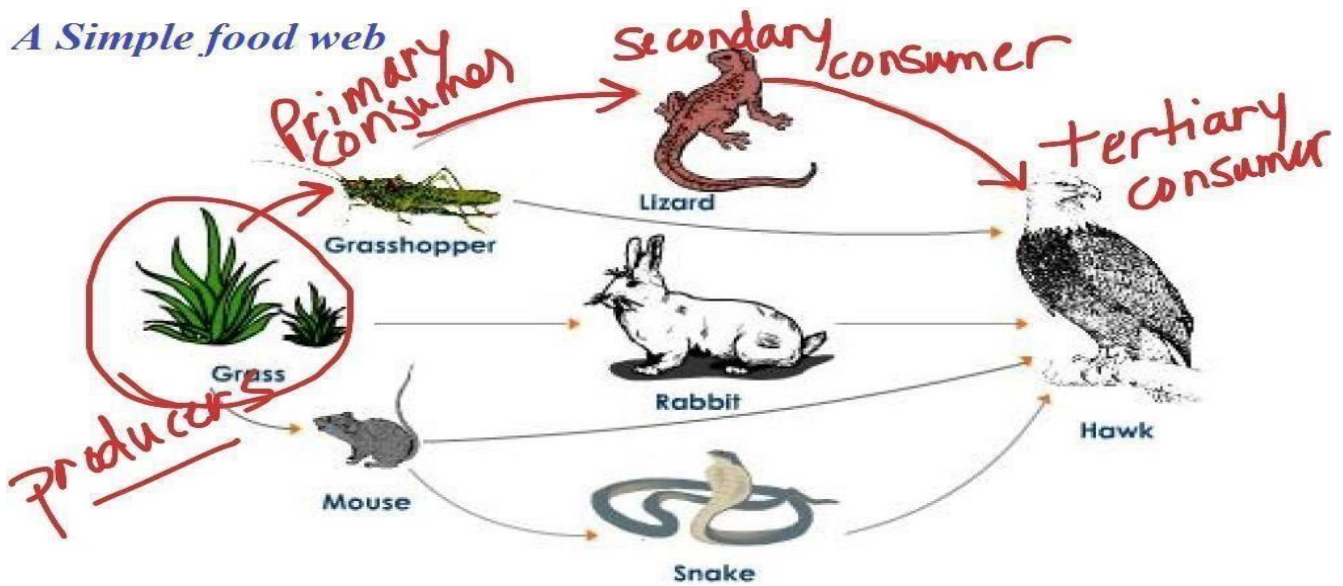
Primary consumer that feeds on plants directly. Zooplankton, Cow, zebra, Rabbits, Grasshoppers, Deer etc.

2. Carnivores

Secondary consumers, or carnivores that feed 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.

A Simple food web



3. Omnivores

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

Topic_49 Primary Consumers

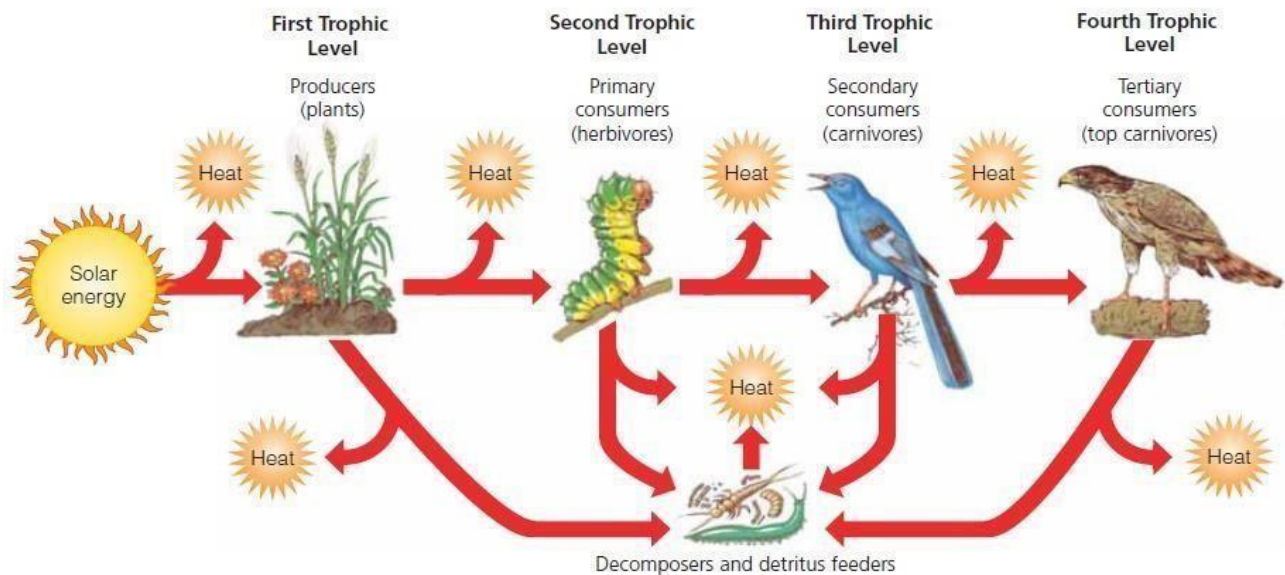
A plant-eating animal (an herbivore) that obtains organic molecules by eating producers (autotrophs) or their products.

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.

- ☀ Some herbivores have a special digestive system so they are able to eat/digest grasses.



- ☀ Many have to eat all day long to get enough energy.

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.

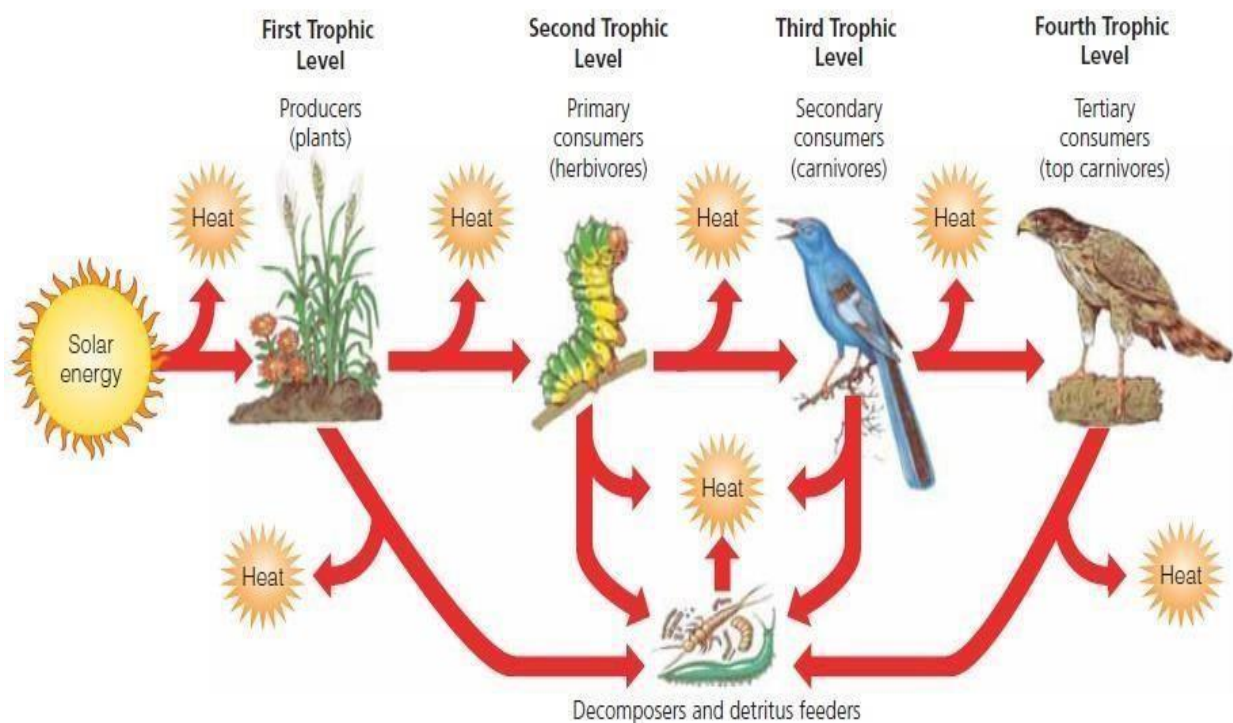
A giraffe lives in Africa and eats leaves from trees. They especially like the leaves of the Arcadia tree. A giraffe may eat 75 pounds of food each day.

Topic_50 Secondary consumers

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

Spiders eat insects.

A frog eats insects, earthworms, and spiders.



Carnivorous fishes possess long stomach and short intestine.

Topic_51 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.

Topic_52 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

Dentition of Omnivores

Omnivores have teeth that can perform a number

of tasks, o Tearing o Ripping o Chiseling o

Grinding

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

A grizzly bear usually eat things such as grasses, roots, berries, insects, fish, and small / 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!

Topic_53 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 breakdown of bodies of dead organisms into nutrient compounds such as water, carbon dioxide, minerals, and simpler organic compounds.

Topic_54 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.

Hordes of decomposers and detritus feeders can transform a fallen tree trunk into a powder and 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.

Topic_55 The 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%).
- 1% of the air includes water vapor, carbon dioxide, and methane, all of which are called **greenhouse gases**, because they trap heat and thus warm the lower atmosphere.

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

3. Geosphere The geosphere 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, and geosphere where life exists. This thin layer of the earth extends from about 9 kilometers (6 miles) above the earth's surface down to the bottom of the ocean.

Topic_56 Population ecology: Dynamics

Populations differ in factors such as their

1. **Distribution**
2. **Numbers**
3. **Age structure**
4. **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.

2. Uniform dispersion

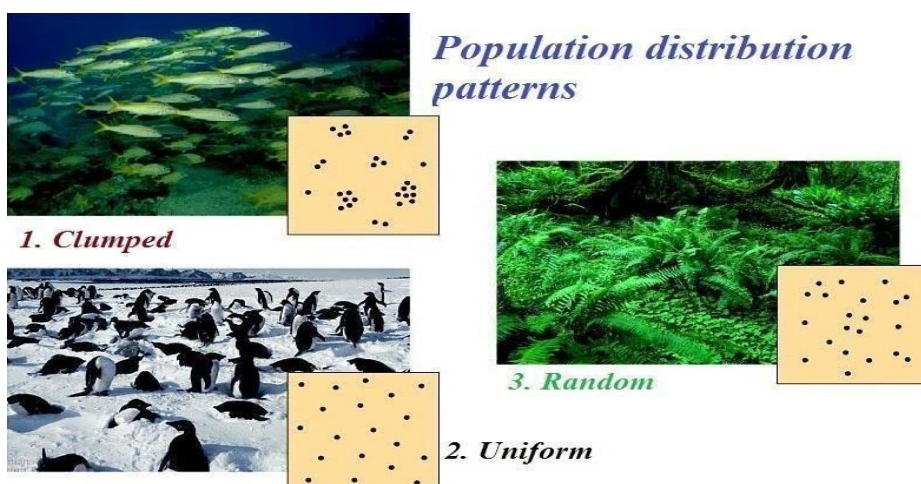
The tendency for populations to be found evenly distributed about their habitat.

This is generally caused by a species ability to survive anywhere in their habitat. They use the resources found immediately around them, and 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.



Topic_57 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 between 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.

Topic_58 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 and other herbivores, and this would decrease the normal carrying capacity for those species.

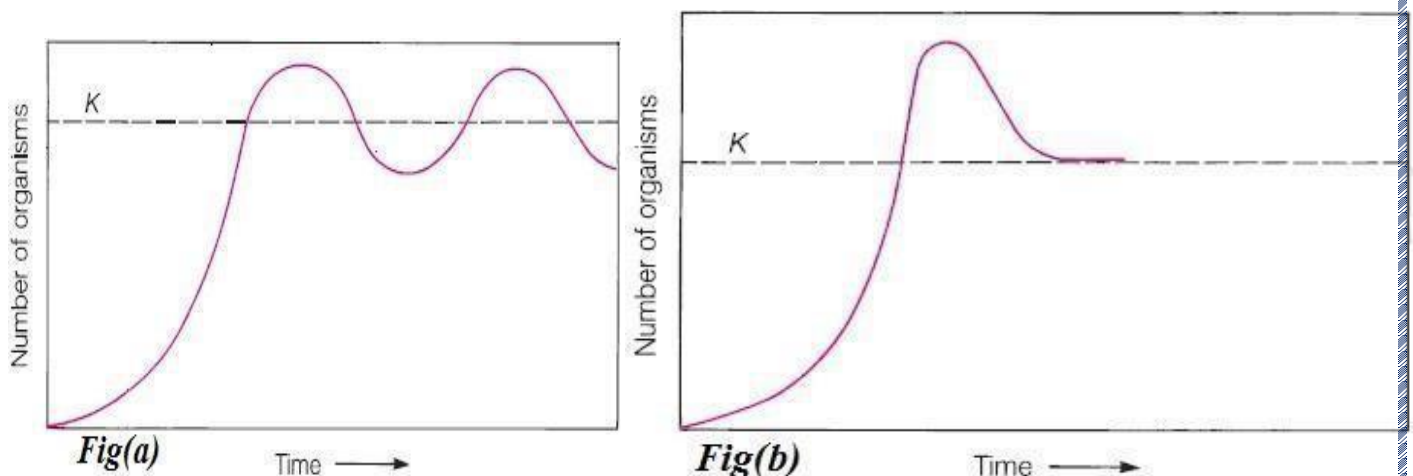
Carrying capacity plays a vital role in sustainability and protection of an environment. When a population exceeds the carrying capacity of an area, it causes damage that reduces the area's carrying capacity.

Topic_59 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 Jshaped curve *fig(b)*.



Reproductive potential

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

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

Topic_60 Logistic population growth

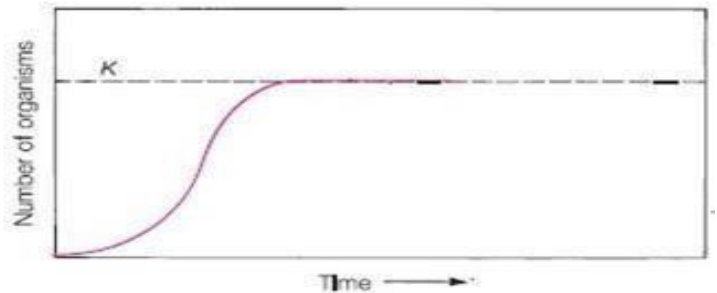
Decrease in growth of rapidly growing populations due to limited resources, until they reach their carrying capacity is termed as logistic population growth.

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 and 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. 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.



Topic 61-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 abiotic 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.

Topic 62-Population density

Population density is the number of individuals in a population found in a particular area.

Population density and 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 and infectious diseases.
- ✦ Smaller organisms have high population density than larger organisms.

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

63-density independent factors

Factors that influence the number of animals in a population and 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,

- o Weather
- o Earthquake
- o Floods
- o Hurricanes
- o Fire
- o Pollution
- o Habitat destruction
- o Climate changes
- o Weather conditions often limit populations.
- o A severe freeze in
- o late spring can
- o kill many individuals
- o in a plant population
- o or a population
- o of monarch butterflies
- o 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.

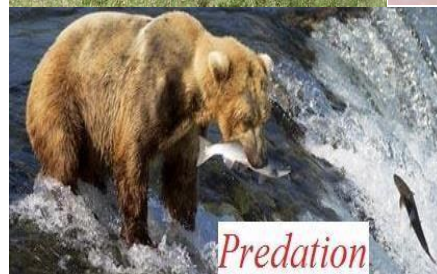
Human activities, such as construction and deforestation, often affect animal populations in a similar fashion.



64-density dependent factors

Factors that influence both, the population size and 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



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

65-impact of human populations

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 severely affected the environment by putting pressure on the natural resources.

Human impact on environmental health,

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



66-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. It 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, and methane, all of which are called greenhouse gases, because they trap heat and 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 following processes:
 Breathing of animals
 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.

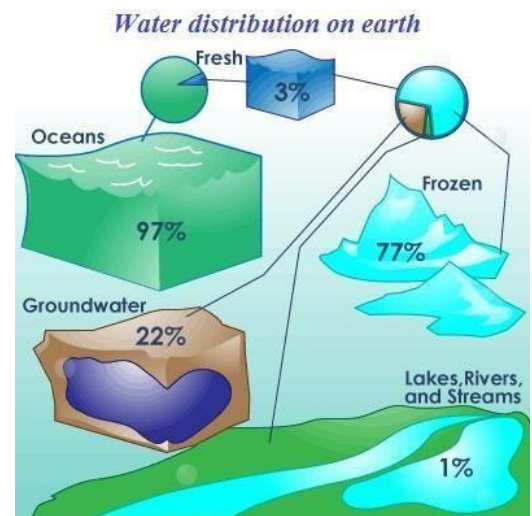
67-Water (abiotic factor)

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

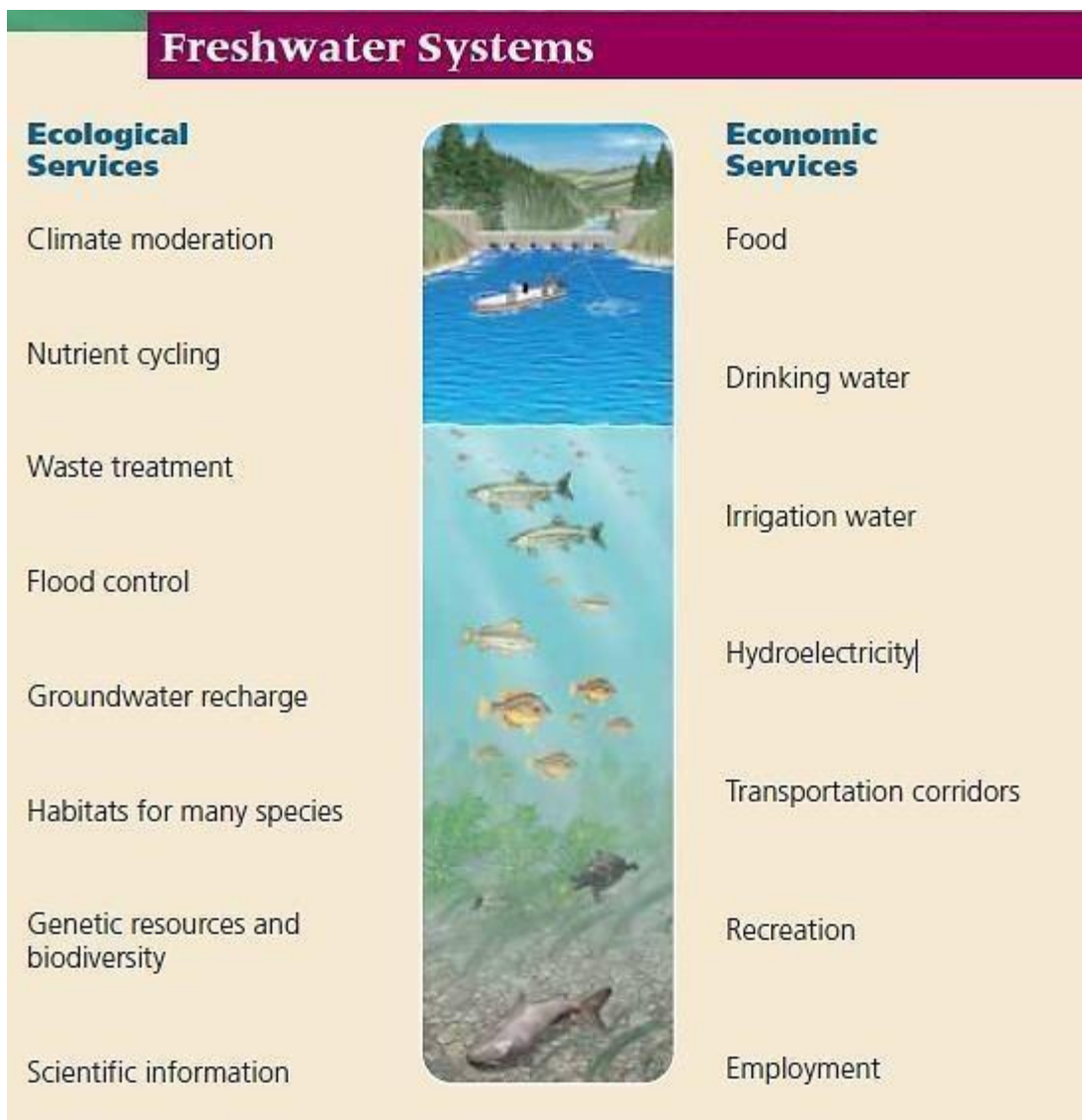


68-freshwater ecosystem

Freshwater Division

Freshwater ecosystem includes

1. **Lentic water bodies or systems**
2. **Lotic water bodies or systems**
3. Cover almost about **3%** of the earth's surface.
4. They provide a number of important ecological and economic services to humans.
5. Possess diverse flora and fauna.



69-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.

Springs

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



70-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, and 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.

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.

Streams receive their water from

- o Precipitation
- o Melting snow
- o Groundwater

They lose water by

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

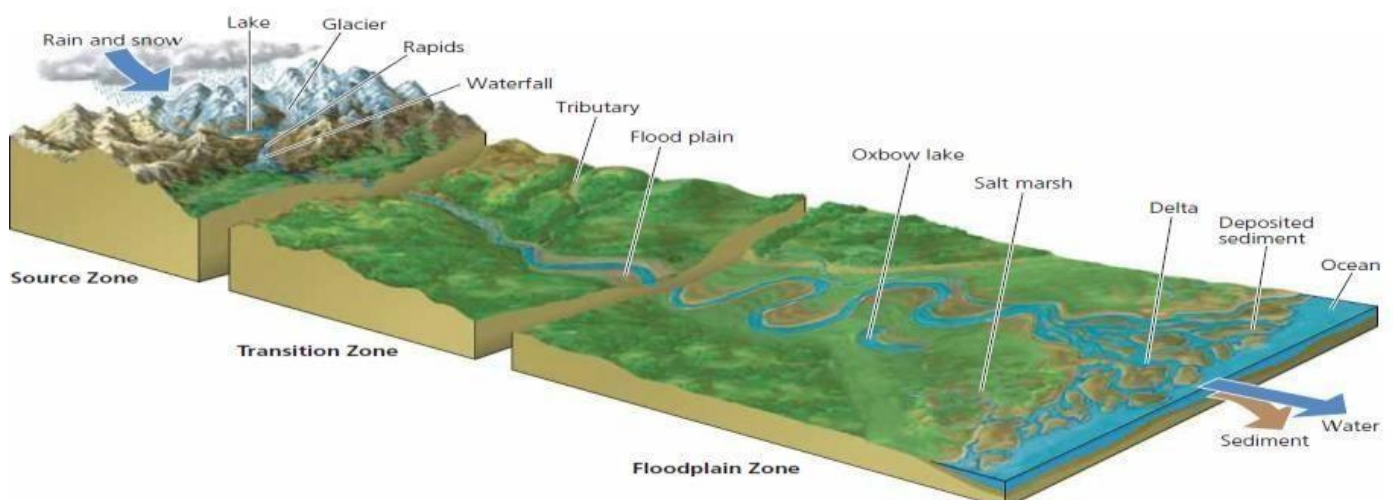
The velocity of a stream depends on following factors

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

71-Rivers

Small streams join to form rivers, and rivers flow downhill to the ocean. Rivers and streams are powerful transporting agents as they roll and 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

72-Lentic water body

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.

73-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.

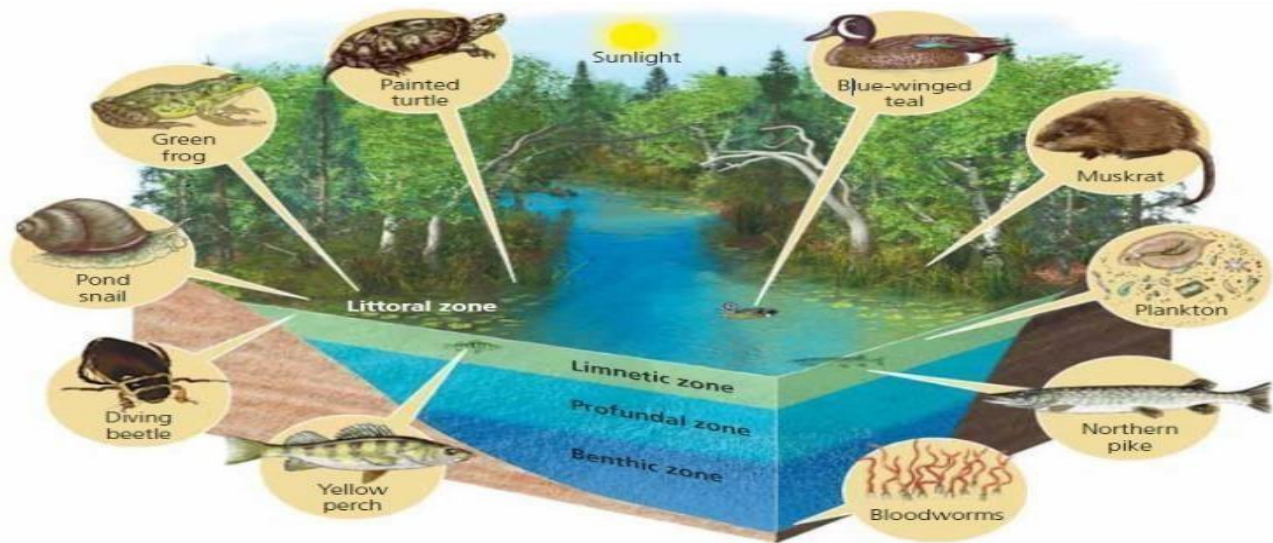
- ✦ No photosynthesis.
- ✦ Oxygen levels are often low

- ✦ Cool and dark water with fish species is found

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



74-Oligotrophic lake

Ecologists classify lakes according to their

1. Nutrient content
2. Primary productivity.
3. Lakes that have a small supply of plant nutrients are called **oligotrophic lakes**.
4. Oligotrophic lakes are poorly nourished lakes.
5. Often deep
6. Steep banks
7. Glaciers and mountain streams supply water
8. Little sediment or microscopic life
9. Crystal-clear water
10. Small populations of phytoplankton and fishes such as smallmouth bass and trout
11. Low net primary productivity.
12. 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.

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

Cultural eutrophication

Human inputs of nutrients from the atmosphere and from nearby urban and agricultural areas can enhance the biological activity of lakes by a process called **cultural eutrophication or simply eutrophication.**

Hypertrophic lake

Lake having excessive amounts of dissolved nutrients.

Mesotrophic lake

A lake 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



76-inland wetland

Inland wetlands are lands covered with freshwater all or part of the time (excluding lakes, reservoirs, and streams) and 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.

- o Prairie potholes
- o Floodplain wetlands
- o Bottomland hardwood swamps

Wetlands are important habitats for

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

77-Ecological and economic services of a wetland

Wetlands are very valuable natural habitats in different areas of world. They provide a number of free ecological and economic services to humans and 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, and waterfowl hunters.

78-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
5. **Fjords**
6. A type of estuary that is formed in river valleys due to the action of valley glaciers. Mostly found in Norway.

79-Coastal wetlands

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

- o Maintain water quality

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

80-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 and 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

Functional Diversity

The biological and chemical processes such as energy flow and matter recycling needed for the survival of species, communities, and ecosystems.

Ecological Diversity

The variety of terrestrial and aquatic ecosystems found in an area or on the earth.



Genetic Diversity

The variety of genetic material within a species or a population.

Species Diversity

The number and abundance of species present in different communities

81-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

2. Open ocean

The part of ocean that is deep and 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 and smaller fishes are the inhabitants of this zone.

Abyssal zone

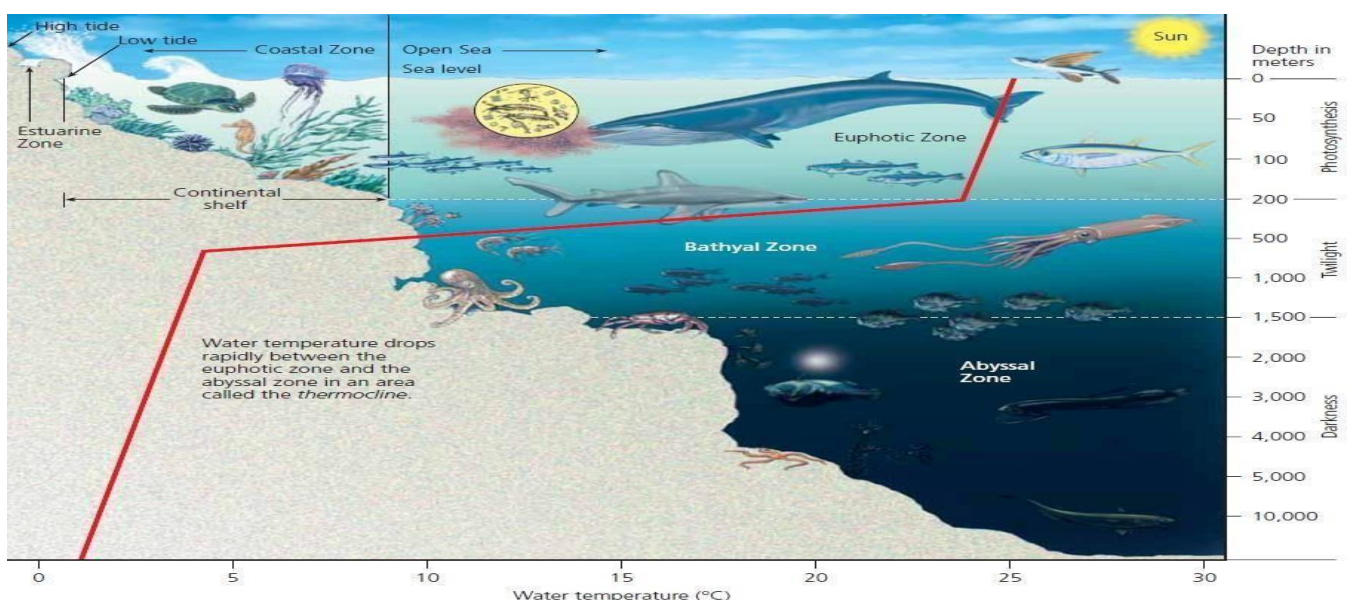
- The deepest zone of ocean that contains cold and dark water.
- -No photosynthetic activity.
- -Contains enough nutrients to support large number of species

3. Ocean floor

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



82-Importance of marine ecosystem

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
- 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 and transportation routes
- ✦ Minerals
- ✦ Oil and natural gas
- ✦ Building materials
- ✦ Coastal habitats for humans
- ✦ Recreation ▪ Employment

83-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 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.
- Bottom dwellers

- Oysters, which anchor themselves to one spot
- Clams and worms, which burrow into the sand or mud
- Lobsters and crabs, which walk about on the sea floor – **Decomposers**
- Mainly bacteria and fungi that break down dead and decaying organic matter and release nutrients. These nutrients in turn are used by the primary producers for manufacturing food.

84-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.



A coral reef with a large number of different species.

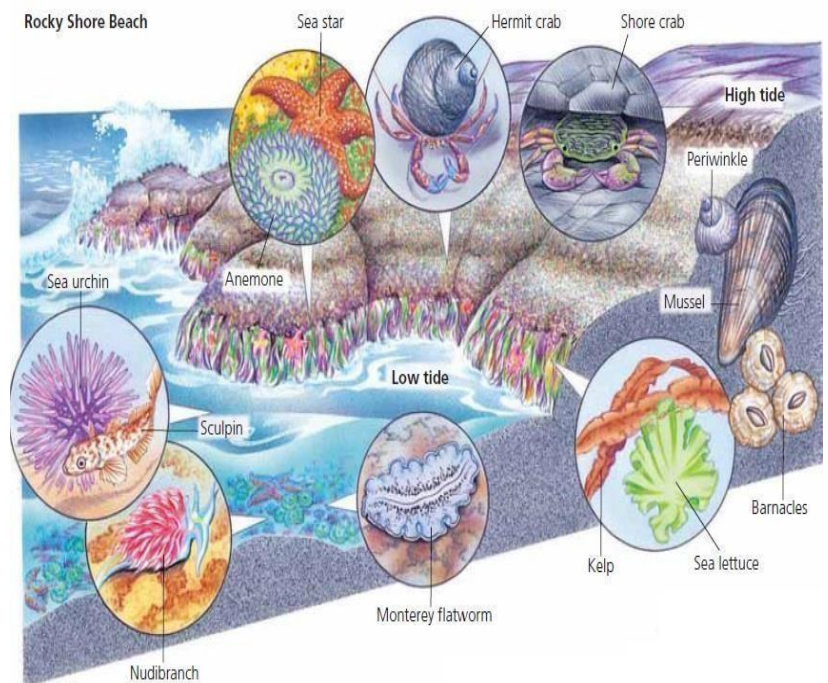
- ✦ Provide natural habitat
- ✦ Economic benefits
- ✦ Food
- ✦ Medicine
- ✦ Recreation
- ✦ Breeding grounds
- ✦ Nursing grounds

85-Rocky and sandy shores

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



Temperatu
re

o Water flow

o Salinity

**Sandy
shore**

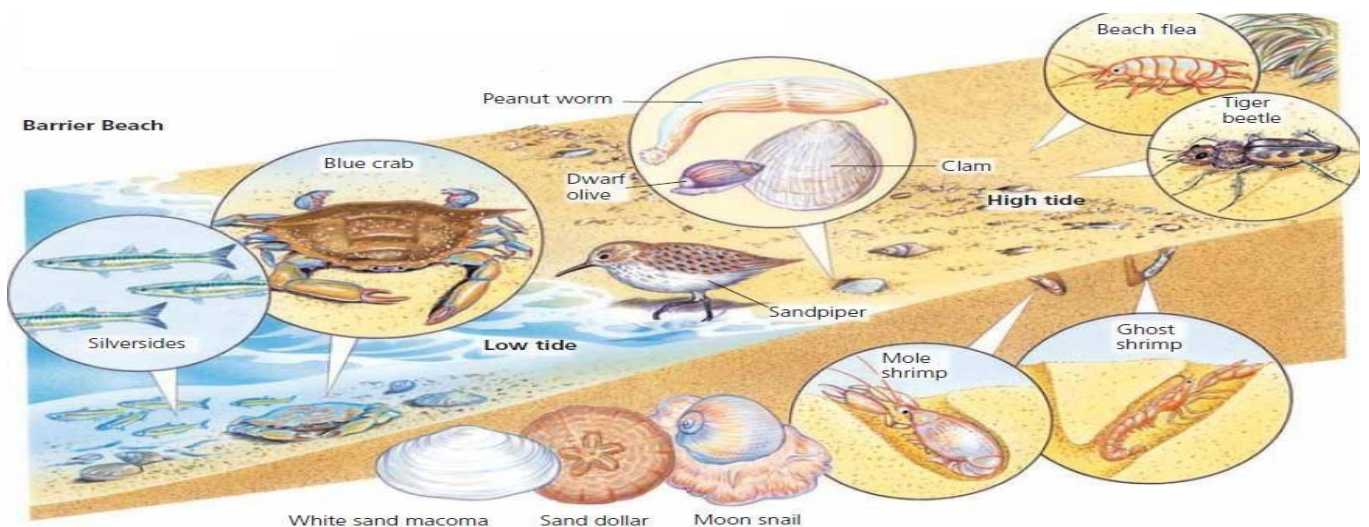
Sandy beaches and their adjoining coastal wetlands are a home to a variety of shorebirds that feed in specialized niches on crustaceans, insects, and other organisms.

Many of these species also live on **barrier islands-**

Low, narrow, sandy islands that form offshore, parallel to some coastlines.

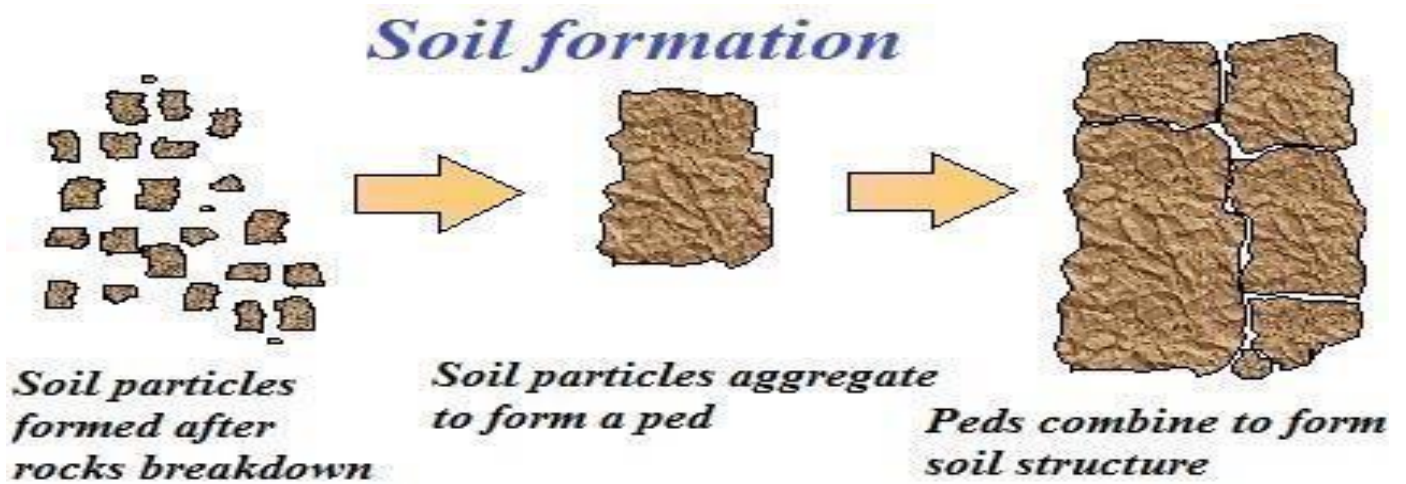
In sandy shore areas organisms can survive by adopting following adaptations,

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



86-Soil (abiotic factor)

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



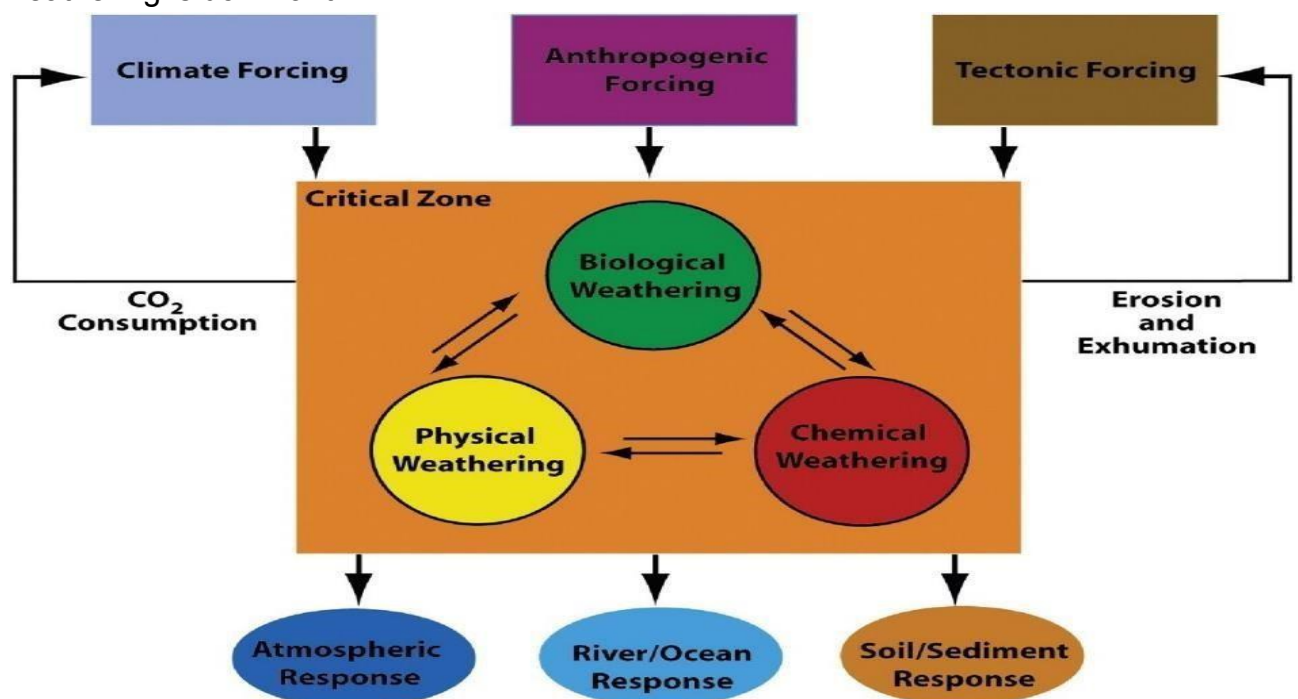
Weathering is an important phenomenon in soil forming process.

Weathering

Process of decomposition and disintegration that causes the rocks to break down in a natural way.

- † 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 and quickly by other plants that take the opportunity to grow in cracks and crevices.

As the plants decay they aid in the soil-forming process.

Soil importance:

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

87-Soil types

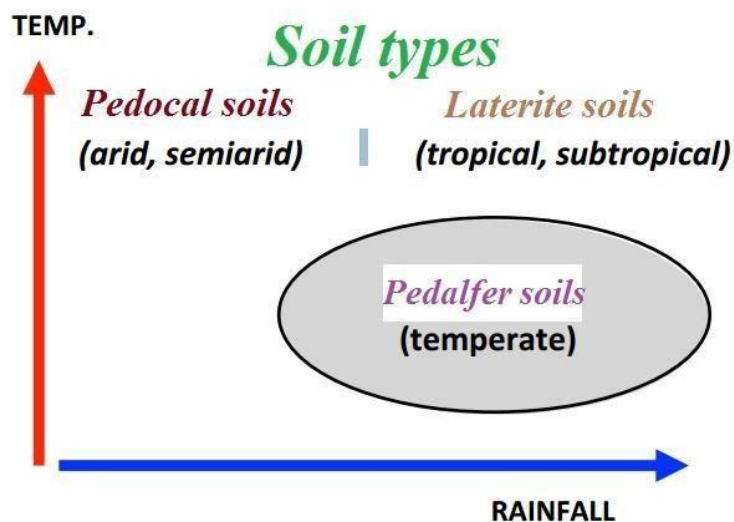
Type of a soil can be determined by,

- Composition of the material
 - Topography
 - Climate
 - Time length
- In general soils are classified into two 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), and *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 and semiarid) climates and are basic in nature. ○ Less leaching activity. ○ Promotes growth of desert shrubs and small and medium grasses. ○ **Laterite soil** ○ A special type of Pedocal that is bright red and forms in tropical and subtropical climates with heavy rain and high temperature.
 - **Caliche** ○ A tough cemented layer developed by the dense mass of calcium carbonate.



88-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**

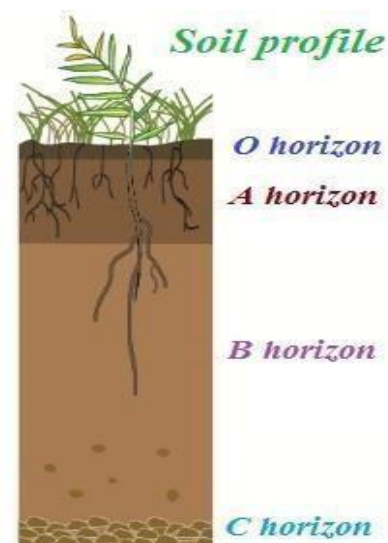
Uppermost zone of soil surface where fallen leaves and other plant matter is deposited.

A-horizon

Zone of leaching because percolating rain picks up the soluble materials and transport it downward to 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 and hard bedrock material. **Factors that influence these horizons are,**

- ✦ Erosion
- ✦ Wind
- ✦ Precipitation
- ✦ Human activity
- ✦ Topography



89-Temperature (abiotic factor)

Temperature controls metabolic rate as well as overall activity of an individual. For example normal body temperature of humans, goat and 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)

90-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

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

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

ZOO507 - Principles of Animal Ecology

Final term 91 to 179

91-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



92-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 o

Sweating o Panting o Vasodilation o

Aestivation

Survival mechanisms in cold

environment o Fat deposits o Fur o Feathers

o Vasoconstriction o Hibernation



93-torper

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, and other animals. Torpor is generally found in small bird and 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.

94-Hibernation

A condition in which animals become inactive usually in cold environments for their survival. Animals hibernate due to following reasons,

- o Very low temperature
- o 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.



95-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.



96-Aestivation

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

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

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

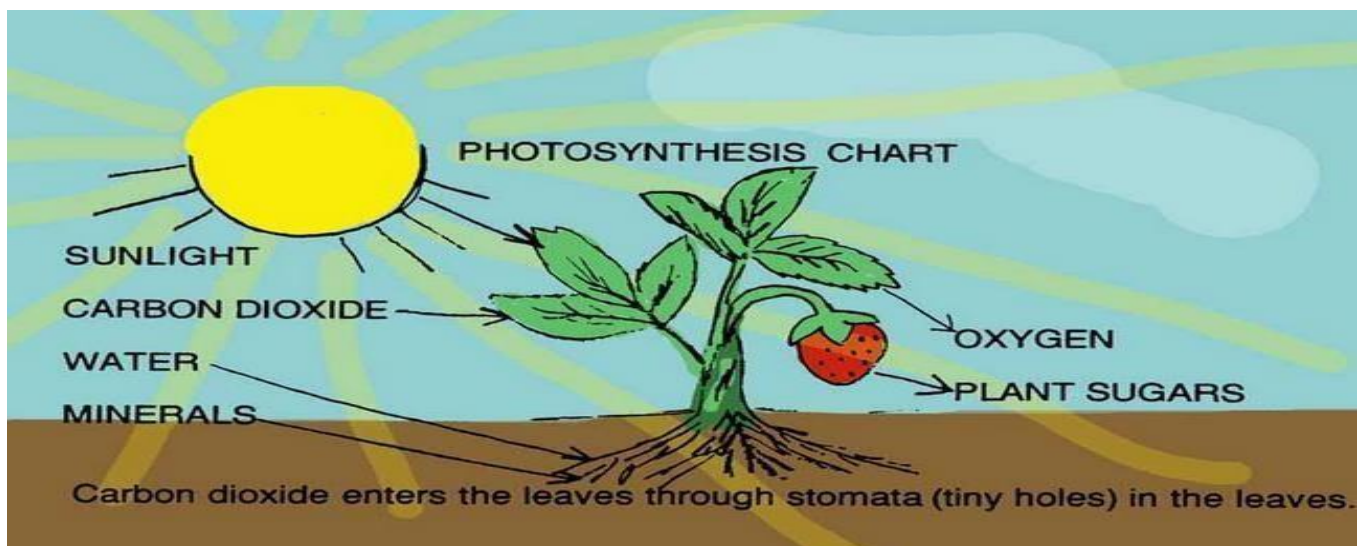
The Australian burrowing frog, *Cyclorana alboguttatus*, in its burrow and water-retaining skin.

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



97-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 and also oxygen for all living organisms which are dependent on plants for this purpose.



Photosynthesis



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

Light plays a vital role in following life running

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

98-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.

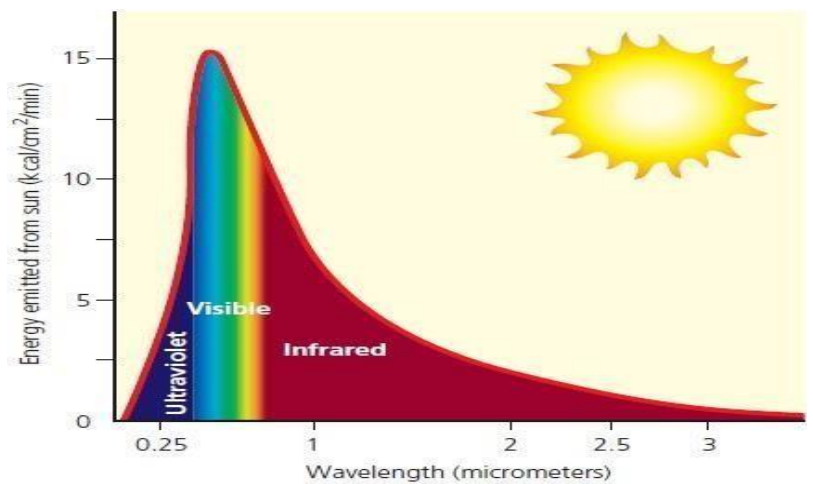
On the base of wavelength there are two types of electromagnetic radiations.

1. **Electromagnetic radiations with short wavelength**
 2. **Electromagnetic radiations with long wavelength**
1. **Electromagnetic radiations with short wavelength** o
- Gamma rays o X rays o
 - (UV) ultraviolet radiation

2. **Electromagnetic radiations with long wavelength**
- wavelength** o Visible light o Infrared radiation
 - (IR)

- o 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.



99-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.

100-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

101. species composition

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

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

It is expressed as a percent.

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

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

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

- Ecological indicators
- Management indicators

Ecological indicators

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

Management indicators

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

102. Species richness

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

Species abundance

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

Species evenness

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

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

103. 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**.

104. Succession

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

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

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

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

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

Autogenic succession

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

Allogenic succession

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

Types of succession

Succession is of two types

1. Primary succession

2. Secondary succession

Succession benefits

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

105. Primary succession

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

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

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

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

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

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

Seral stage

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

Sere

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

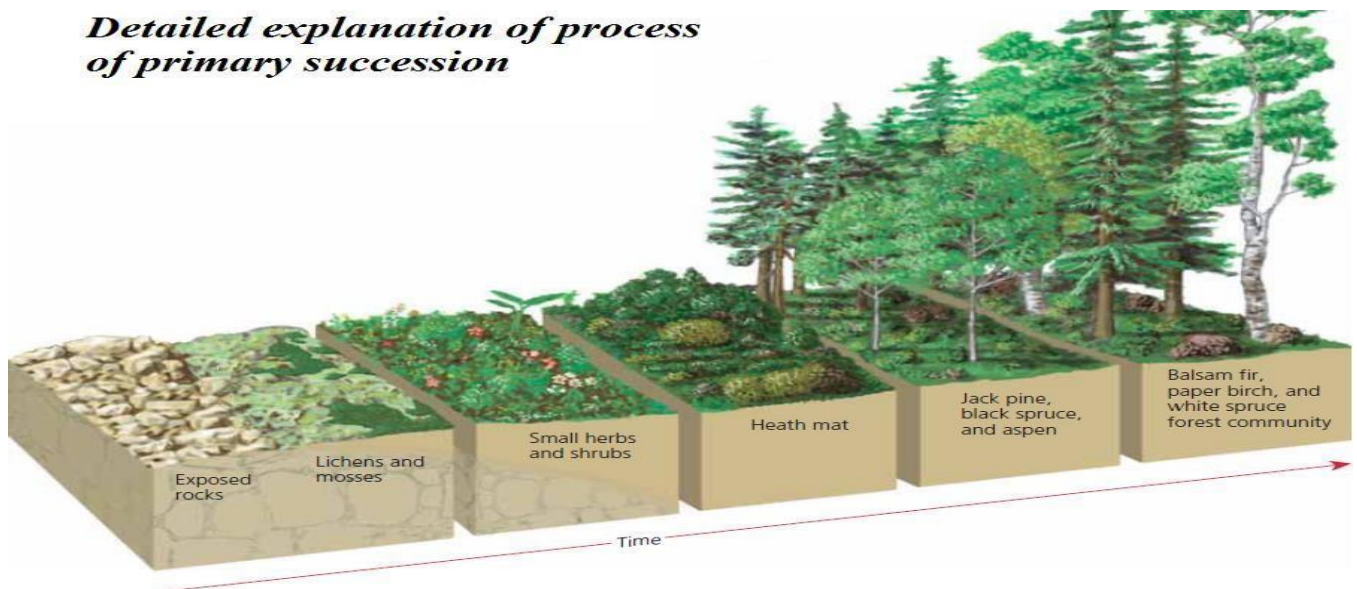
Biomass increases, nutrients are conserved more efficiently, and productivity declines in the course of succession.

Climax community

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

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

Detailed explanation of process of primary succession



106. Secondary succession

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

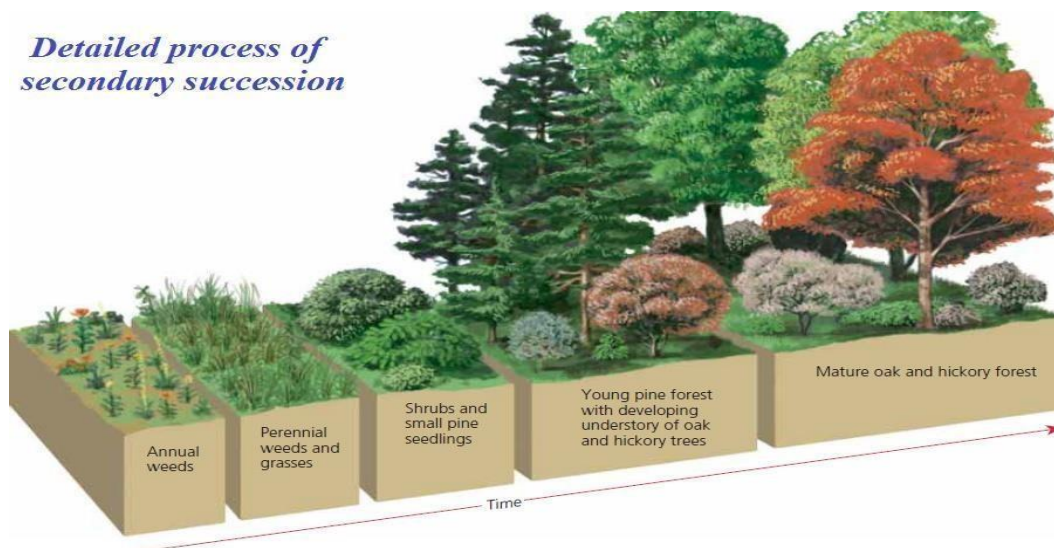
It develops rapidly than primary succession because previous disturbed community has left its marks in form of improved soil and seeds.

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

Candidates for secondary succession include

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

Detailed process of secondary succession



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.

107. Interspecific competition

All organisms require space and food for their survival. Requirement of both space and food causes competition between 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**.

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) *Blackthroated green warbler* (*D. virens*). (e) *Myrtle warbler* (*D. coronata*).

108. Coevolution

The evolution of ecologically related species is sometimes coordinated such that each species exerts a strong selective influence on the other. This is **Coevolution**.

Coevolution may occur when species are competing for the same resource or during predator–prey interactions.

When populations of two different species interact, then changes in the gene pool of one species can lead to changes in the gene pool of the other species. Such changes can help both sides to become more competitive or can help to avoid or reduce competition. Biologists call this process

Coevolution.

One example of Coevolution is the relationships between some flowering plants and their animal pollinators. Insect-pollinated flowers are usually yellow or blue because insects see these wavelengths of light best.

Flowers pollinated by hummingbirds, are often tubular and red. Hummingbirds have a poor sense of smell but see red very well. The long beak of hummingbirds is an adaptation that allows them to reach far into tubular flowers.



Long-term interactions between bats and their prey such as moths and butterflies can lead to Coevolution, as the bats evolve traits that increase their chances of getting a meal and the moths evolve traits that help them avoid being eaten.

109. Symbiosis

Some of the best examples of adaptations arising through Coevolution come from two different species living in continuing, intimate associations, called **symbiosis** (Gr. *sym, together bio, life*).

Symbiosis ('living together') is the term that has been coined for such close physical associations between species, in which a 'symbiont' occupies a habitat provided by a 'host'.

In some instances, one member of the association benefits, and the other is harmed. In other cases, life without the partner would be impossible for both.

Common form of symbiosis

are o

Commensalism o Mutualism

110. Commensalism

Commensalism is a symbiotic relationship in which one member of the relationship benefits, and the second is neither helped nor harmed.

In tropical forests certain kinds of silverfish insects move along with columns of army ants to share the food obtained by the ants in their raids. The army ants receive no apparent harm or benefit from the silverfish.

Epiphytic plants such as certain types of orchids and bromeliads attach themselves to the trunks or branches of large trees in tropical and subtropical forests. These air plants benefit by getting a solid base on which they grow.

They also live in an elevated spot that gives them better access to sunlight, water from the humid air and rain, and nutrients falling from the tree's upper leaves and limbs.

Their presence apparently does not harm the tree.

111. Mutualism

Mutualism is a symbiotic relationship that benefits both members. In mutualism, two species behave in ways that benefit both by providing each with food, shelter, or some other resource.

For example, honeybees, caterpillars, butterflies, and other insects feed on a male flower's nectar, picking up pollen in the process, and then pollinating female flowers when they feed on them.

In gut inhabitant mutualism, vast armies of bacteria in the digestive systems of animals help to break down (digest) their hosts' food. In turn, the bacteria receive a sheltered habitat and food from their host.

Oxpeckers or tickbirds feed on parasitic ticks that infest large, thick skinned animals such as the endangered black rhinoceros.

A clownfish gains protection and food by living among deadly stinging sea anemones and helps protect the anemones from some of their predators.

Some other forms of mutualism

are,

- **Lichen**
- **Mycorrhizae**
- **Root nodules**

112. Lichens

A mutualistic association between algae and fungus in which both the partners get benefits from each other is known as lichen. Fungus are usually Ascomycetes or Basidiomycetes while the other partner is algae or cyanobacteria. **Growth forms of Lichens**

1. Crustose
2. Foliose
3. Fruticose



Crustose:

A type of lichen that form a flat crust on the substratum and firmly attached to substratum.

Foliose:

This type of lichens have flat leaf like structures and are attached to substratum by thread like structures



Fruticose:

This type of lichens have erect filamentous like outgrowths and possess vertical pattern of growth.



Benefits of Lichens

- Bioindicators
- Ecosystem sustainability
- Medicines
- Animal food ➤ Dye for clothes

113-Mycorrhizae

A mutualistic relationship between fungi and roots of higher plants by which both partners are get benefited. A very remarkable group of Ascomycetes fungi, the Clavicipitaceae, grow in the tissues of many species of grass.

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



Major types of Mycorrhizae

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

Endomycorrhizas or Arbuscular mycorrhizas:

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

Ectomycorrhizas:

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

Ericoid mycorrhizas:

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

114. Root nodules

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

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

Types of nitrogen fixing bacteria

Azobactor

- Free living aerobic bacteria

Clostridium

- Free living anaerobic bacteria

Chlorobium

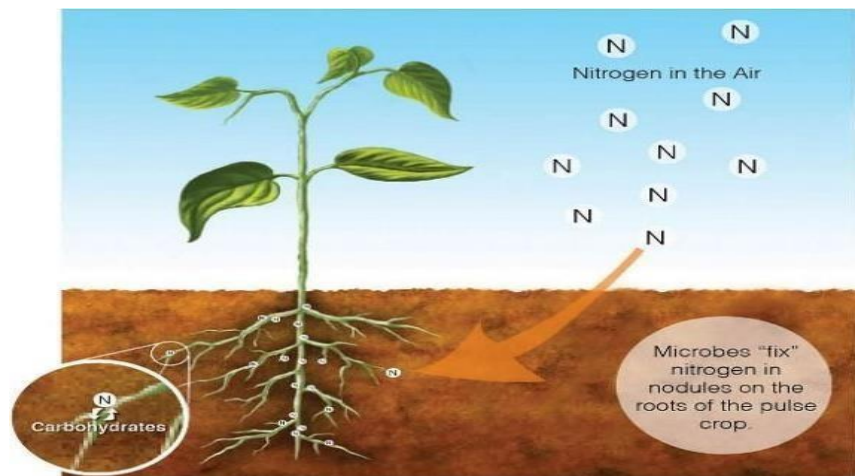
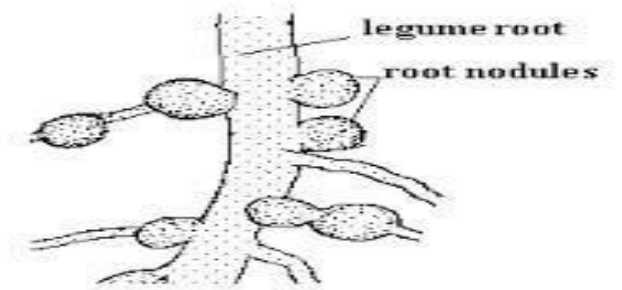
- Photosynthetic bacteria

Thiobacillus

- Chemosynthetic bacteria

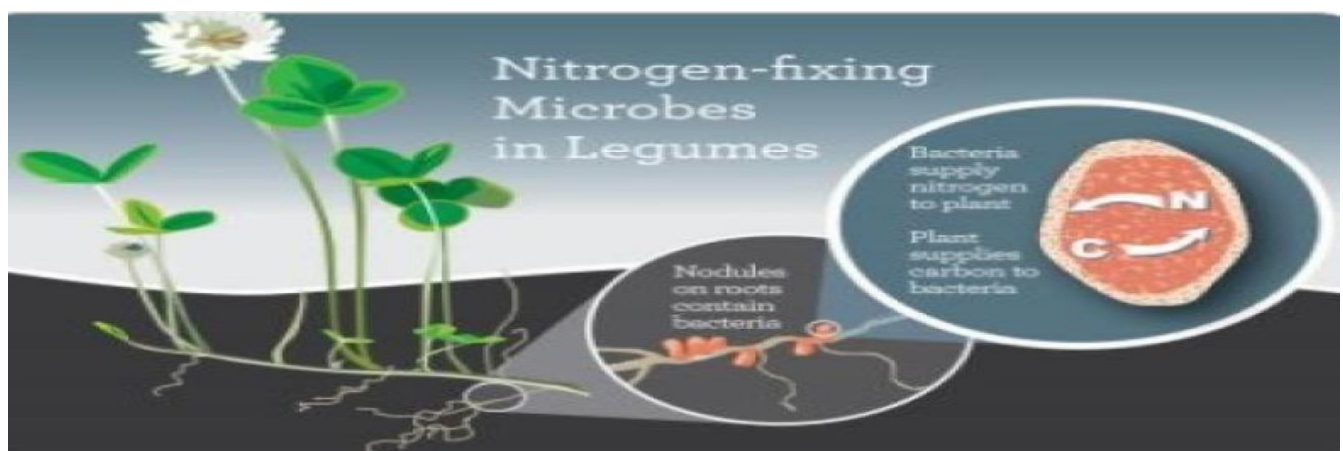
Nostoc

- Blue green algae



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

This whole picture summarizes the process of nitrogen fixation.



115. Parasitism

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

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

Endoparasite

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

- ✦ Pathogens

- ✦ *Entamoeba histolytica*
- ✦ Tapeworms
- ✦ Hookworms

Ectoparasite

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

- Mosquitoes
- Mistletoe plants
- Sea lampreys

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

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

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

116. Interspecific adaptations

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

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

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

Common Interspecific adaptations,

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

117. Camouflage

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

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

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

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



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



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



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

118-Counter-shading

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

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

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

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

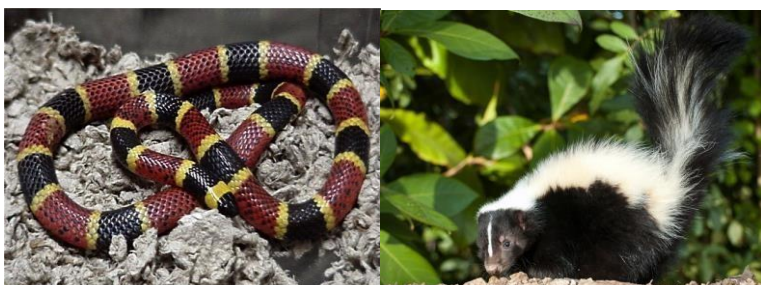
On the other hand, when fish view the eggs from below, the light undersurface blends with the bright air-water interface.

Penguins are another example that exhibit phenomenon of counter shading.

119-Aposematic coloration

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

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



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



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



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

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

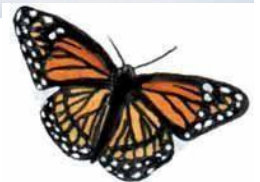
120-Mimicry

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

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



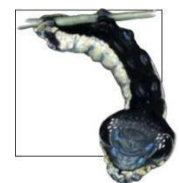
Some butterfly species, such as the non-poisonous viceroy, gain protection by looking and acting like the monarch, a protective device known as mimicry. Viceroy butterfly mimics monarch butterfly.



Some moths have wings that look like the eyes of much larger animals.



Hind wings of a moth resembles eyes of a much larger animal.



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

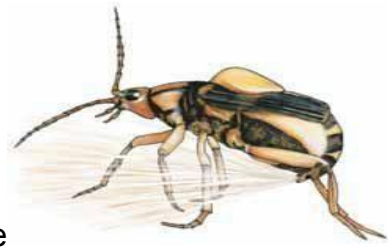
121-Chemical warfare

Chemical warfare is another common strategy to escape from predators.

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

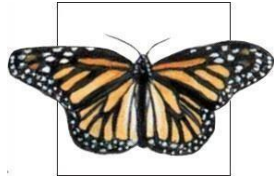
Some predators use chemical warfare to attack their prey. **For example**, spiders and poisonous snakes use venom to paralyze their prey and to deter their predators.

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



Bombardier beetle

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



monarch butterfly

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

122-Biome

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

Plants

Animals

Climate

Main elements of a biome are,

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

There are two broad categories of biomes,

1. Aquatic biomes
2. Terrestrial biomes

Aquatic biomes:

Aquatic biomes are further classified into,

1. -Saltwater biome
2. -Freshwater biome

Terrestrial biomes:

1. -Tundra biome
2. -Desert biome
3. -Grassland biome
4. -Forest biome

123-Biogeochemical cycles

The process that involves the cyclic movement of nutrients between biotic (living portion) and abiotic (non living) environment of earth is **termed as biogeochemical cycle.**

Matter is constantly recycled within ecosystems.

A nutrient is any element essential for life. Approximately 97% of living matter is made of oxygen, carbon, nitrogen, and hydrogen.

Biogeochemical Cycles are of two main types

1. Gaseous cycles

2. Sedimentary cycles

Gaseous Cycles,

- Carbon cycle
- Nitrogen cycle
- Oxygen cycle
- Hydrogen cycle

Sedimentary Cycles,

- Sulfur cycle
- Phosphorus cycle
- Calcium cycle
- These elements are less abundant than those of gases.

In Sedimentary cycles the nonliving reservoir for these nutrients (phosphorus, nitrogen, calcium etc.) is the earth, and the cycles involving these elements are called sedimentary cycles.

Nutrient cycles connect past, present, and future forms of life. Some of the carbon atoms in your skin may once have been part of an oak leaf, a dinosaur's skin, or a layer of limestone rock.

- 1. Carbon cycle**
- 2. Nitrogen cycle**
- 3. Phosphorus cycle**
- 4. Sulfur cycle**
- 5. Water cycle**

124-Carbon cycle

Carbon is the basic building block of the carbohydrates, fats, proteins, DNA, and other organic compounds necessary for life. It circulates through the biosphere, the atmosphere, and parts of the hydrosphere, **in the carbon cycle**.

The carbon cycle is based on carbon dioxide (CO₂) gas, which makes up 0.038% of the volume of the atmosphere and is also dissolved in water. Carbon dioxide is a key component of nature's thermostat.

It depends on photosynthesis and aerobic respiration by the earth's living organisms.

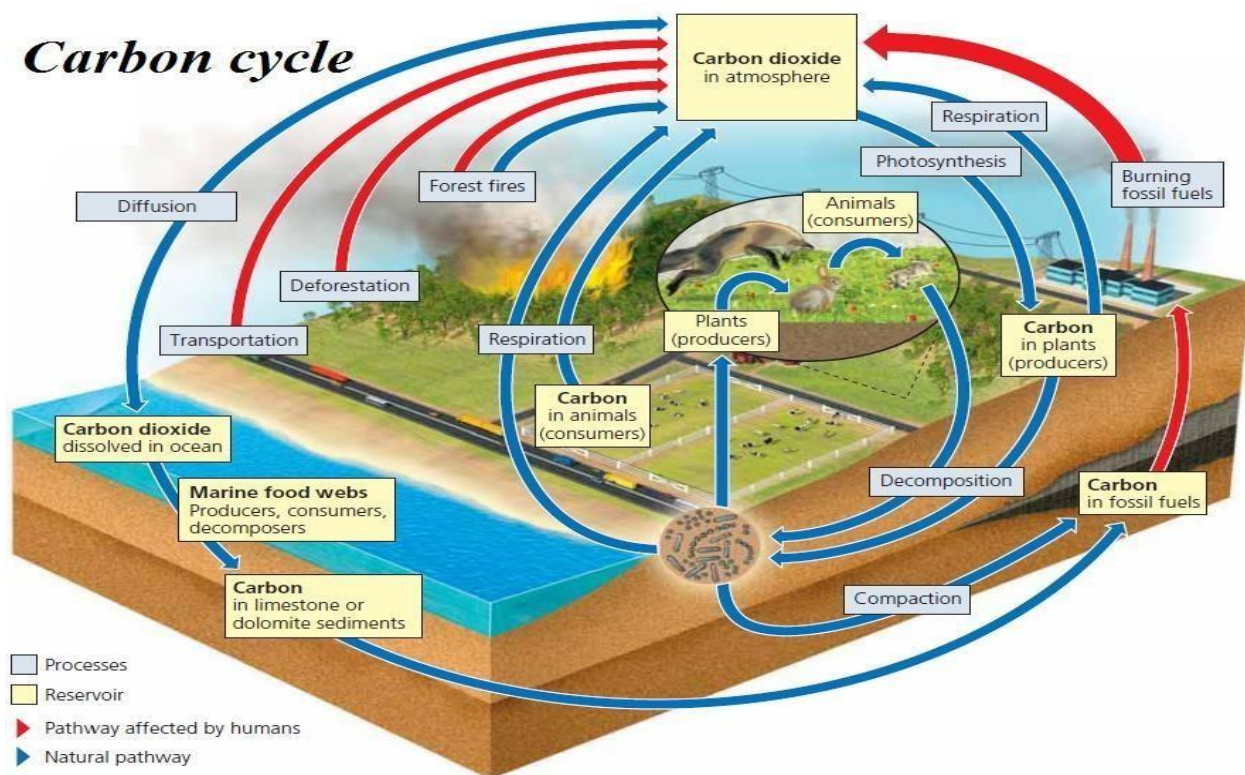
It is released into atmosphere by the process of aerobic respiration while consumed by the process of photosynthesis.

Terrestrial producers remove CO₂ from the atmosphere and aquatic producers remove it from the water.

Photosynthesis converts CO₂ into complex carbohydrates such as glucose (C₆H₁₂O₆).

This linkage between photosynthesis in producers and aerobic respiration in producers, consumers, and decomposers circulates carbon in the biosphere.

Oxygen and hydrogen, the other elements in carbohydrates, cycle almost in step with carbon.



125-Nitrogen cycle

The major reservoir for nitrogen is the atmosphere. Chemically unreactive nitrogen gas (N_2) makes up 78% of the volume of the atmosphere.

Nitrogen is a crucial component of proteins, many vitamins, and nucleic acids such as DNA.

However, N_2 cannot be absorbed and used directly as a nutrient by multicellular plants or animals.

Steps in nitrogen cycle

1. Fixation
2. Nitrification
3. Assimilation
4. Ammonification
5. Denitrification

Fixation:

Two natural processes convert or fix N_2 into compounds useful as nutrients for plants and animals.

1. Electrical discharges, or lightning, taking place in the atmosphere.
2. Nitrogen fixation by nitrogen-fixing bacteria.

Nitrification: Specialized soil bacteria convert most of the Ammonia (NH_3) and Ammonium ions (NH_4^+) in soil to nitrate ions (NO_3^-) which are easily taken up by the roots of plants.

Assimilation:

The plants then absorb nitrates from the soil into their roots to produce various amino acids, proteins, nucleic acids, and vitamins.

Ammonification:

When a plant or animal dies, specialized decomposer bacteria convert this detritus into simpler nitrogen-containing inorganic compounds such as Ammonia (NH_3) and water-soluble salts containing Ammonium ions (NH_4^+).

Denitrification: Specialized bacteria convert (NH_3) and (NH_4^+) back into nitrite and nitrate ions, and then into nitrogen gas (N_2) and nitrous oxide gas (N_2O). These gases are released to the atmosphere to begin the nitrogen cycle again.

126-Phosphorus cycle

Phosphorus circulates through water, the earth's crust, and living organisms in the phosphorus cycle.

In contrast to the cycles of water, carbon, and nitrogen, the phosphorus cycle does not include the atmosphere. The major reservoir for phosphorus is phosphate salts containing phosphate ions (PO_4^{3-}) in terrestrial rock formations and ocean bottom sediments. The phosphorus cycle is slow compared to the water, carbon, and nitrogen cycles.

Phosphorus is a component of biologically important molecules such as,

1. Nucleic acids
2. Energy transfer molecules (ADP and ATP)
3. Vertebrate bones and teeth.

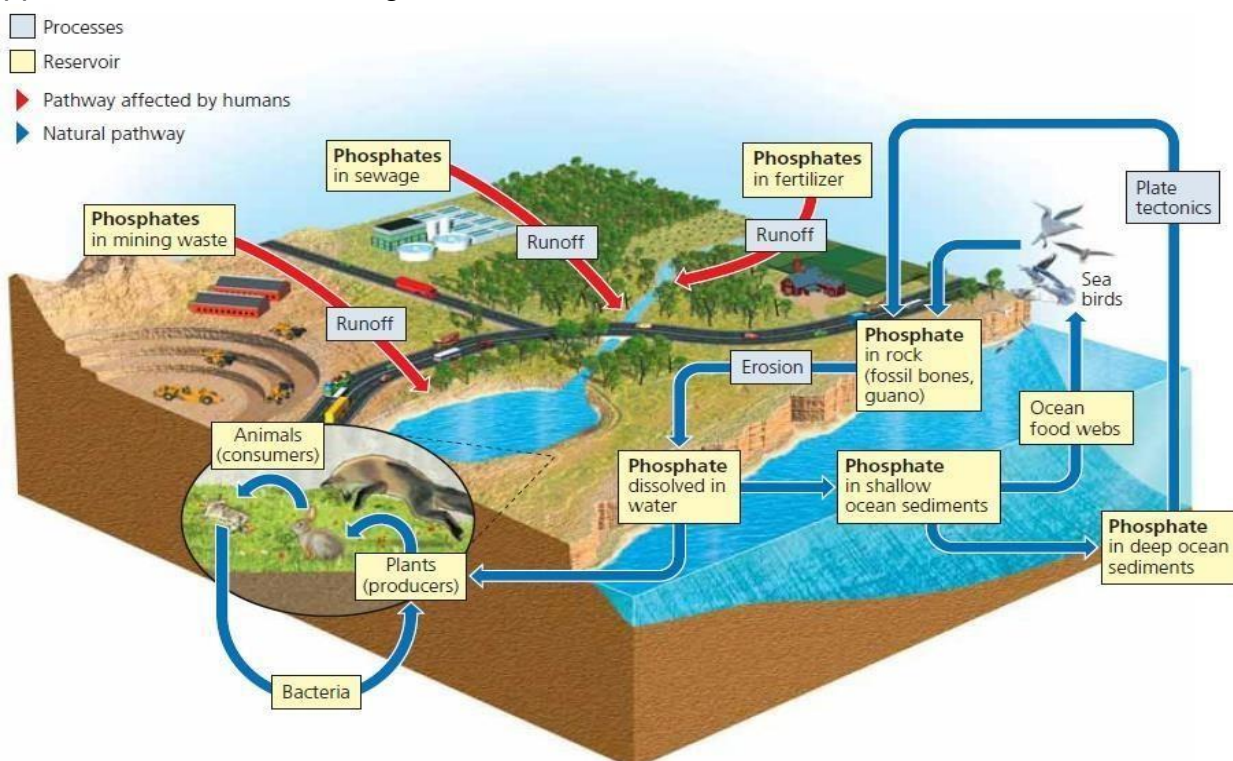
As water runs over exposed phosphorus containing rocks, it slowly erodes away inorganic compounds that contain phosphate ions (PO_4^{3-}).

The dissolved phosphate can be absorbed by the roots of plants and by other producers.

Phosphate can be lost from the cycle when it washes from the land into streams and rivers and is carried to the ocean. In oceans it can be deposited as marine sediment and remain trapped for millions of years.

Someday, geological processes may uplift and expose these seafloor deposits, from which phosphate can be eroded to start the cycle again.

Because most soils contain little phosphate, it is often the limiting factor for plant growth on land unless phosphorus (as phosphate salts mined from the earth) is applied to the soil as an inorganic fertilizer



127-Sulfur cycle

Sulfur circulates through the biosphere in the sulfur cycle. Much of the earth's sulfur is stored underground in rocks and minerals, including sulfate (SO_4^{2-}) salts buried deep under ocean sediments.

Sulfur also enters the atmosphere from several natural sources. Hydrogen sulfide (a colorless, highly poisonous gas with a rotten-egg smell) and Sulfur dioxide (a colorless and suffocating gas) is released from active volcanoes.

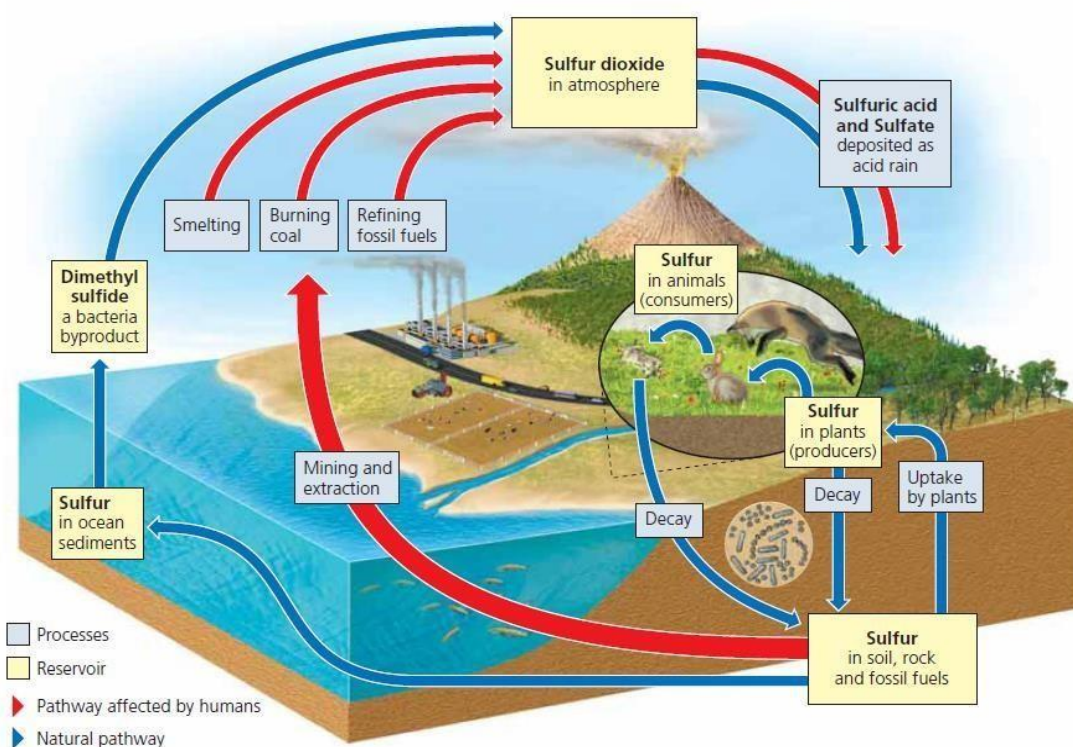
Particles of sulfate (SO_4^{2-}) salts, such as ammonium sulfate, enter the atmosphere from sea spray, dust storms, and forest fires. Plant roots absorb sulfate ions and incorporate the sulfur as an essential component of many proteins.

Certain marine algae produce large amounts of **volatile DMS (dimethyl sulfide)**.

In the atmosphere, **DMS** is converted to sulfur dioxide, some of which in turn is converted to sulfur trioxide gas and to tiny droplets of sulfuric acid (H_2SO_4).

In the oxygen-deficient environments of flooded soils, freshwater wetlands, and tidal flats, specialized bacteria convert sulfate ions to sulfide ions.

The sulfide ions can then react with metal ions to form insoluble metallic sulfides, which are deposited as rock, and the cycle continues



128-Water cycle

The **hydrologic cycle, or water cycle**, collects, purifies, and distributes the earth's fixed supply of water.

Water is an amazing substance which makes the water cycle critical to life on earth.

The water cycle is a global cycle because there is a large reservoir of water in the atmosphere as well as in the hydrosphere, especially the oceans.

The water cycle is powered by energy from the sun and involves three major processes,

1. **Evaporation**
2. **Transpiration**
3. **Precipitation** Evaporation:

Evaporation changes liquid water into water vapor in the atmosphere. Incoming solar energy causes evaporation of water from the oceans, lakes, rivers, and soil.

About 84% of water vapor in the atmosphere comes from the oceans, which cover almost three- fourths of the earth's surface; the rest comes from land.

Transpiration:

Over land, about 90% of the water that reaches the atmosphere evaporates from the surfaces of plants through a process **called transpiration**.

Precipitation:

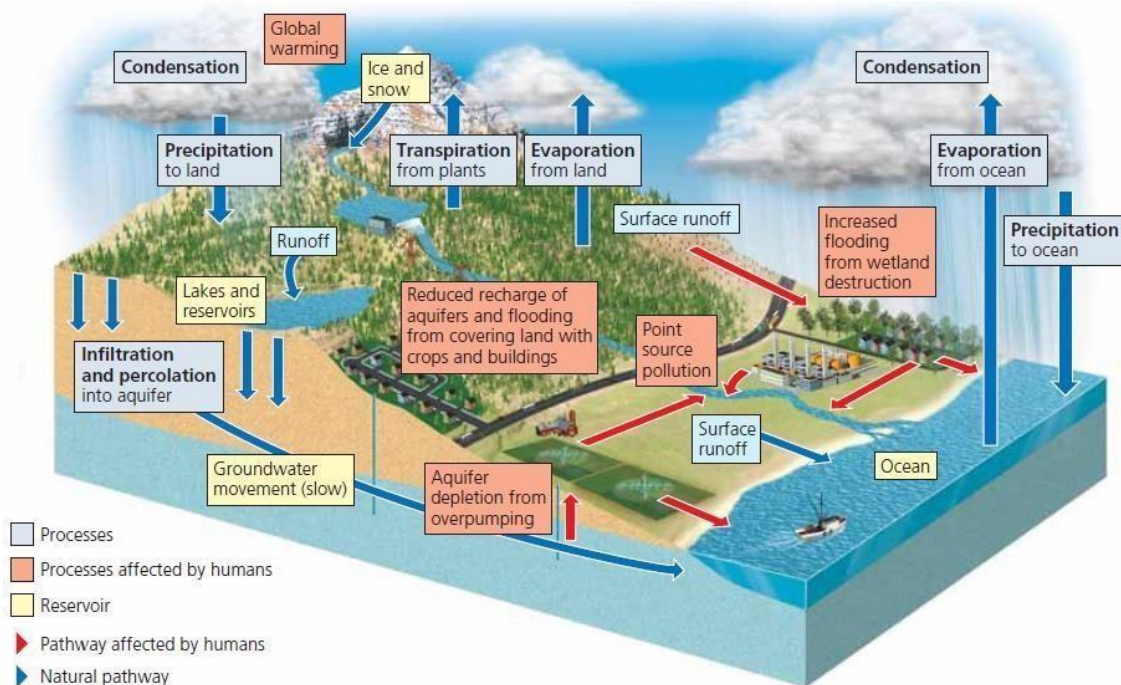
Precipitation returns the water back to earth's surface. Most precipitation becomes surface runoff that flows into streams and lakes and eventually in to the oceans. From oceans it can evaporate to repeat the water cycle.

Some precipitation is converted to ice that is stored.

Some precipitation sinks to underground layers of rock, sand, and gravel called aquifers, where it is stored as groundwater.

A small amount of the earth's water is absorbed by roots of plants. Some of this water is used to make food for consumers by photosynthesis, while most of water is evaporated through process of transpiration.

Consumers get their water from their food or by drinking it.



129-Pollution

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

Pollution is any detrimental change in an ecosystem.

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

Pollutants can enter the environment naturally through,

Volcanic eruptions Human activities -

Burning coal and gasoline

-Discharging chemicals into rivers and the ocean.

The pollutants come from two types of sources.

1. Point sources
2. Non point sources

Point sources are single, identifiable sources.

Examples are,

- Smokestack of a coal-burning power or industrial plant,
- The drainpipe of a factory,
- The exhaust pipe of an auto mobile.

Nonpoint sources are dispersed and often difficult to identify.

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

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

There are two main types of pollutants.

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

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

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

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

130-Organic pollutants or bio stimulants

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

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

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

Eutrophication

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

It decreases the oxygen content rapidly.

131-Water pollution

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

Sources of water pollution

- Domestic waste

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

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

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

Effects of water pollution

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

132-Air pollution

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

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

Air pollutants can be in the form of,

- ❖ Solid particles
- ❖ Gases
- ❖ Liquid droplets

Kinds of air pollutants

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

Effects of Air pollution

- Acid rain ▪ Greenhouse effect

- Global warming
- Ozone layer destruction

Acid rain or deposition

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

Greenhouse effect

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

Global warming

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

Ozone layer destruction

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

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

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

133-Noise pollution

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

Animals rely on hearing to,

- Communicate
- Avoid predators
- Obtain food

Effects of noise pollution,

- ❖ Hearing loss
- ❖ Loss of communication
- ❖ Physiological effects because of increased heart rate and metabolism

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

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

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

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

134-Climate change

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

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

It is estimated that 20,000,000 tons of SO₂ gas erupted into the stratosphere. The resulting H₂SO₄ (sulfuric acid) reflected 2 to 4 percent of the incoming solar radiation back into the space, reducing the mean global temperature at the surface about 0.5°C.

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

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

135-Greenhouse effect

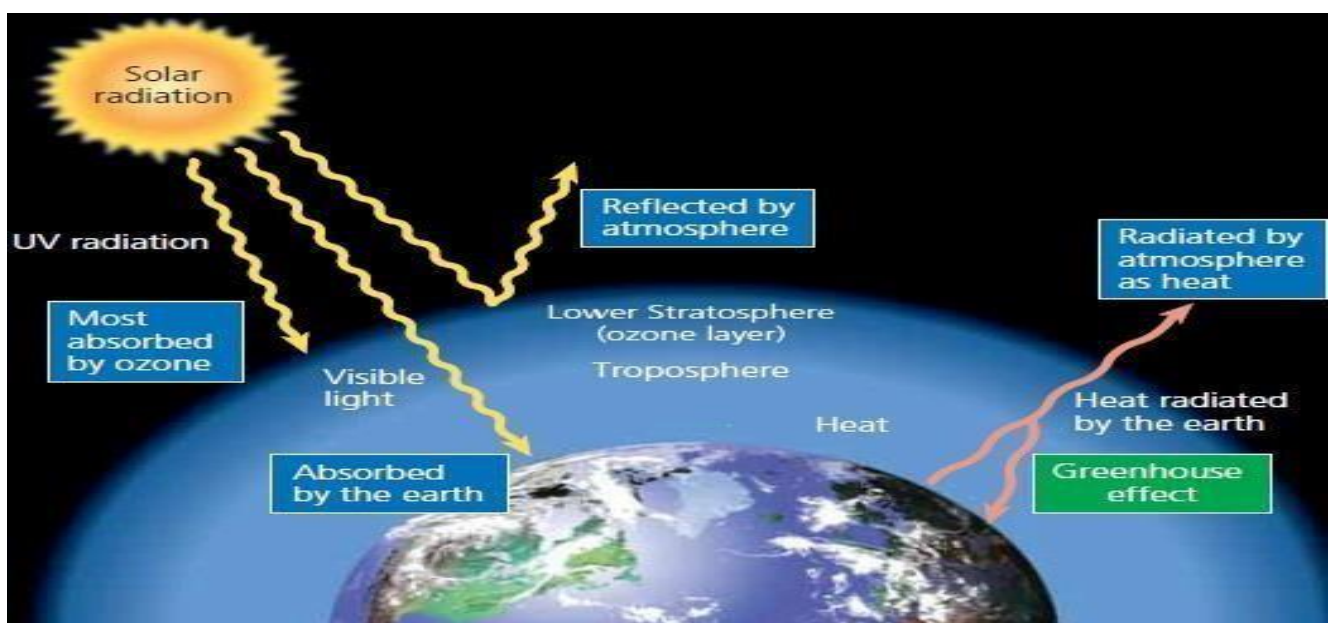
Small amounts of certain gases, including water vapor (H₂O), carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), in the atmosphere play a role in determining the earth's average temperatures and its climates.

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

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

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

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



Causes of Greenhouse effect

Human activities such as,

- Burning fossil fuels

-

Deforestation

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

136-El-nino effect

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

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

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

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

1. This temporary influx of rain on arid and semiarid regions creates the conditions for disastrous down slope movements in the form of mud slides, destroying entire villages.
2. One result of this temporary climate change is the occurrence of major brush fires, which destroy not only vegetation but also wild and domestic animals.
3. Shifts in warm water in the southern Pacific and Indian Oceans cause cooler water to move along the coast of Australia, resulting in decreased rainfall.
4. The warm water El Nino brings to the coasts of North and South America substantially reduces the upwelling of cold, deep water, adversely affecting the cold water fisheries.

137-Global warming

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

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

Causes of Global warming

- Burning of fossil fuels
- Volcanic eruption
- Industrial effluents
- Deforestation
- Transportation
- Power plants
- Effects of Global warming
- Rise in temperature
- Rise in Sea Level

- Climate change
- Extinction
- Droughts
- Loss of biodiversity

138-Effects of global warming

Some major effects are

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

Rise in Temperature:

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

Rise in Sea Level:

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

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

Climate change:

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

Extinction:

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

Droughts:

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

Loss of biodiversity:

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

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

139-Ozone layer

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

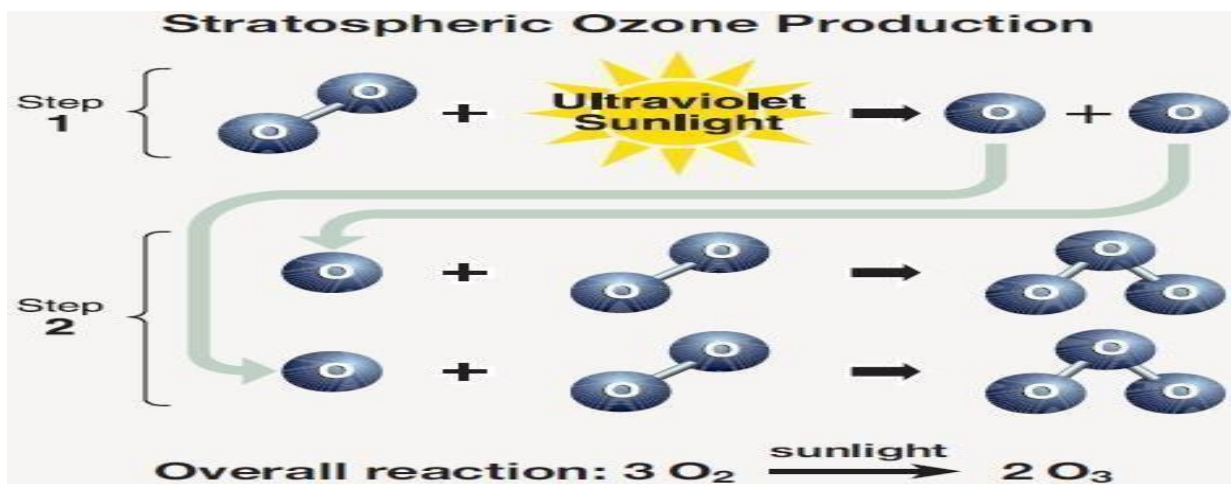
On the base of production ozone is divided into two types,

1. ▪ Stratospheric ozone
2. ▪ Tropospheric ozone

Stratospheric ozone:

In the first step, solar ultraviolet radiation breaks apart one oxygen molecule (O_2) to produce two oxygen atoms.

In the second step, each of these highly reactive atoms combines with an oxygen molecule to produce an ozone molecule (O_3).



Tropospheric ozone:

Nitrogen compounds released from automobiles is broken down by sunlight into nitrogen oxide (NO_2). It is then converted into nitrogen monoxide (NO), releasing an oxygen molecule that combines with oxygen (O_2) in the atmosphere to form Ozone (O_3).

Ozone abundances in the stratosphere and troposphere are determined by,

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

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

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

140-Ozone-layer destruction

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

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

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

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

So CFCs have permanent and continuing affects on Ozone levels.

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

Effects of Ozone depletion

- Skin cancer
- Snow-blindness (inflammation of cornea by UV-rays.
- Cataract
- Low crop production

141-Solid Waste

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

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

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

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

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

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

E-wastes are buried in landfills or incinerated.

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

Solid waste management

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

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

142-Strategy to Protect Ecosystems

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

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

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

- ❖ Map global ecosystems and create an inventory of the species contained in each of them and the ecosystem services they provide.
- ❖ Locate and protect the most endangered ecosystems and species, with emphasis on protecting plant biodiversity and ecosystem services.
- ❖ Seek to restore as many degraded ecosystems as possible.

- ❖ Make development biodiversity-friendly by providing significant financial incentives (such as tax breaks and write-offs) and technical help to private landowners who agree to help protect endangered ecosystems.

143-Stabilize Global Population

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

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

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

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

- Improve the educational and political status of women. When women are intellectually, economically, and politically empowered, they can make decisions about how many children they wish to have.
- Improve the survival and health of children. Low infant mortality rates and improved prospects for healthy children will definitely allow them to run family businesses and carry on family names.
- Provide easy access to family planning resources. Education on spaced births, delayed marriage, breastfeeding, and birth control will allow parents to choose when and whether to start families and how large those families will be.

144-Waste management

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

Therefore, the management of wastes is of prime importance.

Solid waste management

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

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

Collection and Disposal:

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

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

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

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

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

145-Introduction-to biodiversity

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

Biodiversity is a vital renewable resource.

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

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

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

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

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

Biodiversity vary with respect to changes in the following factors,

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

Components of biodiversity

- ✦ Species diversity
- ✦ Population diversity
- ✦ Community diversity
- ✦ Ecosystem diversity
- ✦ Genetic diversity
- ✦ Biogeographic diversity
- ✦ Functional diversity

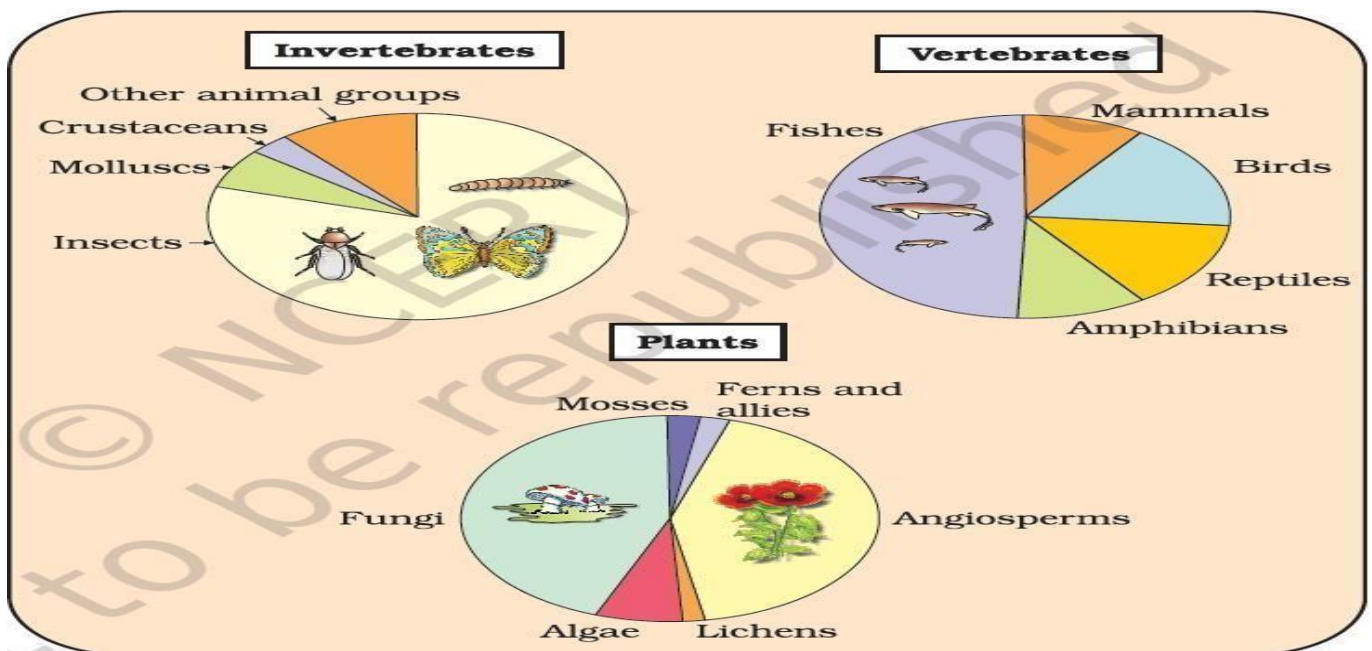
146-Species diversity

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

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

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

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



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

147-Ecosystem diversity

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

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

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

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

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

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

Ecosystems develop in response to local conditions, **which are influenced by**

- ❖ Climate patterns
- ❖ Soil types
- ❖ Topography

148-Genetic diversity

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

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

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

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

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

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

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

149-Types of biodiversity over spatial scale

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

➤ **Alpha diversity**

➤ **Beta diversity**

➤ **Gamma diversity**

Alpha diversity

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

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

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

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

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

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

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

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

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

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

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

150-Importance of biodiversity

Biodiversity performs important biological services.

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

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

Soil formation and protection

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

Water resources protection

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

Education and scientific value

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

Recreation and ecotourism

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

Pollution breakdown and absorption

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

Economic value

- **Goods**
- **Food**
- **Wood and Forest Products**

151-Threats to biodiversity

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

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

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

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

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

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

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

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

- **Industrial release of carbon dioxide**

- **Diminishing the ozone layer by the production of chlorofluorocarbons.** In general, loss of biodiversity in a region may lead to,

- ❖ Decline in plant production.

- ❖ Lowered resistance to environmental distresses such as drought.

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

Main threats to biodiversity are,

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

152-Habitat loss & fragmentation

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

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

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

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

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

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

➤ **Wave action**

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

153-Invasive species

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

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

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

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

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

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

- Dispersal
- Establishment
- Integration

154-Overexploitation

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

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

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

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

Overexploitation can be divided into two major categories:

Direct exploitation

Indirect exploitation

n Direct

exploitation:

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

Indirect exploitation:

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

Both endanger species around the world.

155-Pollution

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

Everyday, thousands of pollutants are discharged into our environment.

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

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

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

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

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

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

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

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

156-Deforestation

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

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

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

Effects of deforestation:

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

Reforestation:

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

It is basically a rehabilitation process of forests.

Reforestation may occur naturally in a deforested area.

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

157-Resource depletion & biodiversity

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

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

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

Habitat loss displaces thousands of native plants and animals. Some of the most important threatened natural areas include, ..

- o **Tropical rain forests,**

- o **Coastal wetlands,**

- o **Coral reefs.**

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

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

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

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

Tropical Deforestation

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

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

158-Exploitation

Predation, Herbivory, Parasitism, and Disease

- The diversity of interactions between herbivores and plants, between predators and prey, and between parasites, parasitoids, pathogens, and hosts can be grouped under the heading of exploitation--interactions between species that enhance the fitness of one individual at the expense of another.
- **Exploitation weaves populations into a web of relationships that defy easy generalization**

- The number of exploitative interactions between species far exceeds the number of species in the biosphere, and the nature of exploitation goes far beyond the typical consumption of one organism by another.
- For instance, many parasites and pathogens manipulate host behaviour to enhance their own fitness at the expense of the host.
- Spiny-headed worms alter the behaviour of a variety of crustacean hosts in a way that increases the probability that the one host species will be eaten by another.
- A **pathogenic fungus** manipulates the growth program of its host plant in a way to produce "**pseudoflowers**," structures aimed at promoting the reproduction of the pathogen.
- In the process the pathogen usually kills the host plant and always renders it sterile.
- Predation by one flour beetle species on another can be used as a potent means of interference competition except in the presence of a protozoan parasite, which seems to give a competitive advantage to less predaceous species.

Examples

- **Predators, parasites, and pathogens influence** the distribution, abundance, and structure of prey and host populations.
- **Herbivorous stream** insects have been shown to control the density of their algal and bacterial food.
- The herbivorous moth larva *Cactoblastis cactorum* combined with pathogenic microbes reduced the coverage of prickly pear cactus in Australia from millions of hectares to a few thousand.
- A **parasitic infestation** reduced the red fox population in Sweden by 70%, which in turn led to increases in the abundance of several prey species eaten by foxes.
- This **parasitic disease** revealed the influence of a predator on its prey populations.

159-Ecological Relationships

- **Predator-prey, parasite-host, and pathogen-host relationships are dynamic.**
- Populations of a wide variety of predators and prey show highly dynamic fluctuations in abundance ranging from days to decades.
- A particularly well-studied example of predator-prey cycles is that of snowshoe hares and their predators, which have been shown to result from the combined effects of the snowshoe hares on the quantity and quality of their food and of the predators on the snowshoe hare population.

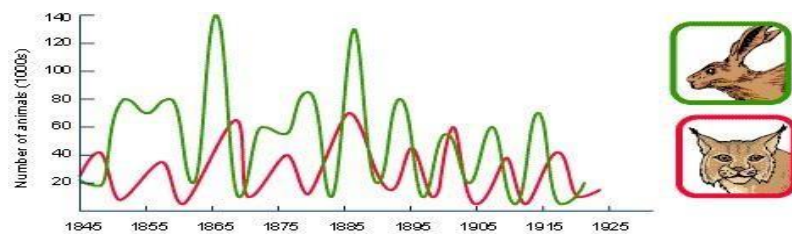
1. Predator Prey Relationships

Learning Objectives

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



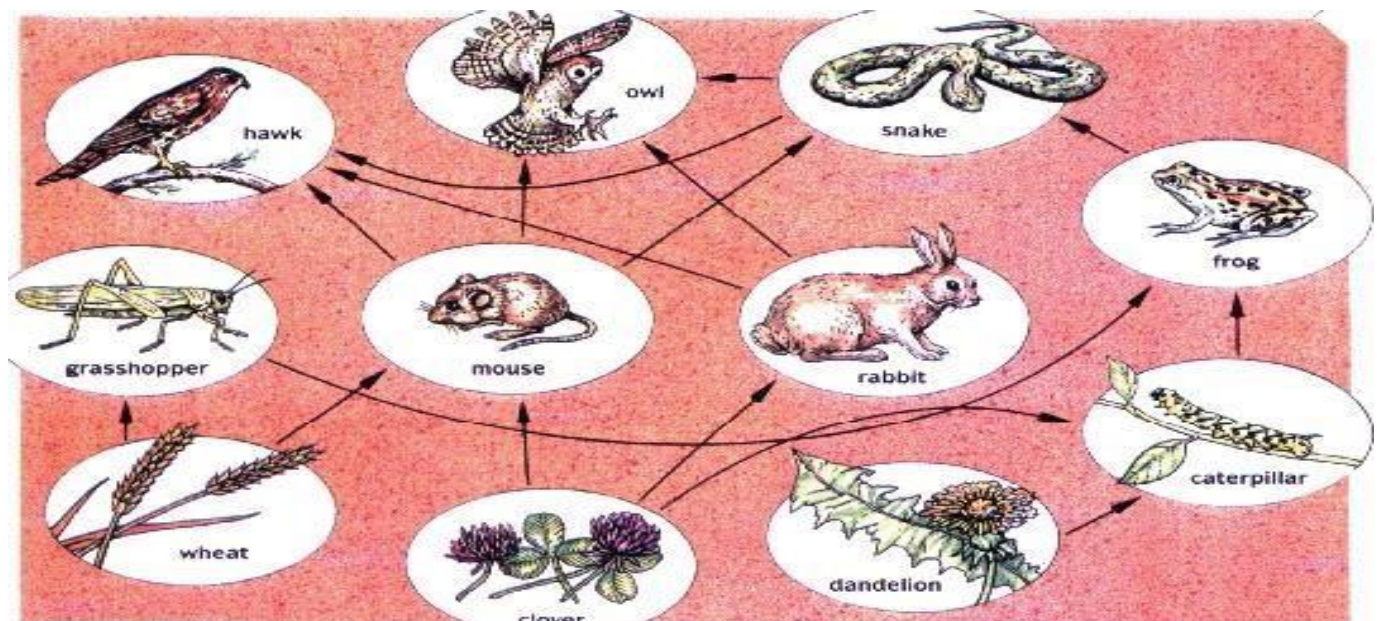
Be able to explain the shape of a predator – prey graph.



2. Food web - Interdependence

Starter

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

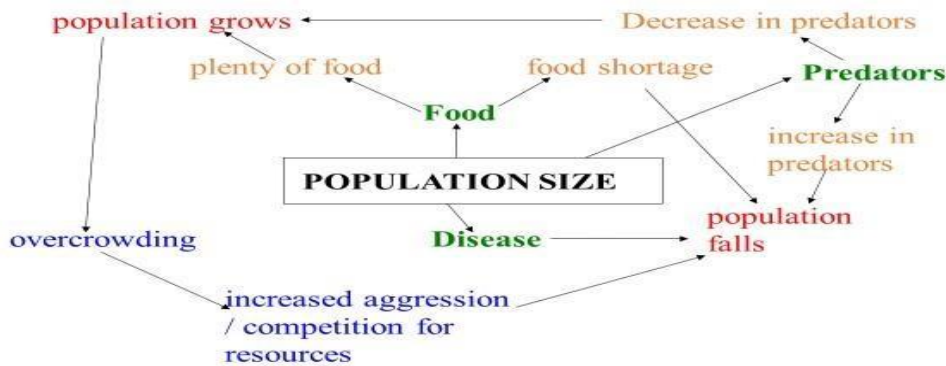


3. Food web – Interdependence

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

4. Population Size

To do: Draw a concept map of what effects the size of a population.



160-Competition 1

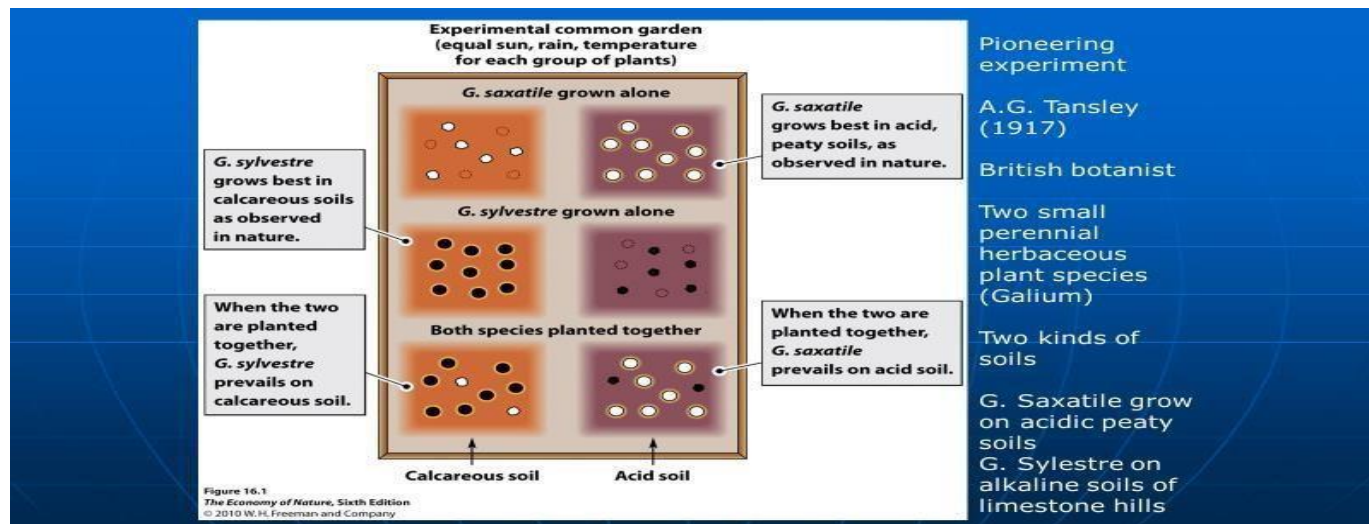
Modes of Competition

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

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

■ **Interspecific:**

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



Competition results when resources are limited

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

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

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

■ Outcome of interspecific competition:

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

161-Competition 2

13.1 Consumers compete for resources

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

■ Examples: • food, water, nutrient,

• light, space

• Refuges, safe site

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

Space is an important resource for sessile animals

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

Competition between closely and distantly related species

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

■ On the Origin of Species:

■ Competition should be most intense between closely related species

■ Structure, Habitat, food resources

Competition between distantly related species is common

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

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

Example 3: birds, lizards eat same insects;

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

Renewable and nonrenewable resources

■ **Renewable: constantly renewed or regenerated**

Natural resources outside ecosystem: such as light and precipitation

Resource regenerated

- Birth of prey provide foods for predator

Consumers directly depress such resources

- Decomposition provide nutrients for plants

Indirectly linked to consumers through food chain or abiotic factors.

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

Limiting resources

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

■ **Liebig's law of minimum**

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

Justus von Liebig (1840)

Limiting resources: may vary

David Tilman's diatom study: both P and silicon

<0.2 mM of phosphate or <0.6 mM

silicate, diatom pop.growth stops.

Positive interaction and synergistic effect

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

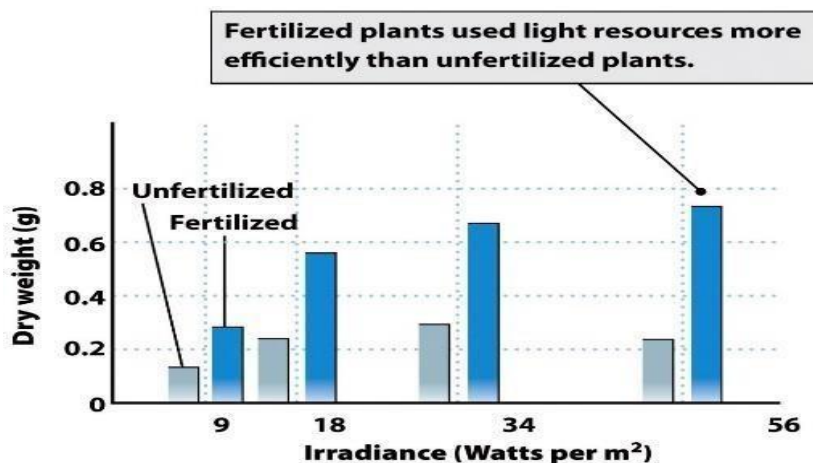


Figure 16.5
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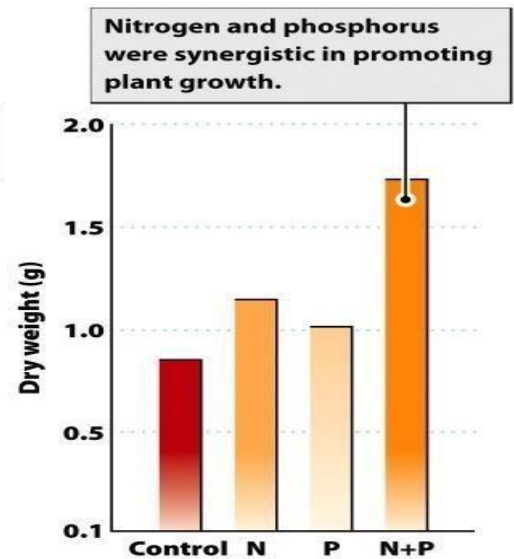


Figure 16.6
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162-Competition 3

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

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

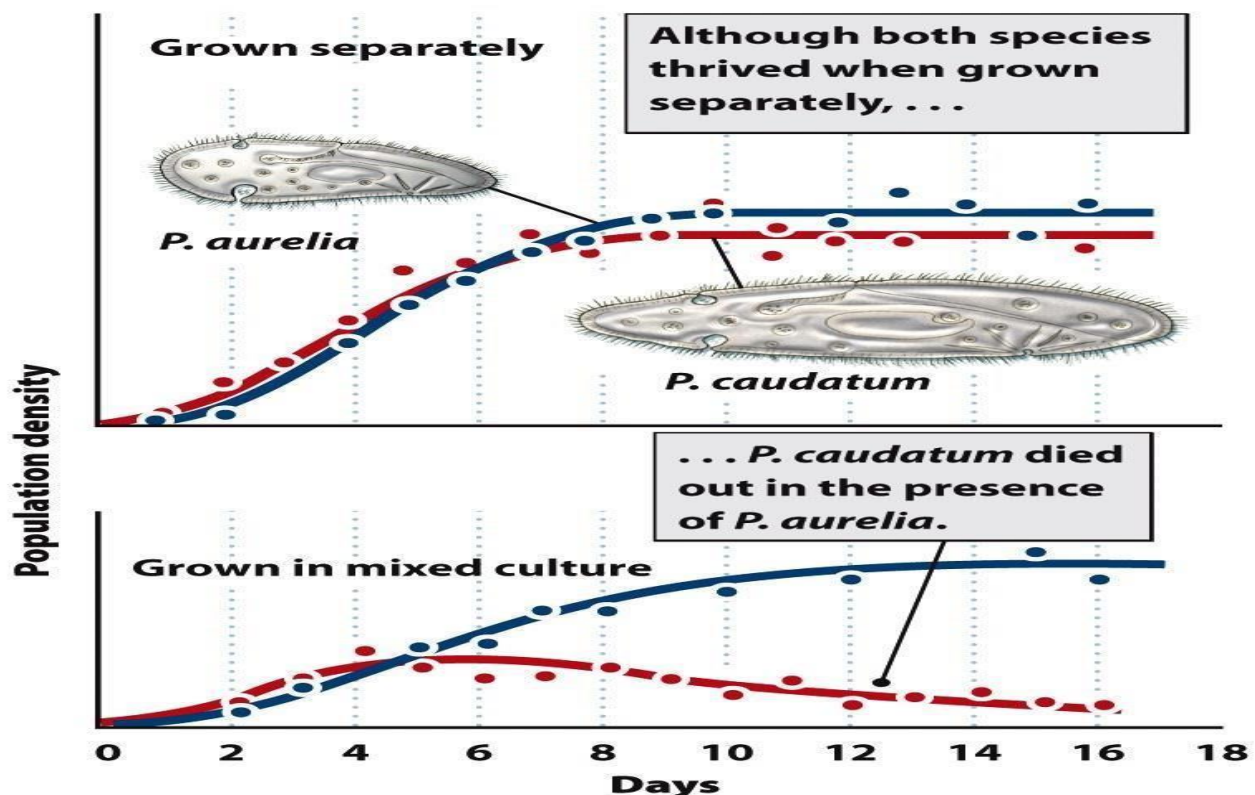


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Diatom experiment

David Tilman, University of Minnesota

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

Grow well alone

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

Competitive exclusion principle

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

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

■ Assumptions:

- Exactly the same resource requirement (no more, no less)
- Environmental conditions remain constant

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

163-Competition 4

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

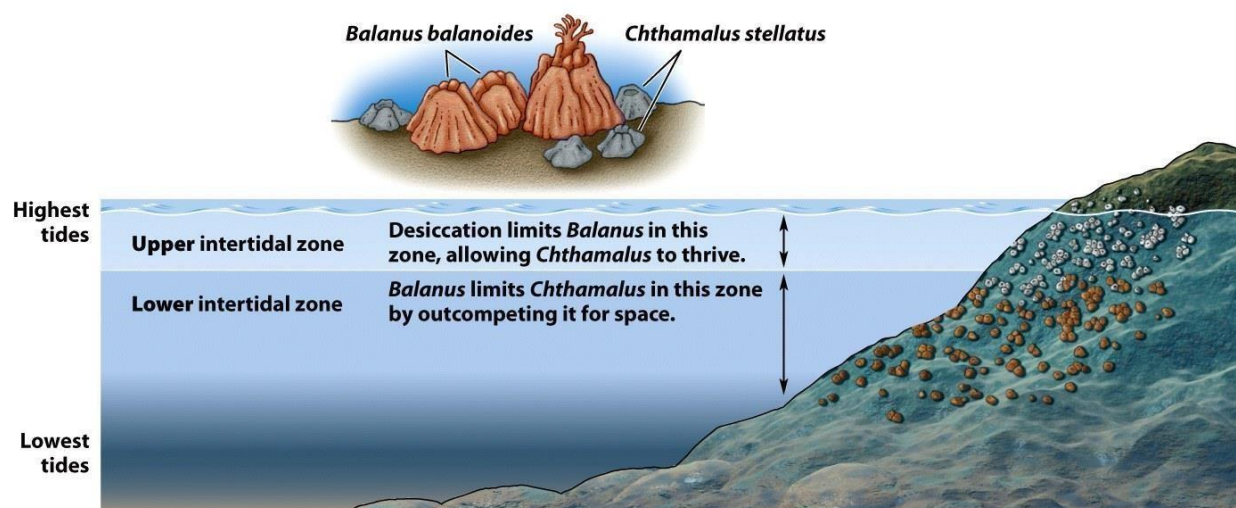
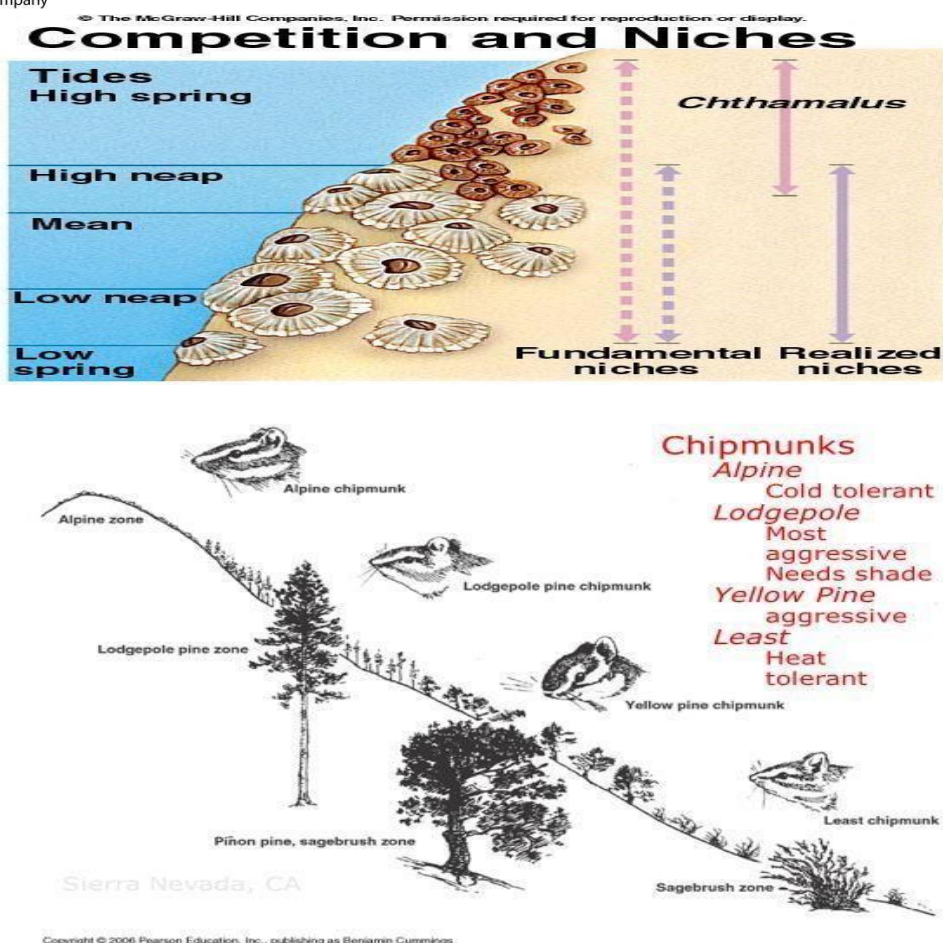


Figure 16.11
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13.4 Habitat productivity can influence competition between plant species

Two hypotheses:

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

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

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

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

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

Habitat productivity can influence competition between plant species

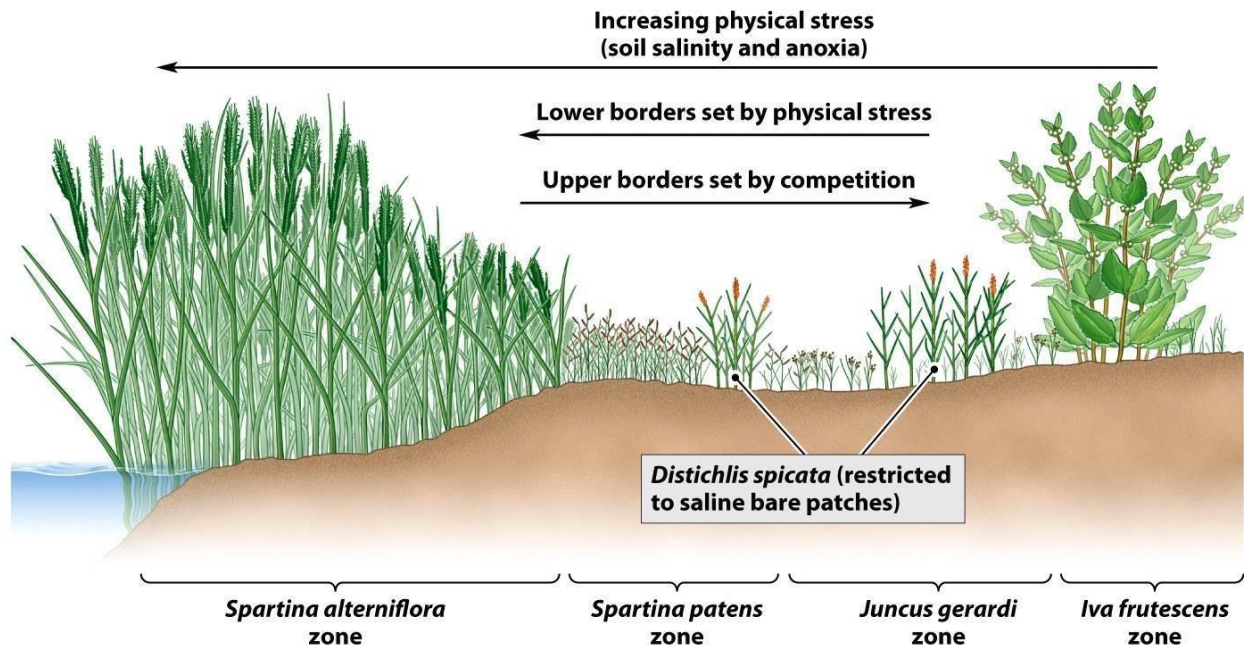


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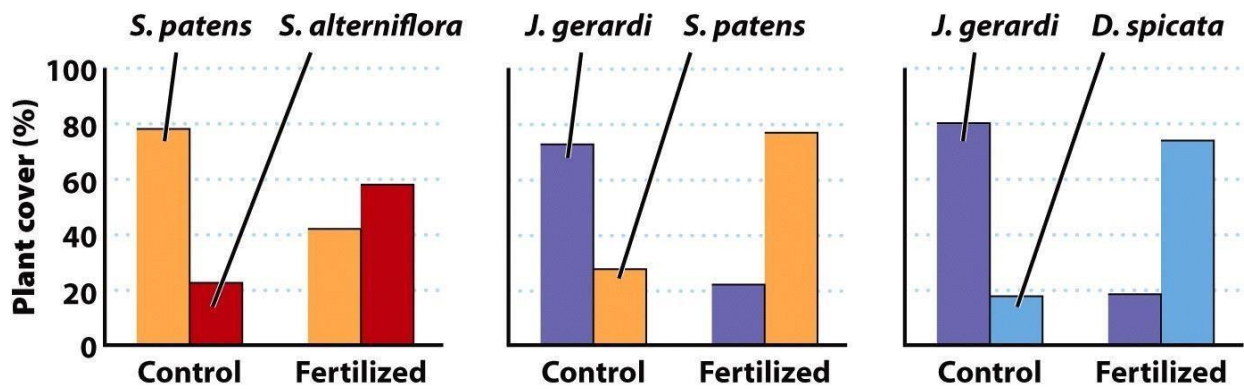


Figure 16.13
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Fertilization alters the outcome of competition by removing nutrient limitation on stress-tolerant plants, expand, away from water.

164-Competition 5

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

Derived from logistic growth equation

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

Add influence of another species (a competition component)

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

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

Lokta-Volterra Model $\alpha_{2,1}N_2$ and $\alpha_{1,2}N_1$: effect of interspecific competition, where $\alpha_{2,1}$ and $\alpha_{1,2}$ per capita effects of competition

In term of resource use, an individual of species 2 is equal to $\alpha_{2,1}$ individuals of species 1

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

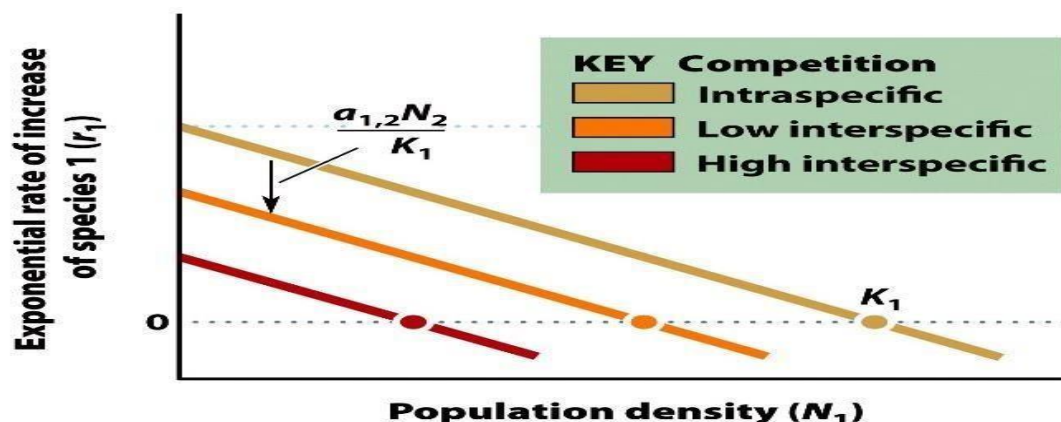


Figure 16.9
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If no interspecific competition

■ **Species 1:** $\frac{dN_1}{dt} = r_1 N_1 \left(\frac{K_1 - N_1 - \alpha_{1,2} N_2}{K_1} \right)$ • In the absence of interspecific competition, $\alpha_{1,2} = 0$ and $N_2 = 0 \rightarrow$ the population of species 1 grows logistically to carrying capacity

■ **Species 2:** $\frac{dN_2}{dt} = r_2 N_2 \left(\frac{K_2 - N_2 - \alpha_{2,1} N_1}{K_2} \right)$ • In the absence of interspecific competition, $\alpha_{2,1} = 0$ and $N_1 = 0 \rightarrow$ the population of species 2 grows logistically to carrying capacity

Lokta-Volterra Model

$\alpha_{2,1}N_2$ and $\alpha_{1,2}N_1$: effect of interspecific competition, where $\alpha_{2,1}$ and $\alpha_{1,2}$ per capita effects of competition

In term of resource use, an individual of species 2 is equal to $\alpha_{2,1}$ individuals of species 1

There Are Four Possible Outcomes of Interspecific Competition

■ Possible outcomes of the Lotka–Volterra equations

- In two situations, one of the species is the superior competitor and wins out over the other
 - In one case, species 1 inhibits the population of species 2 while continuing to increase
 - In one case, species 2 inhibits the population of species 1 while continuing to increase

There Are Four Possible Outcomes of Interspecific Competition

■ Possible outcomes of the Lotka–Volterra equations

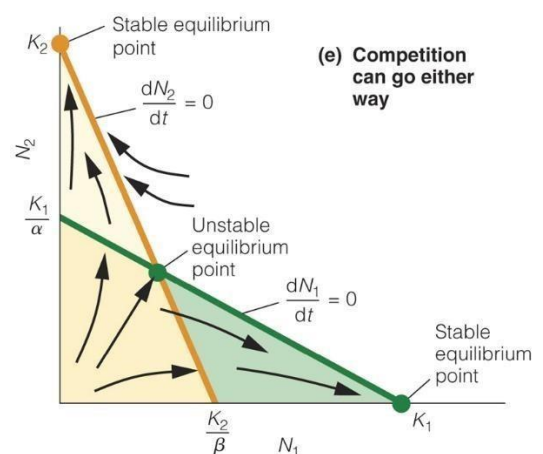
• In a third situation, each species, when abundant, inhibits the growth of the other (more than it inhibits its own growth)

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

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

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

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



165-Competition 6

13.5 Competition may occur through direct interference

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

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

■ Meadow vole (wet) and mountain vole (dry). (Asymmetric competition also) ■ **Allelopathy (chemical competition)**



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

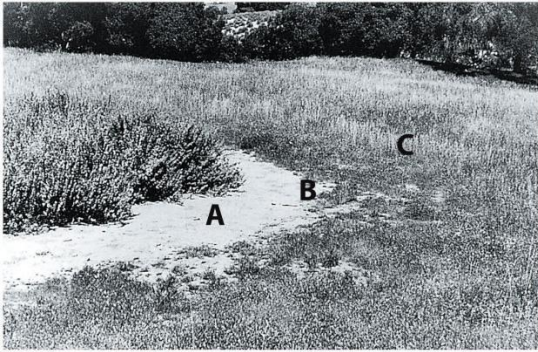


Figure 16.15a
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Clumps of shrubby *Salvia* plants (mint) are usually surrounded by bare zones separating the sage from neighboring grassy areas (Figure 16.15)

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

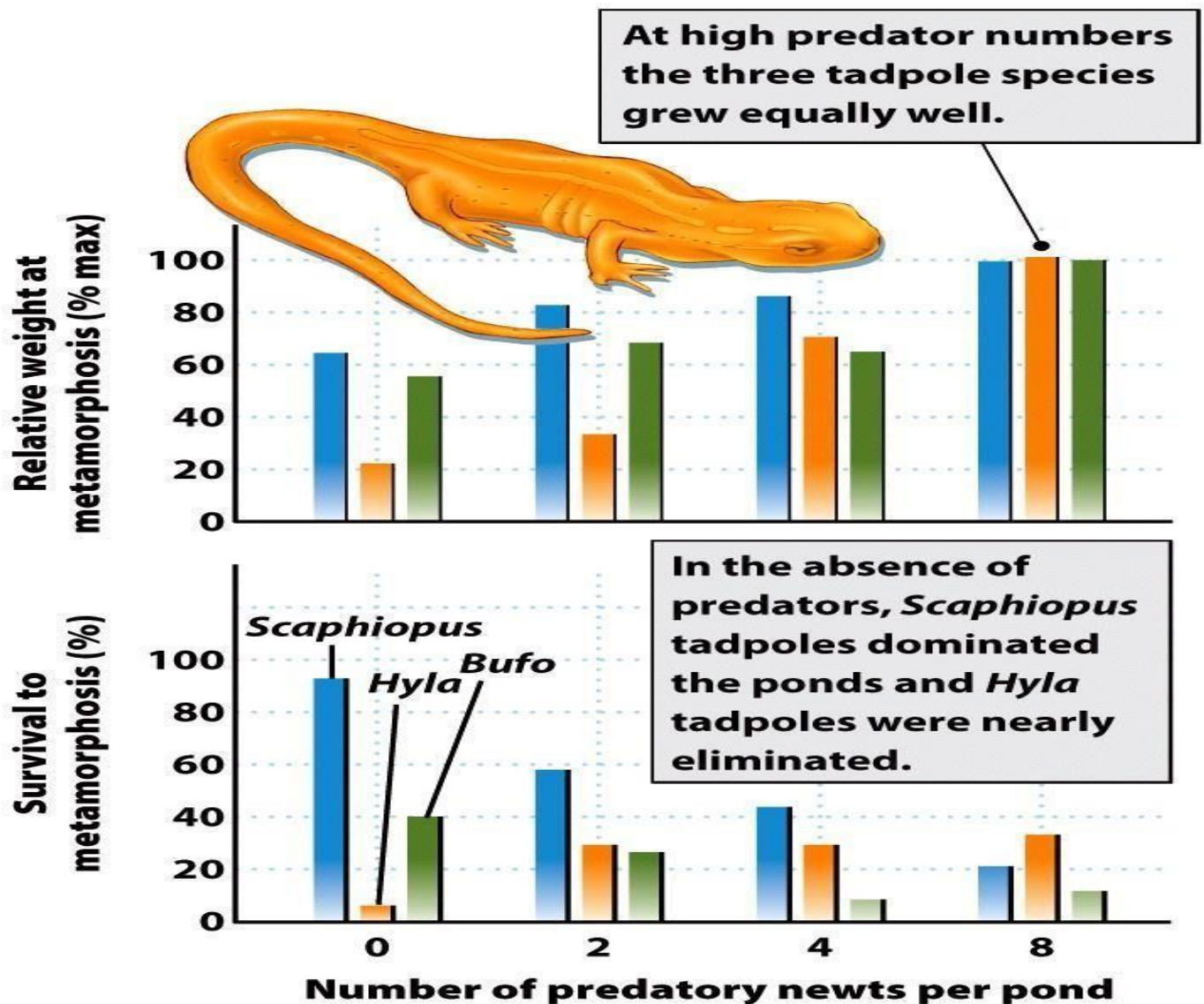


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Apparent competition

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

Experimental supports:

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

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

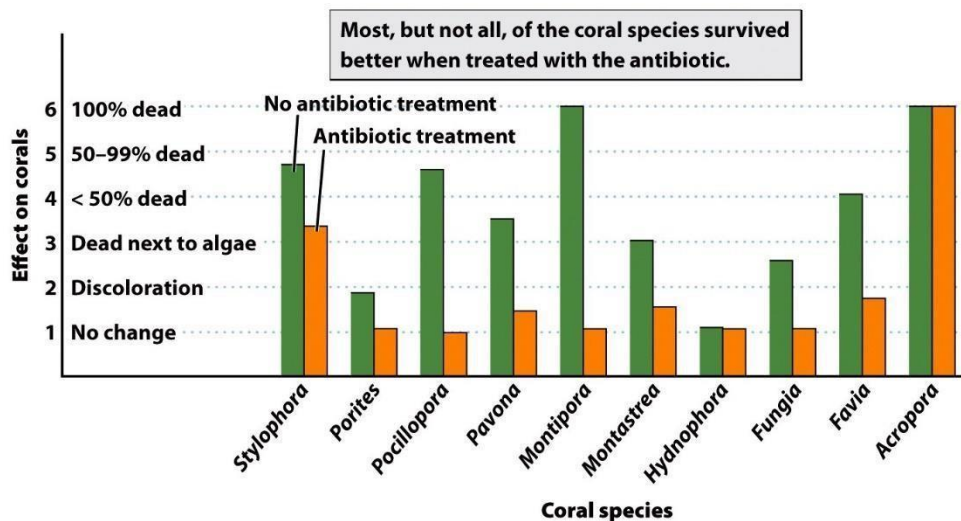


Figure 16.20
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Apparent competition

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

166 -Energy and Nutrient Relations 1

Three main sources of energy

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

PAR quantification

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

Heterotrophs

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

167-Energy and Nutrient Relations 2

Detritivores

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

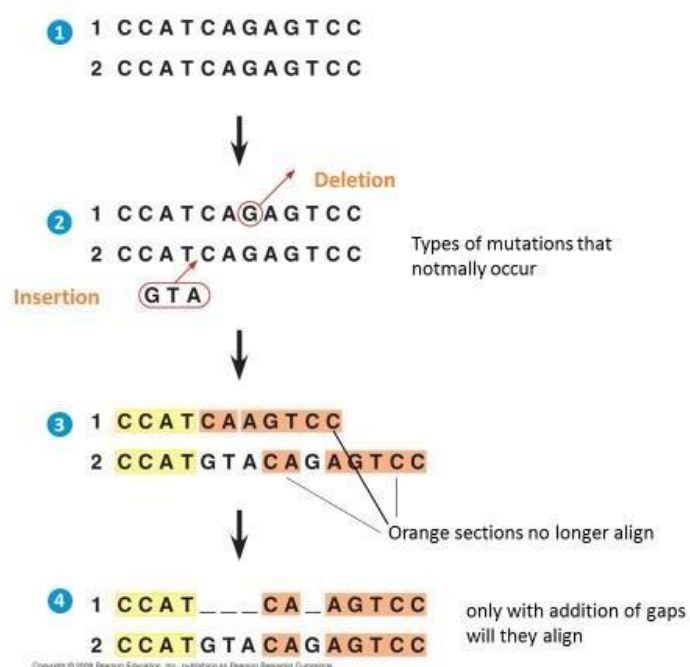
Rate of uptake of energy

- **The rate at which organisms can take in energy is limited**, either by external or internal constraints.
- **The relationship** between photon flux density and plant photosynthetic rate is called photosynthetic response.
- **Herbs** and short-lived perennial shrubs from sunny habitats have high maximum photosynthetic rates that level on at high light intensities.
- The **lowest** maximum rates of photosynthesis occur among plants from shady environments
- The **relationship** between food density and animal feeding rate is called **the functional response**.
- The shape of the functional response is generally one of three types.
- The forms of photosynthetic response curves and type 2 animal functional responses are remarkably similar
- **Energy** limitation is a fundamental assumption of optimal foraging theory.

168-Evaluating Molecular Homologies

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

Fig. 26-8



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

A C G G A T A G T C C A C T A G G C A C T A
T C A C C G A C A G G T C T T T G A C T A G

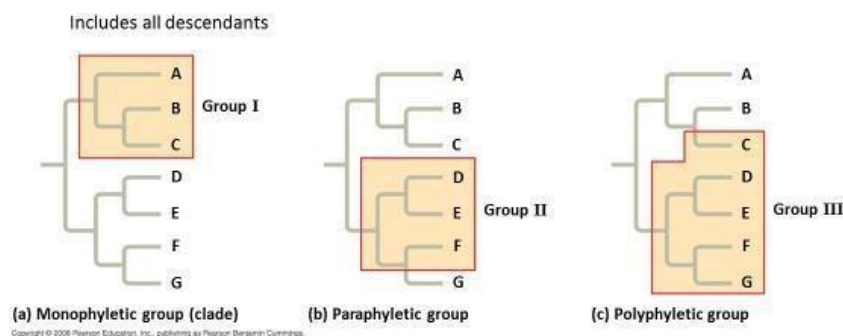
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- **Molecular systematics** uses DNA and other molecular data to determine evolutionary relationships

Shared characters are used to construct phylogenetic trees

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

Fig. 26-10



169-Rate of uptake of energy

- The shape of the functional response is generally one of three types.
- The forms of photosynthetic response curves and type 2 animal functional responses are remarkably similar
- **Energy** limitation is a fundamental assumption of optimal foraging theory.

Optimal foraging theory

- **Optimal foraging theory** attempts to model how organisms feed as an optimizing process.
- **Evolutionary ecologists** predict that if organisms have limited access to energy, natural selection is likely to favour individuals that are more effective at acquiring energy and nutrients.

Optimal foraging theory

- Many animals select food in a way that appears to maximize the rate at which they capture energy
- **Plants** appear to allocate energy to roots versus shoots in a way that increases their rate of intake of the resources that limit their growth.
- Plants in environments with abundant nutrients but little light tend to invest more **energy** in the growth of stems and leaves and less in roots.
- In environments rich in light but poor in nutrients, plants tend to invest more energy in the growth of roots.

Trophic diversity of bacteria

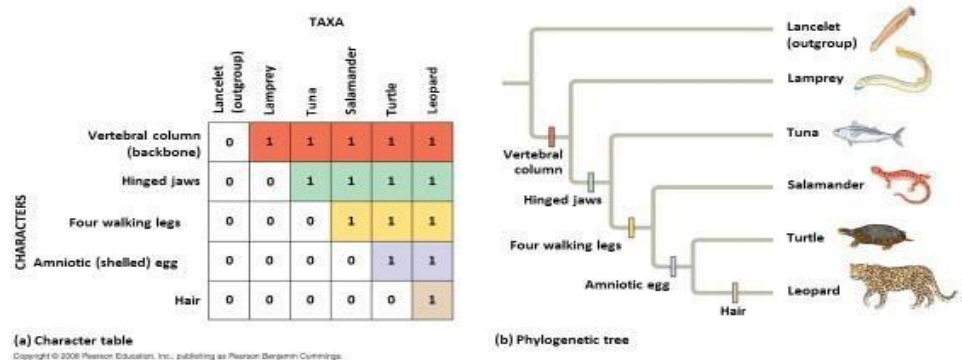
- The **trophic diversity of bacteria**, which is critical to the health of the biosphere, can also be used as a tool to address some of our most challenging waste disposal problems
- **Bacteria** can be used to eliminate the huge quantities of sewage produced by human populations, clean up soils and aquifers polluted by petroleum products such as benzene,
- And eliminate the pollution caused by some kinds of mine waste.

Role of bacteria

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

170-Shared Ancestral and Shared Derived Characters

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



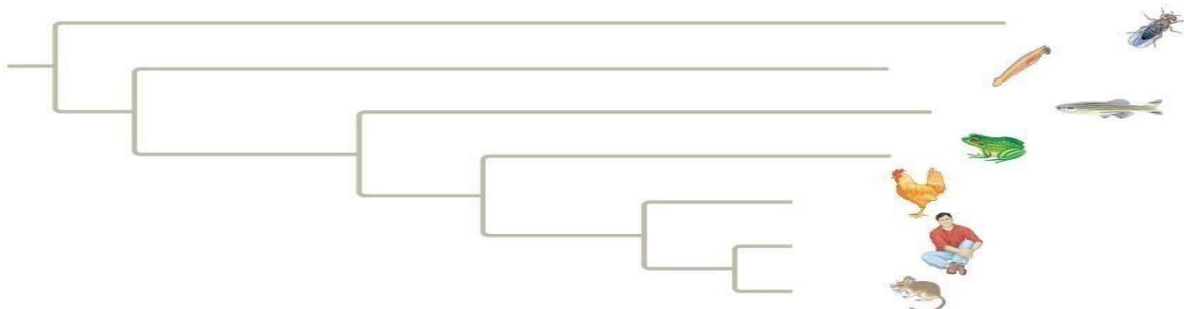
- An **out-group** is a species or group of species that is closely related to the **ingroup**, the various species being studied
- **Systematists** compare each in-group species with the out-group to differentiate between shared derived and shared ancestral characteristics

171-Shared Ancestral and Shared Derived Characters

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

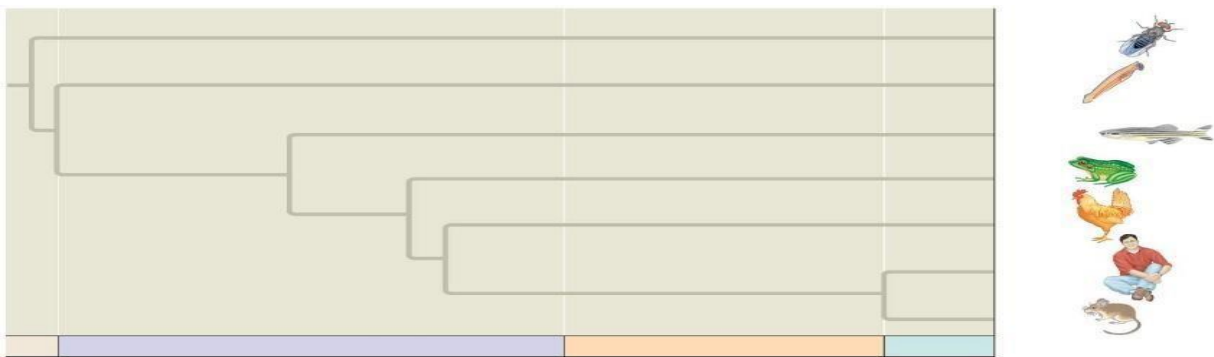
Phylogenetic Trees with Proportional Branch Lengths

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



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



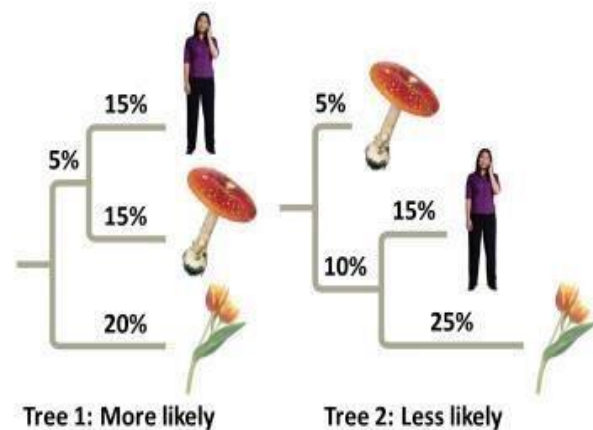
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Maximum Parsimony and Maximum Likelihood

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

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

(a) Percentage differences between sequences



(b) Comparison of possible trees

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172-Evolution of Definitions of Ecology

- **Ecology** = from the Greek root OIKOS, “at home”, and OLOGY, “the study of” Haeckle (1870):
- “By ecology we mean the body of knowledge concerning the economy of Nature - the investigation of the total relations of the animal to its inorganic and organic environment.”
- **Burdon-Sanderson (1890s)**: Elevated Ecology to one of the three natural divisions of Biology: Physiology - Morphology - Ecology
- **Elton (1927)**: “Scientific natural history”
- **Andrewartha (1961)**: “The scientific study of the distribution and abundance of organisms”
- **Odum (1963)**: “The structure and function of Nature”

Our Definition

- “**Ecology** is the scientific study of the processes regulating the distribution and abundance of organisms and the interactions among them, and the study of how these organisms in turn mediate the transport and transformation of energy and matter in the biosphere (i.e., the study of the design of ecosystem structure and function).”
- **Beyond Fundamental Ecology Applied Ecology:**
- Using ecological principles to maintain conditions necessary for the continuation of present day life on earth.

Industrial Ecology

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

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

Ecological Engineering

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

173-Ecological Economics

- Integrating ecology and economics in such a way that economic and environmental policies are reinforcing rather than mutually destructive. **Urban ecology**
- For ecologists, urban ecology is the study of ecology in urban areas, specifically the relationships, interactions, types and numbers of species found in urban habitats. • Also, the design of sustainable cities, urban design programs that incorporate political, infrastructure and economic considerations.

Conservation Biology

- The application of diverse fields and disciplines to the conservation of biological diversity
- Restoration Biology: Application of ecosystem ecology to the restoration of deteriorated landscapes in an attempt to bring it back to its original state as much as possible. Example, prairie grass.

Landscape Ecology

- "Landscape ecology is concerned with spatial patterns in the landscape and how they develop, with an emphasis on the role of disturbance, including human impacts" (Smith and Smith).
- It is a relatively new branch of ecology, that employs Global Information Systems.
- The goal is to predict the responses of different organisms to changes in landscape, to ultimately facilitate ecosystem management.

Organizing principles

- All these disciplines require an understanding of the "organizing principles" of ecosystems, i.e., their ecology. This involves the detailed study of the structure and function of ecosystems in their undisturbed state, and using their designs to:
- **Determine** the resilience of ecosystem functions to human activities.
- **Design ecosystems** which function in the service of human beings with minimal fossil energy input (ideally none) and minimal waste.
- **Design the industrial infrastructure.** integrate the value of "goods and services" of natural ecosystems into the global economic system.

What is "Sustainability"?

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

174-Foundation and keystone species

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



Keystone species

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



175-Reactions in Exon Splicing

Reactions in Exon Splicing

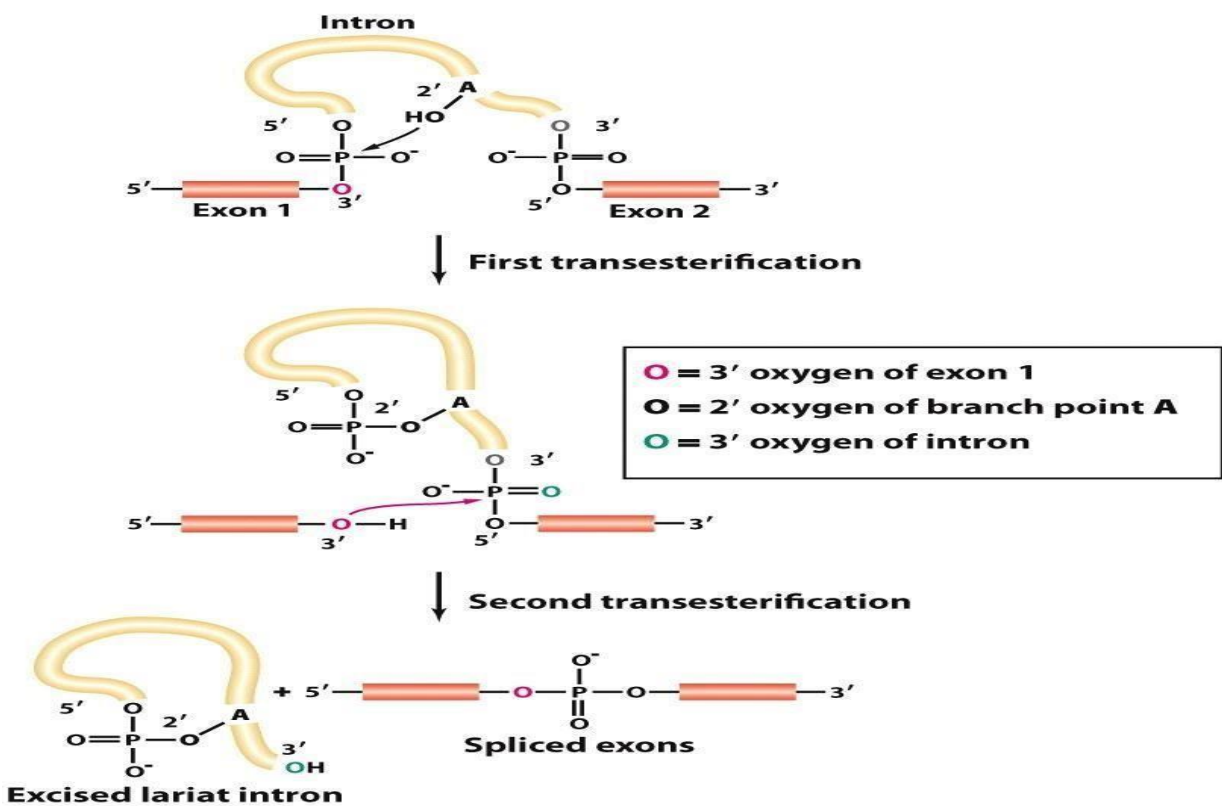


Figure 8-17
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RNA molecules can act somewhat like enzymes (ribozymes).

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

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

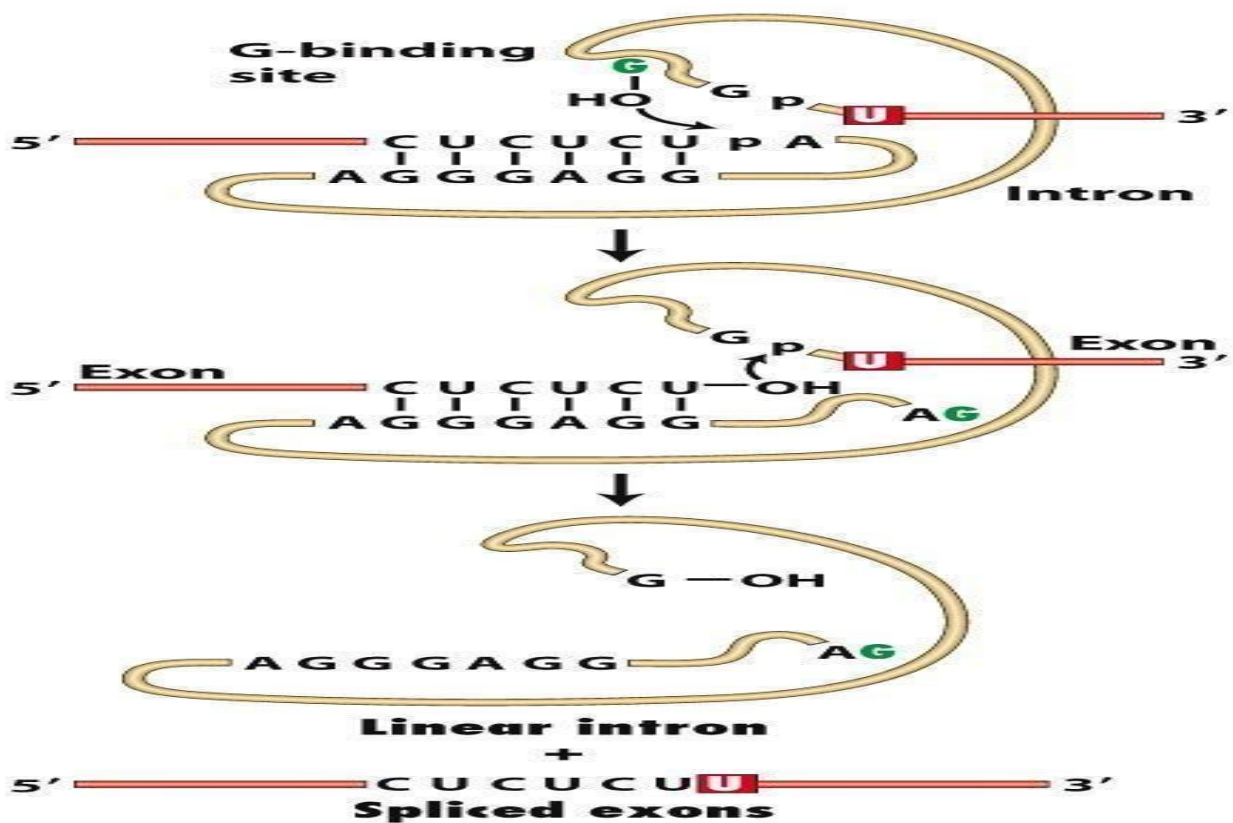
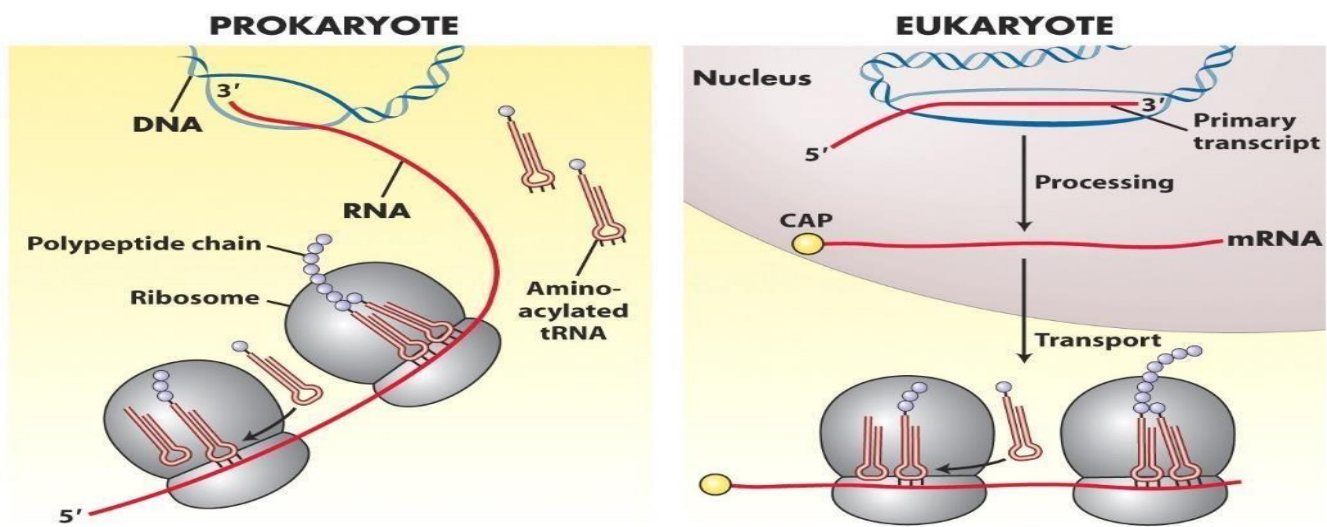
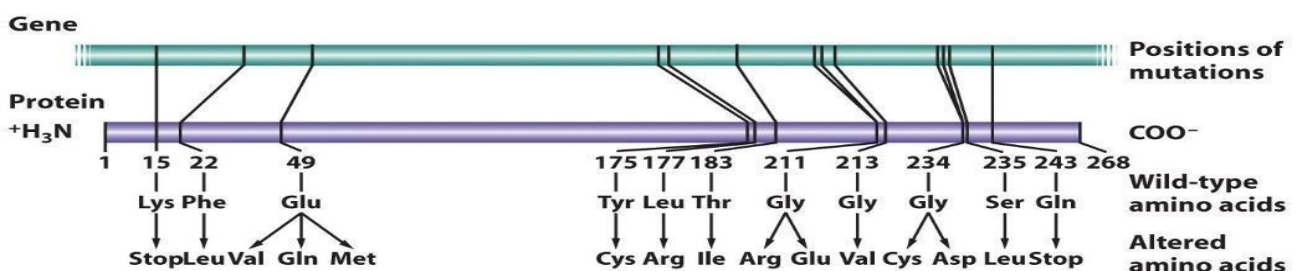


Figure 8-18
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Transfer of Information in Prokaryotes and Eukaryotes



What are the similarities? What are the differences?



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

Mutant alleles of *trpA* gene differed in the position of the mutation at the DNA level, which corresponded to position of amino acid substitution in the gene product. Colinearity of mutations and altered amino acids in a subunit of tryptophan synthetase from *E. coli*

C. Yanofsky, 1967. Scientific American

176-Genetic Diversity in Ecosystem Management

What is genetic diversity?

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

- When genetic variation disappears the **basis for life** on earth becomes impoverished

Some useful definitions

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

177-Levels of genetic diversity

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

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

VU Bio Mates <https://facebook.com/groups/vubiomates/>

Among populations,

- Different gene pools among populations.
- Isolation is an important factor responsible for among population genetic diversity (natural or man made barriers).
- Can lead to
- **local adaptation,**
- Natural local adaptation: Example of mistletoe species in Argentina and Chile,
- Ultimate effect of among population variability: Speciation

Heterozygosity

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

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

- Often **positively correlated** with fitness,
- Often positively correlated with population size (declines in small populations),
- When an organism is referred to as a heterozygote, or being heterozygous for a specific gene, it means that the organism carries two different versions of that gene on the two corresponding chromosomes.

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

Loss of genetic diversity

Two ways of losing it

- Loss of genetic diversity in small populations,
- Changes in **the natural distribution** of genetic diversity among populations (artificial isolation and mixing)
- **Population size critical factor,**
- Census population size (N_c) vs. Effective population size (N_e), Usually N_e is much smaller than N_c (10 to 30%)

178-Factors responsible for genetic diversity loss

Four factors responsible for genetic diversity loss in small populations :

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

• Genetic drift

- "Random change in gene frequency within a population" (Meffe et al.),
- Not necessarily adaptive, Stronger in small populations

• Founder effect,

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

Four factors responsible for genetic diversity loss in small populations

• Demographic bottleneck,

- Population suffers reduction in size and then recovers, Random losses of genetic diversity,
- Usually associated with catastrophic events or diseases,
- Genetic variation doesn't rebound from a decrease as quickly as population size.

• Inbreeding

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

The other way to loss genetic diversity:

- **Changes** in the natural distribution of genetic diversity among populations
- Related with the geographical distribution of the species and therefore with landscape management issues
- **Artificial isolation**

- Avoids genetic flux among populations due to barriers such as highways, dams, etc
- **Artificial mixing** Enhances genetic flux among populations where that flux was not possible due to natural barriers (examples: bridges, tunnels)

Allelic richness

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

Usefulness of Ecosystem Management and Genetics in Conservation

Ecosystem Management and Genetics in Conservation Useful in;

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

179-Geographic ecology

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

Isolation

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

Species richness on habitat islands

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

Models of Species richness on islands

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

The equilibrium model of island biogeography

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