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Theoretical
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المرحلة الثانية - الدراستين الصباحية والمسائية
الفصل الدراسي الثاني

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Evolution

Evolution is the process of change in all forms of life over generations, and **evolutionary biology** is the study of how evolution occurs. Biological populations evolve through genetic changes that correspond to changes in the organisms' observable traits.

Origin of life: Study of living organisms such as plants, animals and human etc. is the active area of life science.

How life originated on the earth? Six major theories are proposed to explain the origin of life on earth. These theories are as follows:

1- Theory of Special Creations:

The theory of special creation is proposed that life on earth is created by a supernatural power, the **GOD**. According to the Christian and Muslim belief, god has created the universe, planet, animal, plant and human in six natural days. There are believes in the theory of special creation. These points are as follows:

1. All living organisms were created same day.
2. They were created in the present form.
3. It was purely based on religious belief.
4. There were no experimental evidences to support the assumptions.

2- Theory of spontaneous generations:

The theory of spontaneous generation that non-living material in a spontaneous manner give rise to life. There are several observations supporting this theory, which are as follows:

1. Hair of horse tail dipped in the water gives rise to horsehair worm.
2. Fly larvae develops on rotten meat.
3. In ancient Egypt, it was believe that frog, snake, crocodiles in the mud of Nile river warmed with sun.

4. Van Helmont claimed that he can produce mice from the dirty shirt and hadful of wheat grains kept in dark cupboard in 3 weeks.

3- Theory of cosmozoic:

This theory was put forward by Richter and strongly supported by Arrhenius. The theory assumes that life was present in the form of resistant spores and appeared on earth from other planet. Since the condition of earth was supporting the life, these spores grew and evolved into different organisms. This theory was also known as "spore theory".

4- Oparin and Haldane theory. The modern theory

-When did life originated?

Life first evolved around 3.5 billion years ago. This evidence takes from the microfossils.

-Where did the life originated?

Scientists are exploring several possible locations for the origin of life including hot springs and near deep sea.

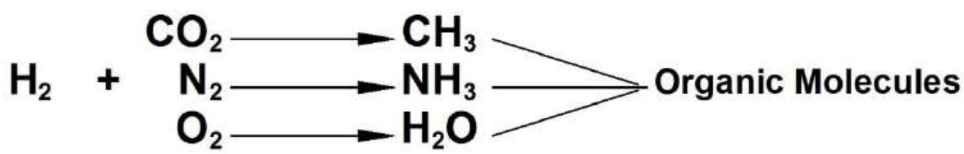
-How did life originates?

Life almost originated in a series of small steps, each building upon the complexity that evolved previously.

1-Forming of simple organic molecules:-

Experiments suggest that organic molecules could have been synthesized in the atmosphere of early earth and rained down into the oceans (as Stanly miller, 1953 proved that in the Laboratory experiment).

In the very beginning of earth forming. There was a great amount of H_2 with little amount of Co_2, N_2 and O_2.



RNA & DNA Molecules are just long chains of simple molecules.

2-Replicating Molecules:

This ability probably first evolved in the form of an RNA self replicator. RNA molecules that could copy itself did many jobs:-

a- Storing genetic information.
b- Copying it selfs.
c- Performing basic metabolic functions.

Today these jobs are performed by many different sorts of molecules (DNA, RNA and Proteins). The ability to copy the molecules that encode genetic information is a key step in the origin of life.

3-Cell Membrane Forming:-

Replicating molecules became enclosed within a cell membrane. This membrane which surrounding the genetic materials and keep the products of the genetic material enclose environment which could be different that the external environment which help in quick replication, This would have given rise to an organisms much like a modern bacteria.

4-DNA Evolving:-

some cell evolved to use different types of molecules for different function. DNA (which is more stable than RNA). So it became responsible for basic metabolic reaction in the cell and RNA was demoted to the role of messenger carrying the information from the DNA to protein building centre in the cell.

5-Multicellularity Evolved:-

Some cells stopped going their separate ways after replicating and evolved specialized functions they gave rise to earths first multicellular organisms such as the 1.2 billion years old fossilized (red algae).

History of evolutionary thought

Lecture 1 Evolution and Biodiversity

Explanations that have a physical basis began with the Greeks:

Thales (640 Thales (640-546 B.C.) the first natural explanation. All life came from water.

Xenophanes (576-480 B.C.) and **Herodotus** (484-425 BC) recognized fossils as the remains of living creatures, and based on the distribution of fossil marine life speculated that oceans had formerly covered some of the land

Democritus (500-404 B.C.) was distinguished between organic and inorganic systems. Organic systems were derived from inorganic systems.

Empedocles (495-435 B.C.) gave a detailed explanation of the natural origin of life. There were 4 basic inorganic materials: fire, air, earth, and water and two basic forces. Love and hate.and the mixture of this materials resulted in reduced survival.

Hippocrates (460-370 B.C.). He stated two principles that seemed to be valid:

1. the characteristics of the parent will be passed to the offspring
2. a part that is not used will be lost .

Aristotle (384-322 B.C.) The first great naturalist:

1. He was the first to use the gradations in form among organisms to arrange them into a ladder like scale - with man at the top of the living world a teleological system.
2. accepted the idea that species have fixed properties.
3. Developed the beginnings of biology: anatomy, reproductive and ecology of many plants and animals.

Carolus Linnaeus (1707-1778) a classification of plants and animals - a hierarchical classification with species organized into genera, and into families, orders, etc. He did not believe in change or common descent. He saw all species as fixed structure.

Jean Baptiste LaMarck (1744-1829) he was interested in the relationship between organisms and their environment, and adaptations., he suggested species could change in response to their environment.

Charles Darwin (1809–1882):was an English naturalist, geologist and biologist, best known for his contributions to the science of evolution.

Darwinism is a theory of biological evolution developed by Darwin and others, stating that all species of organisms develop through the natural selection of small, inherited variations that increase the individual's ability to compete, survive, and reproduce. Also called Darwinian Theory, Darwin published On the Origin of Species in 1859.

Evidences against the theory of natural selection:

1. The populations have the capability to increase in numbers at an great rate.
2. Darwin could not be able to explain the source of variation in organisms.
3. According to theory, Darwin supposed that any variation essential for animal survival will be transmitted to next generation.

Mechanisms of Evolution

In nature difference between individuals in one species and between different species may be caused by fundamental forces of evolution:

1. **Natural Selection**
2. **Mutations**
3. **Gene Flow (migration)**
4. **Recombination or Variation**
5. **Genetic Drift**
6. **Isolation (speciation).**

1. Natural selection: is a change in allele frequencies from generation to generation.

Types of natural selection : Natural selection can take many forms.

I. Stabilizing selection

The most common of the types of natural selection is stabilizing selection,

When selection acts to eliminate both extremes from an array of phenotype,

For example in humans, infants with intermediate weight at a birth have the highest survival rate.

II. Directional selection

acts to eliminate the extreme from an array of phenotypes.
ex: Drosophila population, the investigations alimentation of flies that move toward light causes the population to contain fewer individuals with alleles promoting such behavior. The new fly populations have a lesser chance of moving toward right than the old population.

III. Disruptive Selection

In the same situations selection acts to eliminate rather than favor, the intermediate type. For example, in different part of Africa the color pattern of butterfly *papilo dardamus* is dramatically different in each instance it closely resembles to the coloring of some other butterfly species that birds do not like to eat. Birds quickly detect and eat butterflies with different color patterns. So any intermediate color patterns are eliminated. In this case selection is acting to eliminate the intermediate phenotypes. The distributive selection is far less common than the other two types of selection. This is the rarest of the types of natural selection.

IV. Sexual Selection

Sexual Selection is another type of Natural Selection. However, In sexual selection, the female of the species tends to choose mates based on traits they show that are more attractive. The fitness of the males is judged based on their attractiveness and those who are found more attractive will reproduce more and more of the offspring will also have those traits.

The peacock is an example of sexual selection between the two sexes, or sexual selection. Just like a muscular, bearded human, it's assumed that female peacocks choose brightly colored male peacocks because in order to produce such a large, colorful tail the male peacock must have good genes. These good genes, in turn, will contribute to the success of the offspring.

V. Artificial selection or Selective Breeding

Artificial selection is not a type of natural selection, obviously, but it did help Charles Darwin obtain data for his theory of natural selection. Artificial selection mimics natural selection in those certain traits is chosen to be passed down to the next generation. However, instead of nature or the environment in which the species lives being the deciding factor for which traits are favorable and which are not, it is humans that do the selecting of traits during artificial selection.

Perhaps the best-known use of artificial selection is dog breeding from wild wolves to dog show winners of the American Kennel Club (AKC), which recognizes over 700 different breeds of dogs.

Most of the breeds the AKC recognizes are the result of an artificial selection method known as crossbreeding wherein a male dog from one breed mates with a female dog of another breed to create a hybrid. One such example of a newer breed is the labradoodle, a combination of a Labrador retriever and a poodle. (**Figure 6**).

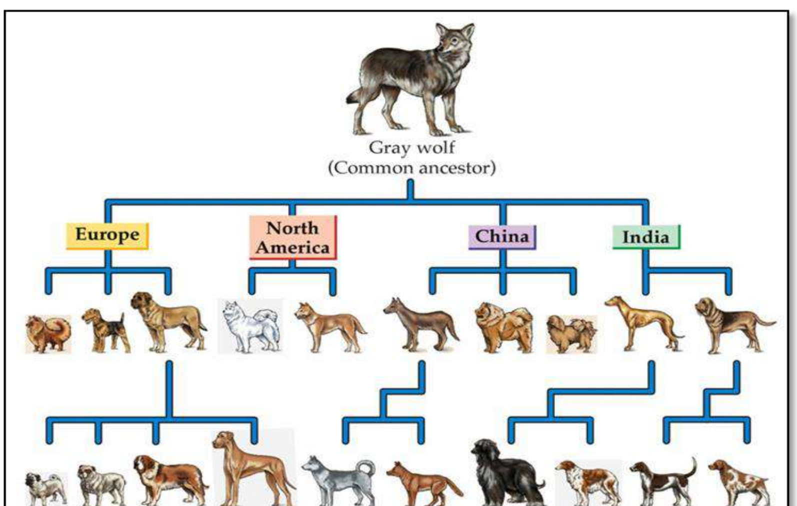


Figure 6: Artificial selection in dogs

2- Mutation

Mutation: its any change in genetic material of an organism. What causes a mutation? Mutations can be caused by high-energy sources such as radiation or by chemicals in the environment. They can also appear during the replication of DNA.

the types of mutations are

a- **Chromosome mutations** occur in somatic cells (aren't passed to offspring). Some type of skin cancers and leukemia result from somatic mutations. **somatic mutations** occur in the DNA of individual cells at some time during a person's life, these changes can be caused by environmental factors such as ultraviolet radiation from the sun, mutagenic chemicals, heat, or can occur if a mistake is made as a DNA copies itself during cell division.

Types of it ;

A- **Deletion:** apiece of chromosome is lost.

B- **Inversion:** chromosome segment breaks off and segment flips around backwards then reattaches.

C- **Translocation:** involves two chromosomes that aren't homologous. part of one chromosome is transferred to another chromosome.

D- **Duplication:** occur when a gene sequence is repeated.

b- **Gene mutations** change in the nucleotide sequence of a gene . occur in gametes (eggs and sperm) and be passed to offspring.

Mutations can have a range of effects. They can often be harmful. Others have little or no detrimental effect. Sometimes ,the change in DNA sequence may even turn out to be beneficial to the organism.

if the mutation has a positive effect on the fitness of the offspring, it is called an adaptation. Thus, all mutations that affect the fitness of future generations are agents of evolution.

3- Gene flow

Gene flow can be defined as the transfer of alleles or gametes from one population to another. It is also known as gene migration. When individuals of one population migrate to another population the allele frequency (the proportion of individuals carrying the same allele) of the population changes. In simple words, if individuals of population A are introduced into population B, there is a change brought about in the composition of the gene pool of population B (through interbreeding). It may also result in the addition of new variants of that allele in the population.

Example of Gene Flow

Populations of moths that are white in color migrate to a population of brown-colored moths and successfully mate to give rise to viable offspring. Here, we can say that there is a change in the allele frequency. Over time, the number of these white moths will increase.

4- Recombination

1- **Recombination:** forming new genetic composition from old one. This could be performed:
   - **A-** By production (Heterozygous) bears two different allele for the same gene.
   - **B-** Randomly mixing of parent chromosomes to produce offspring with different genetic constitution.
   - **C-** By exchange the alleles between the chromosomes (Crossing).

5- Genetic drift

Genetic drift describes random fluctuations in the numbers of gene variants in a population. Genetic drift takes place when the occurrence of variant forms of a gene, called alleles, increases and decreases by chance over time. These variations in the presence of alleles are measured as changes in allele frequencies

Typically, genetic drift occurs in small populations, where infrequently occurring alleles face a greater chance of being lost. Once it begins, genetic drift will continue until the involved allele is either lost by a population or until it is the only allele present in a population at a particular locus. Both possibilities decrease the genetic diversity of a population. Genetic drift is common after population bottlenecks, which are events that drastically decrease the size of a population. In these cases, genetic drift can result in the loss of rare alleles and decrease the gene pool. Genetic drift can cause a new population to be genetically distinct from its original population, which has led to the hypothesis that genetic drift plays a role in the evolution of new species.

Examples of Genetic Drift:

1. A population of rabbits can have brown fur and white fur with brown fur being the dominant allele. By random chance, the offspring may all be brown and this could reduce or eliminate the allele for white fur.
2. A mother with blue eyes and a father with brown eyes can have children with brown or blue eyes. If brown is the dominant allele, even though there is a 50% chance of having blue eyes, they might have all children with brown eyes by chance.

The reproductive Isolations:-

It’s a special adaptations characteristic to the living organisms lead to prevent individuals from interbreeding with other different species. There are two types of Reproductive isolation:

3. **Prezygotic**: happen before zygotes are formed.
4. **Post zygotic**: happen after zygotes are formed

1. Prezygotic mechanisms prevent interspecies mating and fertilization. There are four types of isolation that prevent mating from occurring, thus maintaining species isolation.

1- Ecological isolation
2- Temporal isolation
3- Behavioural isolation
4- Mechanical isolation

1- Ecological Isolation:-

When the species are found in different habitats or different ecosystem such as forests or aquatic ecosystem cannot meet each other so the ecosystems play significant role in species isolation. , such as ground squirrel species occupy different habitats .

2- Temporal isolation

When two species are found in the same area, but are incapable of mating due to different reproductive cycles for flowering or mating. Such as Red and black sea urchins live in the same location, but release their gametes at different times of the year .

3- Behavioral isolation

Behavioral isolation when distinct mating rituals by one species may prevent members of another species from recognizing or selecting a mate. Such as male jumping spiders dance (shake their legs and wave their palps), Females of different species do not respond to the dance (**Figure17,A**). In many species, elaborate courtship displays identify potential mates of the correct species and synchronize gonadal maturation (**Figure17,B**).

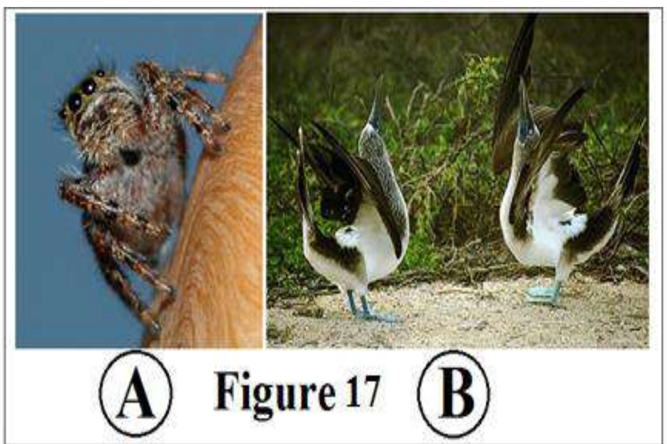


Figure 17

4- Mechanical isolation:

Closely related species may attempt to mate but fail because they are anatomically incompatible and transfer of sperm is not possible.

1- To illustrate, mechanical barriers contribute to the reproductive isolation of flowering plants that are pollinated by insects or other animals.

2- With many insects the male and female copulatory organs of closely related species do not fit together, preventing sperm transfer.

2- Postzygotic barriers:

Postzygotic barriers prevent the hybrid zygote from developing into a viable, fertile adult. These barriers include: Postzygotic isolating mechanisms

1- Hybrid inviability: Development of the zygote proceeds abnormally and the hybrid is aborted. (For instance, the hybrid egg formed from the mating of a sheep and a goat will die early in development.)

2- Hybrid sterility: The hybrid is healthy but sterile. (The mule, the hybrid offspring of a donkey and a mare, is sterile; it is unable to produce viable gametes because the chromosomes inherited from its parents do not pair and cross over correctly during meiosis (cell division in which two sets of chromosomes of the parent cell are reduced to a single set in the products, termed gametes).

3- Hybrid is healthy and fertile, but less fit, or infertility appears in later generations (as witnessed in laboratory crosses of fruit flies, where the offspring of second-generation hybrids are weak and usually cannot produce viable offspring).

Types of Evolution

The biological evolution is defined as any genetic change in population that is inherited over several generations. These changes may be small or large, noticeable or not so noticeable.

Microevolution is the occurrence of small-scale changes in gene frequencies in a population over a few generations, also known as change at or below the species level. These changes may be due to several processes: mutation, gene flow, genetic drift, as well as natural selection. (**Figure 22**).

Macroevolution which is the occurrence of large-scale changes in gene frequencies in a population over a long period of time (and may culminate in the evolution of new species).(**Figure 22**).

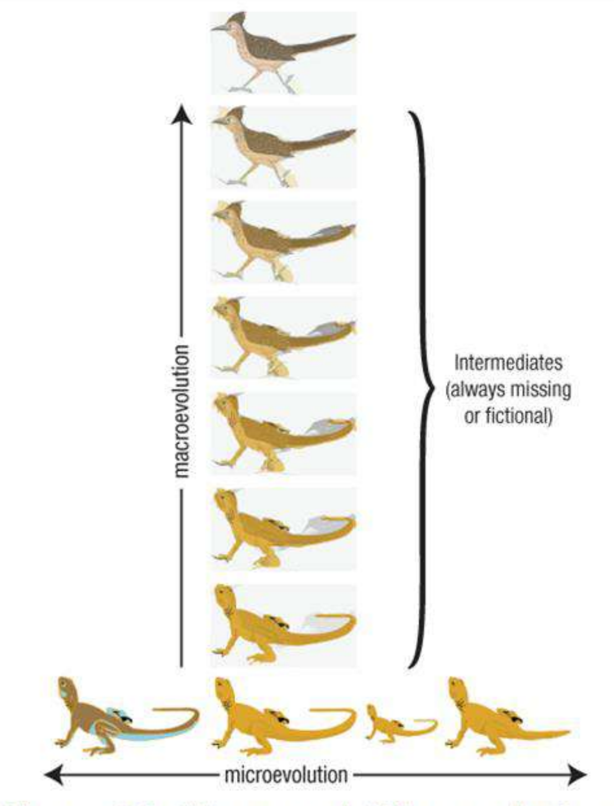


Figure 22: Macro and Microevolution

Patterns of evolution:

Evolution helps us to understand the history of life. Progressive evolution is in process, species adapt and evolve to better survive in their environments and caused changes in their traits. Similar environments can cause similar adaptation in different species, and different environments can cause different adaptation in similar species this differences lead to diversity in environment. There are five main patterns of evolution:

Divergent evolution, Convergent evolution, Parallel evolution, Coevolution, Adaptive evolution

1. Divergent evolution

Divergent evolution is when two related species are evolving to become more and more dissimilar. An example of divergent evolution is the red and the kit fox. The red fox lives in farmlands and forests where its red color easily camouflages it, as compared to the kit fox that lives on the plains and in deserts where it is also easily camouflaged by its sandy coloring. Also, the kit fox has larger ears as opposed to the red fox. These characteristics show a common ancestor between the two; however, they are evolving farther and farther apart. (**Figure23**)

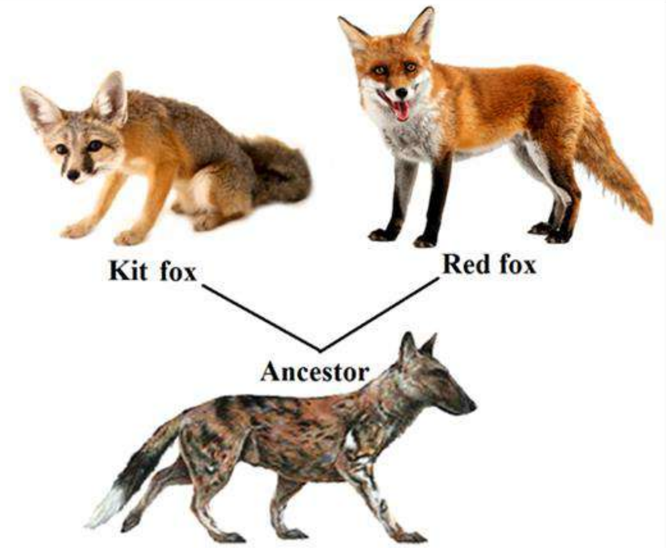


Figure23 : Divergent evolution

2. Adaptive evolution

Natural selection can ultimately lead to the formation of a new species. Sometimes many species evolve from singles ancestral species ,adaptive radiation most commonly occur when species of organisms successfully invades an isolated region where a few competing species exist. If new habitats are available, a new species will evolve (**Figure 24**).

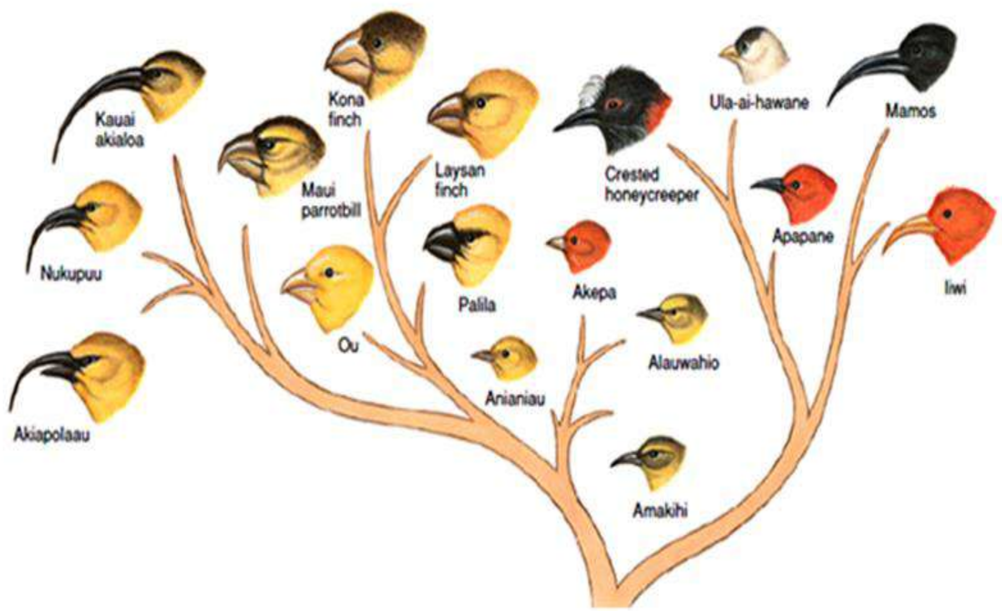


Figure 24: Adaptive evolution

3. Convergent evolution

Convergent evolution is the opposite of divergent evolution. Instead of growing farther apart, two unrelated species evolve to be more and more similar. An example of convergent evolution is a cactus which grows in the American deserts and the euphorbia, which grows in African deserts. Both plants have fleshy stems loaded with spines which help the plantsstore water and ward off predators. (**Figure25**)

Figure25: Convergent evolution

4. Parallel evolution

Parallel evolution: two or more species from similar evolutionary history continue to evolve similar characters, example: social behavior in bees, wasps, and Ants (**Figure 26).**

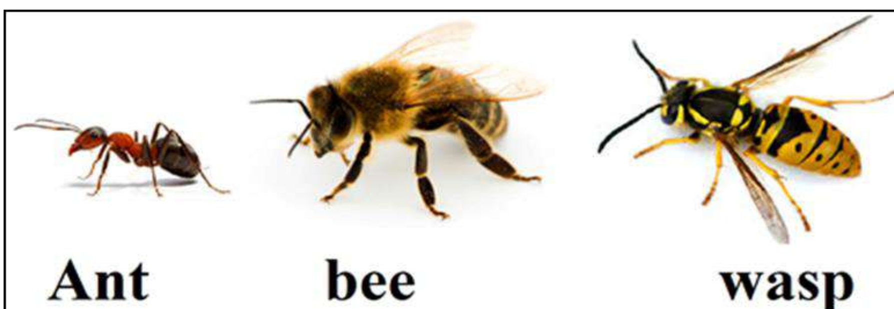


Figure 26: Parallel evolution

5. Coevolution

Coevolution is when one species evolves in response to another species evolution.While the process of coevolution generally only involves two species, multiple species can be involved. Moreover, coevolution also results in adaptations for mutual benefit. An example is the coevolution of flowering plants and associated pollinators (e.g., bees, birds, and other insect species).

Figure 27: Coevolution

An example of coevolution is when a plant's morphology changes, thus affecting the herbivore that eats the plant, which could affect the evolution of the plant, then the animal again, so on and so forth (**Figure27**).

Biodiversity

The term of biodiversity was first used by wildlife scientist, Raymond F.Dasman in 1968. This term was widely adapted only after decade (10 years).

Biodiversity can have many interpretation:-

1-Biodiversity is the degree of variation of life forms within given ecosystem or an entire planet.

2-Biodiversity is the total number of living organism's species within ecosystem or on the entire planet. There is about 3-5 millions of species, only 1-7 million have been described already, most of these species are microorganisms and insects.

3-Biodiversity is the total of genes, species and ecosystem of region. An advantage of this definition is that seems to describe most circumstances of the three levels at which biodiversity variety have been identified (species, genes and ecological diversity).

In 2003 Prof. Anthony at Gradiff University U.K. defined a fourth level of Biodiversity which is molecular diversity.

Biodiversity Studies:-

The Biodiversity referring to the last definition (3) can be studied by many aspects.

Elements or levels of biodiversity

1-Genetic Diversity:-

This study deals with role of genes as the genes is the responsible of transmitting the character of organism through the generations. Any chances in structure or arrangement of the genes by mutation or recombination will be transmitted to next generation and leads for more adaptation with ecological changes.

2-Ecological Diversity:-

This study deals with relationships between the living ecosystem (all the forms of life) and non-living ecosystem (Soil, Water, Air, Light…) and also between the bio-ecosystem contents (Producers, Consumers and Decompositors).

3-Species Diversity:-

The study of species by recognition, description, classification and estimation of the species numbers.

Species Concept:-

Each kind of animal and plant belongs to a single species, and the individuals of one species are related more closely to one another than to individuals of any other species. The concept of species may be explained as follow:-

1-Typdogical Concept:

That mean each species has a certain type with specific morphology. This type unchangeable and give the species its recognition from other species.

This concept established by (Linaeus) but was unacceptable for many reasons:-

A- That some species have the polymorphism and metamorphism. And also there is a morphological difference between the sexes.

B- Some species divided between into subspecies in their population with variable morphology. Or sibling species (different species with similar morphology).

2-Biological Concept:-

A species is a series of population, that are capable in nature of interbreeding with another to yield fertile offspring. But that are ordinary unable to interbreed with other different species, cannot mate and produce fertile offspring.

This definition of species is applicable only to sexually reproducing organisms, for species that reproduce a sexually species.

3-Non Dimensional Concept:

The individual of the same species are not always alike, there is differences between them such as morphological differences.

(Ex sibling species) or functional differences.
(Ex polymorphisms) or developmental differences.
(Ex metamorphism) etc…

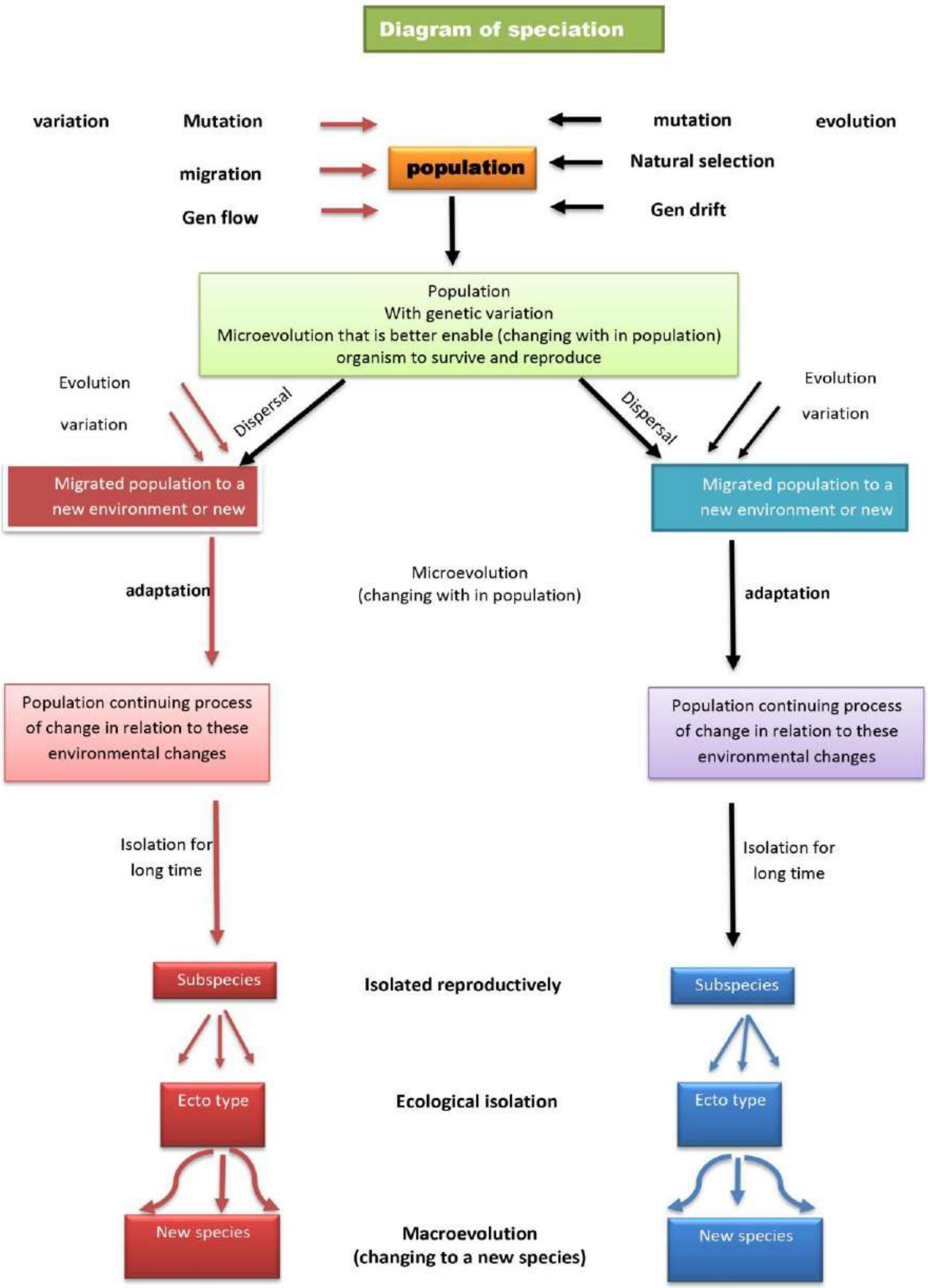


Diagram of speciation
variation
Mutation
migration
Gen flow
population
mutation
evolution
Natural selection
Gen drift
Population
With genetic variation
Microevolution that is better enable (changing with in population)
organism to survive and reproduce
Evolution
variation
Dispersal
Dispersal
Evolution
variation
Migrated population to a
new environment or new
Migrated population to a
new environment or new
adaptation
Microevolution
(changing with in population)
adaptation
Population continuing process
of change in relation to these
environmental changes
Population continuing process
of change in relation to these
environmental changes
Isolation for
long time
Isolation for
long time
Subspecies
Isolated reproductively
Subspecies
Ecto type
Ecological isolation
Ecto type
New species
Macroevolution
(changing to a new species)
New species

Biome

What is a Biome?

A biome is a large geographical area of distinctive plant and animal groups which are adapted to that particular environment.

Most terrestrial biomes are defined by the dominant plant life. The plant life is determined in part by the climate in a region, and climate is controlled by many factors, including latitude and geography.

Type of biome

There are many different types of biomes on the Earth's surface. Each biome is unique in that it has its own weather and temperature patterns, plant species, and animal species. It is important to understand the uniqueness of each biome in order to understand why certain animals and plants thrive in one area yet would not be able to survive in another. Biomes are also very sensitive and each has special needs in order to maintain itself. Although there are many types of biomes, they each fit into two categories: aquatic biomes and terrestrial biomes.

A fundamental classification of biomes is:

1-Aquatic biomes (including freshwater biomes and marine biomes)

2- Terrestrial (land) biomes which includes grassland, forest, desert and tundra.

Aquatic Biomes

Water is essential for life in the sea and on land. 70% of the Earth’s surface is covered by water. However, only a tiny proportion (3%) of this is fresh water, a large amount (around two thirds) of which is unavailable, being frozen as polar ice-caps or glaciers. Another large part (about a third) is stored as deep groundwater. As a result, all, non-marine, living creatures rely on less than 1% of the planet’s total freshwater for their survival.

Aquatic biomes are those that occur under water. This can be saltwater and freshwater. There is saltwater in the ocean and this is where one would find the ocean biome and the coral reef biome. The shallow part of the ocean that contains coral is a part of the coral reef biome.

The Marine Biome

Marine regions cover about three-fourths of the Earth's surface and include oceans, coral reefs, and estuaries. Marine algae supply much of the world's oxygen supply and take in a huge amount of atmospheric carbon dioxide. The evaporation of the seawater provides rainwater for the land.

- Oceans
- Coral reefs
- Estuaries

Oceans

The largest of all the ecosystems, oceans are very large bodies of water that dominate the Earth's surface. Like ponds and lakes, the ocean regions are separated into separate zones: **intertidal, pelagic, abyssal, and benthic**. All four zones have a great diversity of species. **Some say that the ocean contains the richest diversity of species even though it contains fewer species than there are on land.**

- **The *intertidal zone* is where the ocean meets the land — sometimes it is submerged and at other times exposed, as waves and tides come in and out.**

Because of this, the communities are constantly changing. On rocky coasts, the zone is stratified vertically; there are only a few species of algae and mollusks. In those areas usually submerged during high tide, there is a more diverse array of algae and small animals, such as herbivorous snails, crabs, sea stars, and small fishes. At the bottom of the intertidal zone, which is only exposed during the lowest tides, many invertebrates, fishes, and seaweed can be found.

From left: mussels, worms, and a spider crab at a hydrocarbon seep community

The *pelagic zone* includes those waters further from the land, basically the open ocean. The pelagic zone is generally cold though it is hard to give a general temperature range. The flora in the pelagic zone includes surface seaweeds. The fauna include many species of fish and some mammals, such as whales and dolphins. Many feed on the abundant plankton.

The *benthic zone* is the area below the pelagic zone, but does not include the very deepest parts of the ocean (see *abyssal zone* below). Here temperature decreases as depth increases toward the abyssal zone, since light cannot penetrate through the deeper water. Flora are represented primarily by seaweed while the fauna, since it is very nutrient-rich, include all sorts of bacteria, fungi, sponges, sea anemones, worms, sea stars, and fishes.

The deep ocean is the *abyssal zone*. The water in this region is very cold (around 3° C), highly pressured, high in oxygen content, but low in nutritional content. The abyssal zone supports many species of invertebrates and fishes. Chemosynthetic bacteria thrive near these vents because of the large amounts of hydrogen sulfide and other minerals they emit. These bacteria are thus the start of the food web as they are eaten by invertebrates and fishes.

Coral Reefs

Coral reefs are widely distributed in warm shallow waters. They can be found as barriers along continents.

Corals are interesting since they consist of both algae (zooanthellae) and tissues of animal polyp. Since reef waters tend to be nutritionally poor, corals obtain nutrients through the algae via photosynthesis and also by extending tentacles to obtain plankton from the water. Besides corals, the fauna include several species of microorganisms, invertebrates, fishes, sea urchins, octopuses, and sea stars.

From left: reef life in the Gulf of Aqaba, Red Sea

Estuaries

Estuaries are areas where freshwater streams or rivers merge with the ocean. This mixing of waters with such different salt concentrations creates a very interesting and unique ecosystem. Microflora like algae, and macroflora, such as seaweeds, marsh grasses, and mangrove trees (only in the tropics), can be found here. Estuaries support a diverse fauna, including a variety of worms, oysters, crabs, and waterfowl.

From left: Mangrove roots, south Florida; wetlands and tidal streams in the Ashe Island area

The Freshwater Biome

The freshwater biome includes areas of land covered in water that contains less than 1% of salt water. This includes rivers, lakes, ponds, and wetlands such as swamps and marshes.

Fresh water holds over 10% of all life on the planet. Between 1970 and 2000 populations of freshwater species declined by 55% compared with a decline of about 32% for both marine and terrestrial species.

There are different types of freshwater regions:

- Ponds and lakes
- Streams and rivers
- Wetlands

Ponds and Lakes

These regions range in size from just a few square meters to thousands of square kilometers. Scattered throughout the earth. Many ponds are seasonal, lasting just a couple of months while lakes may exist for hundreds of years or more.

Ponds and lakes may have limited species diversity since they are often isolated from one another and from other water sources like rivers and oceans.

Lakes and ponds are divided into three different “zones” which are usually determined by depth and distance from the shoreline.

The topmost zone near the shore of a lake or pond is the *littoral zone*. This zone is the warmest since it is shallow and can absorb more of the Sun's heat. It sustains a fairly diverse community, which can include several species of algae (like diatoms), rooted and floating aquatic plants, grazing snails, clams, insects, crustaceans, fishes, and amphibians. In the case of the insects, such as dragonflies and midges, only the egg and larvae stages are found in this zone. The vegetation and animals living in the littoral zone are food for other creatures such as turtles, snakes, and ducks.

From left: a view across Manzanita Lake

The near-surface open water surrounded by the littoral zone is the *limnetic zone*. The limnetic zone is well-lighted (like the littoral zone) and is dominated by plankton, both phytoplankton and zooplankton. Varieties of freshwater fish also occupy this zone.

The *profundal zone*. This zone is much colder and denser than the other two zones. Little light penetrates all the way through the limnetic zone into the profundal zone. The fauna are heterotrophs, meaning that they eat dead organisms and use oxygen for cellular respiration.

Temperature varies in ponds and lakes seasonally. During the summer, the temperature can range from 4° C near the bottom to 22° C at the top. During the winter, the temperature at the bottom can be 4° C while the top is 0° C (ice).

Streams and Rivers

These are bodies of flowing water moving in one direction. Streams and rivers can be found everywhere — they get their starts at **headwaters**, which may be springs, snowmelt or even lakes, and then travel all the way to their **mouths**, usually another water channel or the ocean.

The characteristics of a river or stream change during the journey from the source to the mouth.

1. **The temperature** is cooler at the source than it is at the mouth.
2. **The water is also clearer** has **higher oxygen levels**, and freshwater fish such as trout and heterotrophs can be found there.

3. **Towards the middle part of the stream/river**, **the width increases**, as does species diversity — numerous aquatic green plants and algae can be found. **Toward the mouth of the river/stream,** the water becomes murky from all the sediments that it has picked up upstream, decreasing the amount of light that can penetrate through the water. Since there is less light, there is less diversity of flora, and because of the lower oxygen levels, fish that require less oxygen, such as catfish and carp, can be found.

Wetlands

Wetlands are areas of standing water that support aquatic plants. Marshes, swamps, and bogs are all considered wetlands. Plant species adapted to the very moist and humid conditions are called hydrophytes. These include pond lilies, cattails, sedges, tamarack, and black spruce. Marsh flora also include such species as cypress and gum.

Wetlands have the highest species diversity of all ecosystems. Many species of amphibians, reptiles, birds (such as ducks and waders), and furbearers can be found in the wetlands. **Wetlands are not considered freshwater ecosystems as there are some, such as salt marshes, that have high salt concentrations** these support different species of animals, such as shrimp, shellfish, and various grasses.

Importance of Freshwater Biome

1. Freshwater make up only 0.01% of the world water.
2. Cover 0.8% of the earth's surface.
3. Freshwater supports at least 100.000 species.
4. Over 100.000 –fish species live in fresh water. Approximately 40% of global fish diversity.
5. 6% of all described species found in freshwater.

The Benefits of Biodiversity for Water

1. Protection of Water Resources.
2. Nutrient Storage and Cycling.
3. Pollution Breakdown and Absorption.
4. Climate and Flood Regulation Water Purification.
5. Medicinal Resources.
6. Recreation.
7. Food Resources

The Desert Biome

Deserts makeup about 20% of total land cover on earth and are characterized by little (less than 50cm/yr) or no rainfall. Desert biomes come in four major kinds each of these having their unique features but have similarities in their biotic and abiotic makeup. They are the:-

1. **Hot and Dry Deserts (**Central America, southern Asia, Africa, and Australia)**.**
2. **Semi Arid Deserts (**North America, Europe, and northern Asia)**.**
3. **Coastal Deserts (**parts of Chile in South America)**.**
4. **Cold Deserts (**Antarctic, Iran, Turkestan, Northern and Western China).

The characteristics of the desert biome:

1. Little rainfall (less than 50 centimeters per year)
2. Temperatures vary greatly between day and night
3. High evaporation rates
4. Coarse-textured soils
5. High resistant organisms

Plants that survive here are short shrubs and cacti, which have the ability to conserve water. Plants are also less leafy, using their stems for photosynthesis. Examples of plants are the yuccas and the sotol. Animals here tend to burrow, or stay in hideaways till dusk to avoid the heat. They are mainly small carnivores, birds, insects, snakes and lizards, and are adapted to survive with very little water.

Hot and Dry Deserts

Cold Deserts

The Forest Biome

Forests makeup about 30% of the total land cover on earth and are of incredible value to life on earth.

The characteristics of the forest biome:

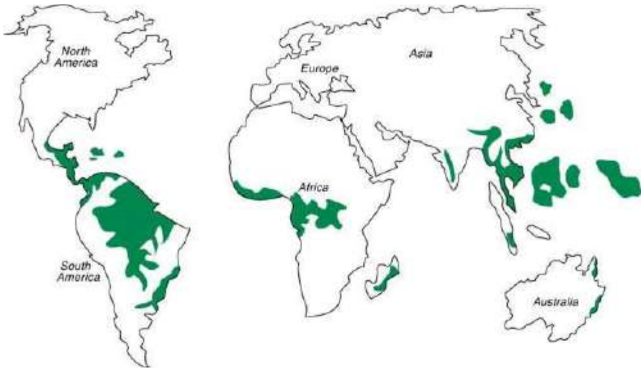
1. Largest and most complex terrestrial biome
2. Dominated by trees and other woody vegetation
3. Significant role in the global intake of carbon dioxide and production of oxygen
4. Threatened by deforestation for logging, agriculture, and human habitation
5. A source of many raw materials that humans depend on.
6. It is believed that forests have the most biodiversity.

There are three main biomes that make up Forest Biomes. These are

1-The Tropical Rainforest

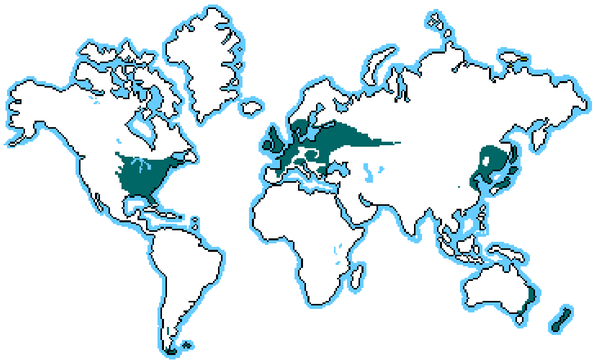
A tropical rainforest is the richest biome in the world and is one of the most diverse and productive biomes on Earth. It is rich in biodiversity with over 15 million species of plants and animals living within the biome. Nearly 50% of the living organisms on Earth are found in these forests. An example of the Tropical Rainforest is the Amazon.

One of the distinctive features of the tropical rainforest is its climatic conditions that include rains, humidity and temperature. These forests experience equatorial climate with average day temperature of 27^{o}C. Tropical rainforests are characterized by rainfall and evergreen species. The forests are located in the tropical wet / humid regions with an average annual rainfall of around 200-225 cm/y.



2-Temperate Deciduous Forests

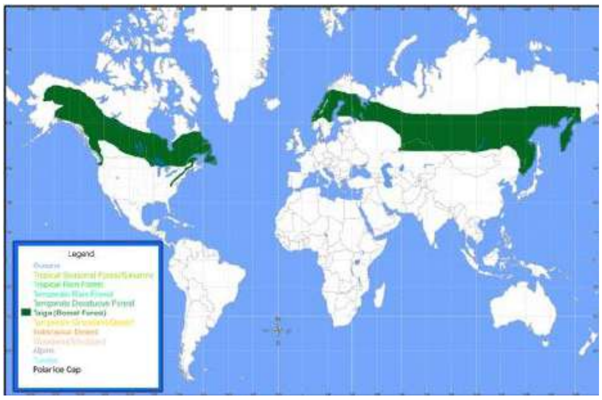
Most temperate, deciduous (leaf-shedding) forests are located in the eastern United States, Canada, Europe, China, Japan, and parts of Russia. Summers are mild, and average about (21°C), while winter temperatures are often well below freezing. Trees and plants in deciduous forests have special adaptations to survive in this biome. Deciduous trees are trees with leaves rather than pine needles, and they dominate temperate forests. Animals in temperate deciduous forests have to adapt to changing seasons. They must be able to cope with cold winters and hot summers. Some animals hibernate or migrate during the winter to escape the cold.



3-Boreal Forests (also called the Taiga)

Boreal forests are the northernmost forests in the world. These are vast forests that include 29% of all the world's forest area in a belt around the Northern Hemisphere, including Scandinavia, Russia, and Canada. In the United States, boreal forests occur in central Alaska and northeastern Minnesota. Boreal forests are dominated by species of spruce, fir, pine, larch, birch, and aspen. Their forest floors are usually covered with mosses and many species of wildflowers.

The distinguishing climatic features are long winters with five to seven months of snow cover and a short cool summer. July mean temperatures fall between 13 and 18 ºC. Characteristic wildlife in the boreal forests includes bear, moose, woodland caribou, wolves, lynx, and wolverine. Deer are restricted to the southern margin of the boreal forest. Many migratory birds use the boreal forest during summer, including warblers, pelicans, seagulls, and hawks. Species of owls and ravens are year-round residents.



The Grassland Biome

As the name suggests, these are massive areas dominated by one or a few species of grass, with a few sparsely distributed trees. There are two main types of grassland biomes: the **Savanna Grasslands and the Temperate Grasslands**. One major savanna is located in Africa and takes up more than a third of the continent's land area. Others can be found in India, South America and Australia.

Grassland regions with limited rainfall, which prevents forest growth. Savannas, on average, receive roughly 76 to 101 centimeters/year. Temperatures vary much more in temperate grasslands than they do in savannas. Savannas are in warm climates with average annual temperatures that only vary between 21 and 26 degrees Celsius . They typically have only two seasons, a wet and a dry season. Temperate grasslands have hot summers where temperature can exceed 38 degrees Celsius (100 degrees Fahrenheit) and cold winters that can drop below negative 40 degrees Celsius (negative 40 degrees Fahrenheit). Savannas are home to some of the largest mammals on the planet such as elephants, giraffes, rhinos, lions and zebras. Temperate grasslands are also home to large mammals, particularly bison and horses, medium-sized mammals like deer, antelope and coyotes, as well as small mammals such as mice and jack rabbits. The type of grasses that grow depend upon the amount of rainfall. Shorter steppe grasses often consist of buffalo grass, and savanna grasses will contain taller grasses like bluestem and rye.

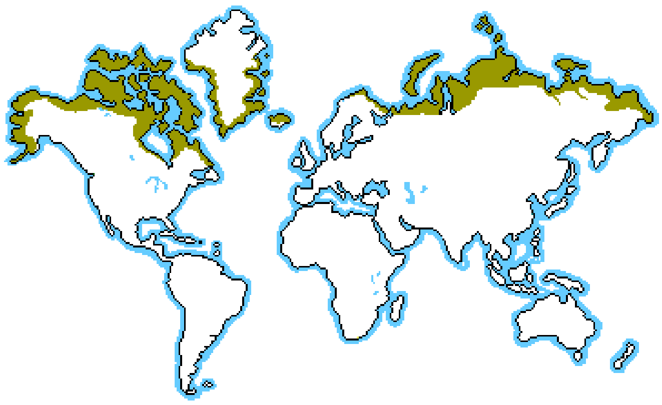
The Tundra Biome

This is known to be the coldest of all the terrestrial (land) biomes, with the least bio-diversity capacity. This biome has very little rain with freezing temperatures, and covers about a fifth of the earth's land surface.

There are two major tundra biomes: **The Arctic Tundra and the Alpine Tundra**. The Arctic tundra is located around the north-pole in the northern hemisphere. This biome has temperatures of about 2-3℃ in the summer and about -35℃ in the winter. Swamps and ponds are common as a result of constantly frozen surface moisture and melted permafrost.

Plants in the Arctic Tundra are short and grow closely to each other. Examples include mosses, heaths and lichen. They are adapted to perform photosynthesis even in the freezing conditions. Animals here include herbivores like hares and squirrels. Carnivores include polar bears and arctic foxes. It also has lots of birds, insets and fish like cod and salmon.

The Alpine Tundra is very cold, located on top of high mountains, often with very few trees and very little vegetative cover. They are icy for a larger part of the year. Animals in this biome include some birds, mountains goats and marmots. There are also beetles and butterflies.



Evolution

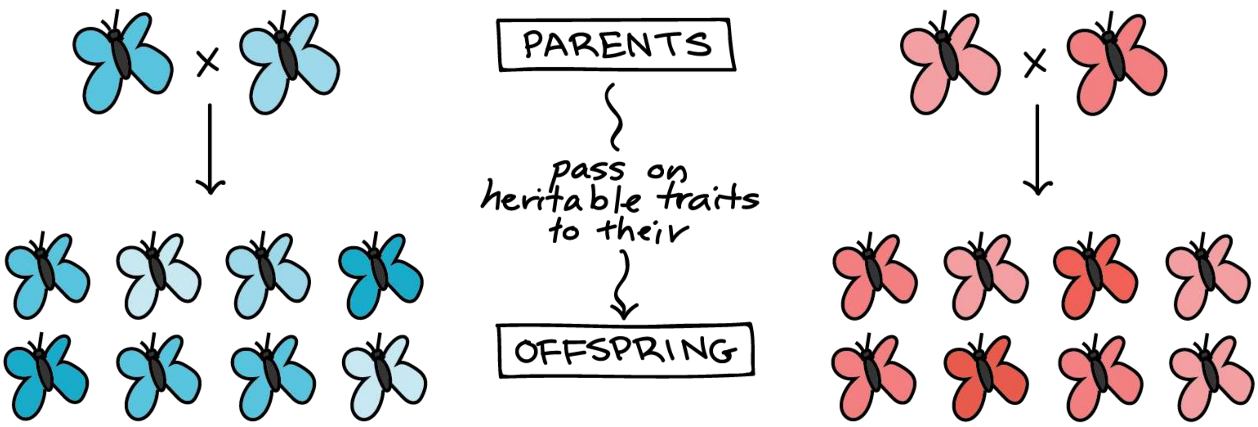
Charles Darwin proposed the idea of evolution in his book '*On The Origin Of Species*' in 1859. He called evolution 'descent with modification'. It is the process by which all life on earth has diversified from bacterial mats that existed over 3.6 billion years ago. Evolution has had a long time.

In biology, evolution is the change in the characteristics of a species over several generations and relies on the process of natural selection.

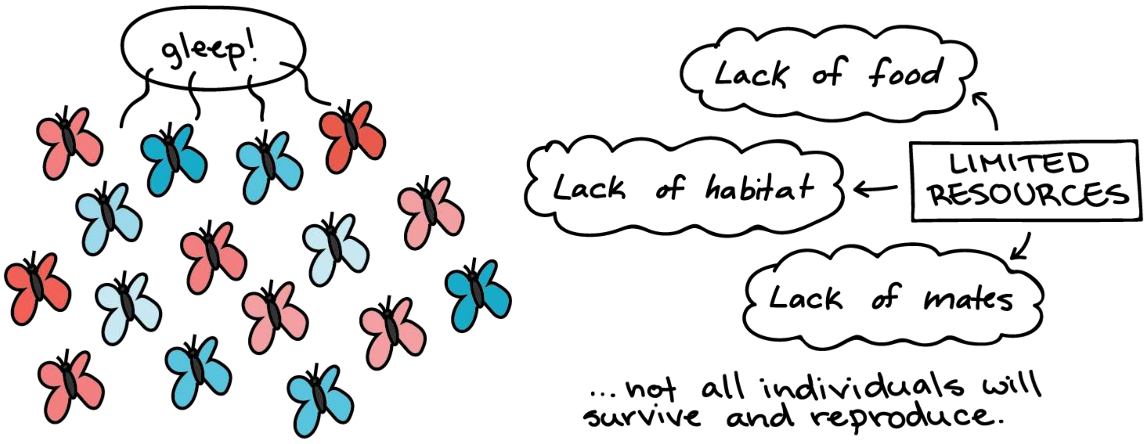
Natural selection is the process that drives the evolution of new species. It is based around the concept that individuals with beneficial traits for in their environment are more likely to reproduce and pass on their traits and genes to more offspring.

Darwin's concept of natural selection was based on several key observations:

- **Traits are often heritable.** In living organisms, many characteristics are inherited, or passed from parent to offspring.



- **More offspring are produced than can survive.** Organisms are capable of producing more offspring than their environments can support. Thus, there is competition for limited resources in each generation.



- **Offspring vary in their heritable traits.** The offspring in any generation will be slightly different from one another in their traits (color, size, shape, etc.), and many of these features will be heritable.

An organism's environment is shaped by a range of factors such as temperature, precipitation, wind, predation, competition and disease. As environmental factors change, the level of benefit gained from certain genes and traits varies. Some genes and traits become more beneficial in a specific environment while others lose their benefit.

For example, the photos above show two different colored moths in two completely different environments. One environment is filled with green leaves while the other is a desert made from orange sand.

In the desert environment, the green moths stick out against the orange sand. In this environment, the orange moths have a much better camouflage and would be less likely to be eaten by predators and more likely to reproduce.

If the same species of moth lived in both of these environments, over time, natural selection would change the two populations in different ways. The population of moths living in the green, leafy environment would be more likely to gradually become green while the population of moths living in the desert would be more likely to become orange. Over many generations, two new species would have evolved through natural selection.

Different Types of Evolution

1-Convergent Evolution

When the same adaptations evolve independently, under similar selection pressures.For example, flying insects, birds and bats have all evolved the ability to fly, but independently of each other.

2-Co-Evolution

When two species or groups of species have evolved alongside each other where one adapts to changes in the other. For example, flowering plants and pollinating insects such as bees.

3-Adaptive Radiation

When a species splits into a number of new forms when a change in the environment makes new resources available or creates new environmental challenges.For example, finches on the Galapagos Islands have developed different shaped beaks to take advantage of the different kinds of food available on different islands.

3-Microevolution

Microevolution is simply a change in gene frequency within a population,evolution at this scale can be observed over short periods of time.

There are a few basic ways in which microevolutionary change happens. Mutation, migration, genetic drift, and natural selection are all processes that can directly affect gene frequencies in a population.

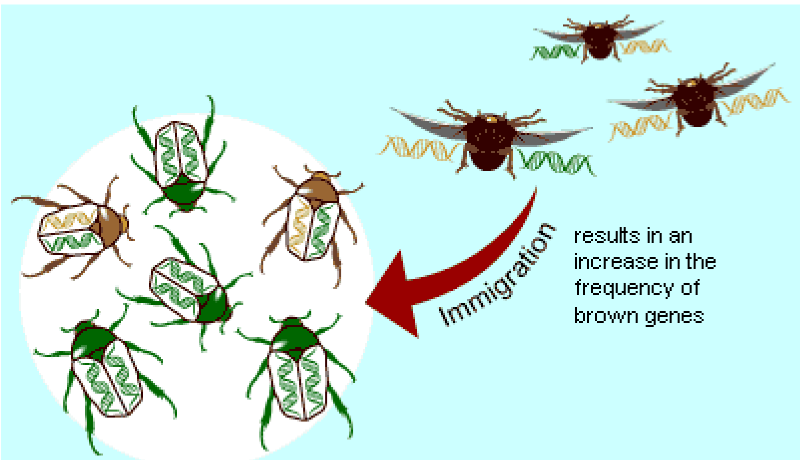
A-Mutation

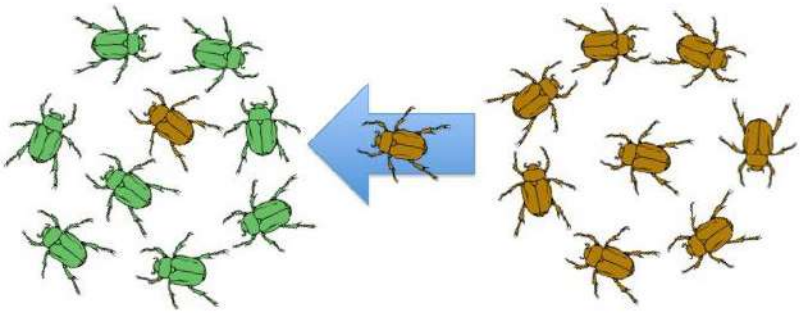
Any change in the DNA sequence of a cell. Mutations may be caused by mistakes during cell division, or they may be caused by exposure to DNA-damaging agents in the environmentsuch as radiation, viruses and mutagenic chemicals. Mutations can be harmful, beneficial, or have no effect. If they occur in cells that make eggs or sperm, they can be inherited; if mutations occur in other types of cells, they are not inherited.Thethe only source of new alleles. Certain mutations may lead to cancer or other diseases.

If the mutation is advantageous to the point where it gives the organism an adaptive advantage in an environment, it is likely to spread through the population through the process of ***natural selection***, eventually leading to macroevolution.

B-Gene Flow(Migration)

Also known as "gene migration', *gene flow* ***is the transfer of alleles (variants of a gene) from one population to another.*** Gene flow occurs when individuals or their *gametes* are able to migrate between populations that are physically separated. For example, some beetles with brown genes immigrated from another population, or some beetles carrying green genes emigrated.



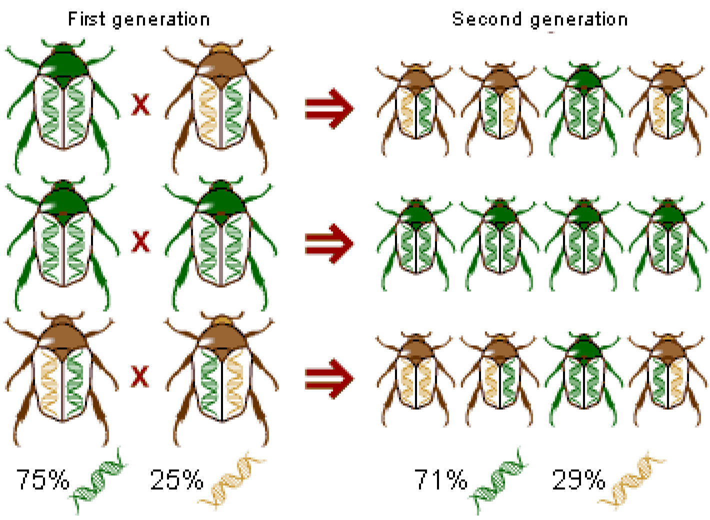


Gene flow can also increase the genetic diversity of a population. For example, if an allele that has evolved within population B is introduced to population A, the genetic diversity of population A increases.

C-Genetic drift

Genetic drift ***is the process of microevolution that describes the random fluctuations in the frequency of alleles within a population.***

When the beetles reproduced, just by random luck more brown genes than green genes ended up in the offspring. In the diagram at right, brown genes occur slightly more frequently in the offspring (29%) than in the parent generation (25%).



Additionally, the *founder effect*, in which a small number of individuals becomes separated and isolated from a population, can cause genetic drift. The new population of individuals contains a limited sample of the full diversity of alleles in the original population, which will then increase in frequency.

E-Selection

The *natural selection* of alleles that control for certain traits occurs when an organism’s gene variants give it an adaptive advantage over the other gene variants in a population, ultimately allowing it to reproduce and increase the frequency of these genes.

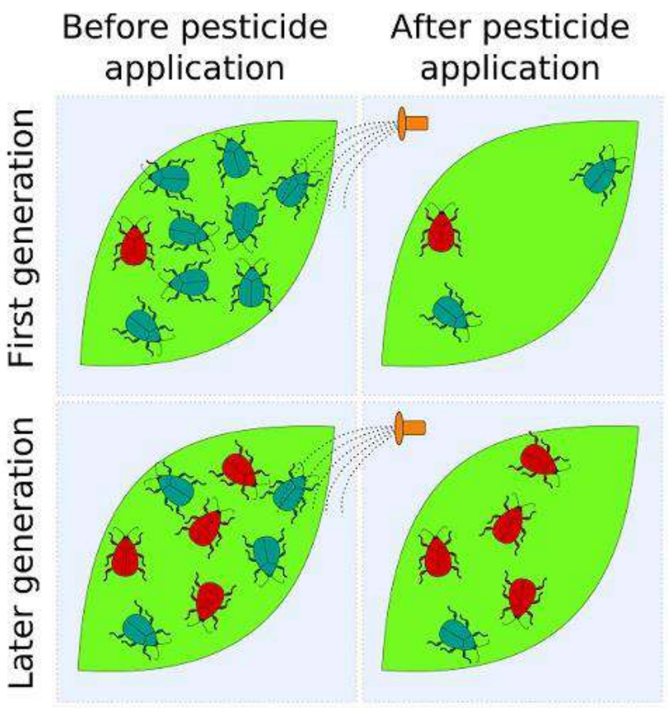
Another way that alleles may be selected for is through *sexual selection*. ***Sexual selection is a "special case" of natural selection. Sexual selection acts on an organism's ability to obtain (often by any means necessary!) or successfully copulate with a mate.*** for example, bright eyespots on a peacock’s tail or large heavy antlers on a deer. Displaying the desired trait gives the mate a competitive advantage in reproduction, and eventually leads to an increase in the frequency of alleles associated with that trait. Selection may also be controlled through *artificialselection* ***Human intervention in animal or plant (Bacteria recently)reproduction or survival to allow only individuals with desirable traits toreproduce.***

In this case, which is similar to sexual selection, certain desirable physical or behavioral traits of a plant or animal are chosen, and individuals that possess them are bred.

Examples of Microevolution

Pesticide Resistance

Pesticides are designed to kill insects that might feed on a particular plant. Each time the pesticide is applied to the plant; a few individuals may survive, including those possessing certain genes that cause resistance to the pesticide. The surviving individuals will go on to reproduce and increase the frequency of the genes that enabled them to survive in the population.



Pesticide resistance

Evolution of Viral Disease

Unlike other organisms, viruses may store their genetic information using either DNA or RNA. Mutation rates during replication are much higher in RNA than in DNA and therefore new genes, which may be beneficial to the Viruses also have large population sizes and short generation times, which further increases the probability of a possible genetic mutation and allows mutations to spread rapidly through populations.

The constant emergence and microevolution of viruses due to their high mutation rate makes them incredibly hard to treat when they infect other animals, as the populations can quickly develop resistance to drugs.

4-Macroevolution

The term "macroevolution" refers to a change of an evolutionary nature in a species. A species that splits into two or a species that change into another species over a given time are examples of macroevolution. These changes can be a result of species selection, independent evolution (also called vicariance), historical constraints or developmental constraints.

Mutation
Gene Flow
Genetic Drift
Natural Selection
+ 3.8 billion years = Macroevolution

Macroevolution can be used to describe the differences between two closely related but distinct species, such as the Asian Elephant and the African Elephant, which cannot mate due to the barriers imposed by *reproductive isolation*. This is the process of *speciation*, which can be driven by a number of different mechanisms.

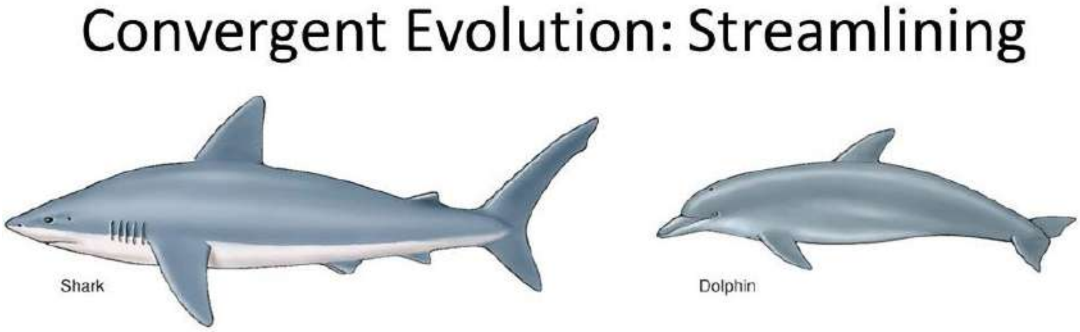
The term macroevolution can also be used to explain the shared common ancestry between all living organisms, a concept known as *Universal* **Common Descent.** This describes the derivation of all existent and extinct life forms from a single origin, and includes evolutionary milestones such as the origins of plants, mammals, reptiles, birds, fish, non-avian dinosaurs and more.

There is a dispute among scientists about the legitimacy of evolutionbecause microevolution is demonstrable within a lab, whereas macroevolution cannot be observed within the lifetime of a human. There are, however, many ways to observe macroevolution using the evidence available from fossils, geology and radiometric dating, genetics, and the ecology, morphology and behavior of living organisms.

TheDifferent Types Of Macroevolution

A-Convergent Evolution

The word *converge* means "to come together". *Convergent evolution is the process by which unrelated or distantly related organisms evolve similar adaptations. Organisms displaying these similarities usually live in similar environments, and the force driving convergence is natural selection. Similar environments pose similar challenges to survival, and traits that aid in survival are selected for in each environment. Convergent evolution is seen in the* *fusiform (tapering toward the end) shapes and similar countershading coloration of sharks and dolphins, both of which are adapted to marine environments. Their shape facilitates rapid and efficient movement through water, and their light underbelly and a gray upper surface make them less visible from both below and above.*



B-Divergent Evolution

Nearly the opposite of convergent evolution is divergent evolution. The term*diverge* means "to split apart". Also called adaptive radiation,

Divergent evolution occurs when a group from a specific population develops into a new species. In order to adapt to various environmental conditions, the two groups develop into distinct species due to differences in the demands driven by the environmental circumstances.

The vertebrate limb is a classic example. The first tetrapod vertebrates had a simple limb adapted for crawling on land, like that of a salamander. Descendants of this ancestor have evolved all sorts of cool limbs - arms for climbing, flippers for swimming, wings for flying, shovel-shapes for digging - all evolved from the same original format.

C-Coevolution

Coevolution is a change in the genetic composition of one species (or group) in response to a genetic change in another.

Plants and insects represent a classic case of coevolution — one that is often, but not always, mutualistic. Many plants and their pollinators are so reliant on one another and their relationships are so exclusive that biologists have good reason to think that the "match" between the two is the result of a coevolutionary process.

D-Extinction

Extinction, in biology, the dying out or termination of a species. Extinction occurs when species are diminished because of environmental forces (habitat fragmentation, global change, overexploitation of species for human use) or because of evolutionary changes in their members (genetic inbreeding, poor reproduction, decline in population numbers).Many different species have gone extinct throughout history. Most famously, the dinosaurs went extinct. The extinction of the dinosaurs allowed mammals, like humans, to come into existence and thrive. However, descendants of the dinosaurs still live on today. Birds are a type of animal that branched off from the dinosaur lineage.

The DifferencesbetweenMicroevolution and Macroevolution

Microevolution	**Macroevolution**
Intra-species genetic change	Change leads to formation of a completely new species.
Occurs over small-time scales	Occurs over large-time scales
Genetic information that already exists is put in a new arrangement, altered, or lost.	New information is added to the existing genetic structure.
Can be experimentally proven	Difficulty in providing experimental proof
Example: New breeds of dogs or other living species	Example: Amphibians undergoing evolution to form reptiles or reptiles undergoing evolution to form birds
Creationists support this.	Creationists do not support this

Formationof a new species

Speciation (the formation of a new species) can be broken down into a few concise steps.

The most important step is the isolation of two populations. This usually occurs because of physical factors such as a lake drying up and being separated into two smaller lakes.

As a result the fish in each lake are no longer able to breed with the fish in the other lake, resulting in no alleles being transferred between the populations.

Within each population mutations (random changes in the base sequence of DNA) will occur. But importantly since the changes are random the mutations that occur in each population will be different.

Similarly since both populations are now in different environments, physical characteristics of each environment such as water temperature will vary. As a result a mutation which may be favorable to cooler water conditions such as a thicker fat layer may be favorable to one population of fish but detrimental to the other where the water is warmer.

As a result of differing selection pressures due to the differences in physical conditions(example above), both populations will evolve in separate directions to favor their new environment. This will lead to greater and greater genetic differences between the populations over time as a result of changing allele frequencies.

Eventually both populations even if no longer physically isolated will be reproductively isolated. Reproductive isolation is where both populations are no longer able to interbreed to produce fertile offspring, a requirement for an individual species.

Reproductive isolation can occur due to factors such as incompatible genitalia and non-overlapping mating seasons. But importantly when two populations can no longer reproduce to produce fertile offspring they are considered two separate species.

EXTINCTION

Extinction is the process in which groups of organisms die out. If over an extended period of time the birth rate of a species is less than the death rate, then extinction will eventually occur.

Extinction is a natural phenomenon predicted by **Darwin** in his theory of evolution. A species goes extinct if it is not able to adapt to changes in its environment, or compete effectively with other organisms. In fact, the species that are alive today are only a small fraction of all the species that have ever existed.

The International Union for Conservation of Nature (IUCN) The organization is best known to the wider public for compiling and publishing the IUCN Red List of Threatened Species, which assesses the conservation status of species worldwide. Species are classified by the IUCN Red List into nine groups, specified through criteria such as rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation. There is an emphasis on the acceptability of applying any criteria in the absence of high quality data including suspicion and potential future threats, "so long as these can reasonably be supported."

EXTINCTION TERMS

- **Extinct (EX)**: a species which no longer exists.
- **Extinct in the Wild (EW):** known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.
- **Critically Endangered (CR**): facing an extremely high risk of extinction in the wild.
- **Endangered(EN)**: a species which is threatened with imminent extinction or extirpation
- **Vulnerable (VU)**: considered to be facing a high risk of extinction in the wild
- **Near Threatened (NT):** is close to qualifying for a threatened category in the near future.

- **Least Concern (LC):** lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category.

Threatened: a species which is likely to become endangered if limiting factors are not reversed.

Extirpated: a species that no longer exists in a certain region (i.e.Canada) but exists else where.

The current species extinction rate is estimated to exceed the natural or ‘background’ rate by 100 to 1000 times.(**Background extinction rate**, known as **normal extinction rate**, refers to the standard rate of extinction in earth’s geological and biological history before humans became a primary contributor to extinctions).

TYPES OF EXTINCTION

1. **Pseudoextinction** (or **phyletic extinction**) of a species occurs when all members of the species are extinct, but members of a daughter species or subspecies remain alive. As all species must have an ancestor of a previous species, much of evolution is believed to occur through pseudoextinction. It is difficult to prove that any particular fossil species is pseudoextinct unless genetic information has been preserved. For example, it is sometimes claimed that the extinct *Hyracotherium* (an ancient horse-like animal commonly known as an eohippus) is pseudoextinct, rather than extinct. However, it is not known, and probably cannot be known, whether modern horses actually descend from members of the genus *Hyracotherium*.

2. **Coextension:** The loss of one species leads to the loss of another in a chain effect. A small impact in the beginning of extinction can have an overall larger effect. Reasons for coextinction could be as a result of a predator losing its food source or if a key species becomes extinct and the ecosystem becomes off balance.

3. **Mass extinction or extinction event:** refers to sudden decrease in the number of species in a short span of geological time, in which from 40% to 95% of all plant and animal species died out. It has occurred several times in the distant past.Following each mass extinction; there was a rapid radiation of new species.

Five mass extinctions events have been recorded in the last 500 Ma

1-**Ordovician–Silurian extinction event** (End Ordovician): (440 Ma) Two events occurred that killed off 27% of all families, 57% of all genera and 85% of all species. Together they are ranked by many scientists as the second largest of the five major extinctions in Earth's history in terms of percentage of genera that went extinct.Extinction has been linked with environmental changes accompanying the **glaciation**.

2-**Late Devonian extinction:** (375 Ma) a prolonged series of extinctions eliminated about 19% of all families, 50% of all genera and 80% of all species. This extinction event lasted perhaps 20 Ma. Evidence such as glacial deposits in Brazil suggests widespread glaciation at the end-Devonian. A cause of the extinctions may have been an episode of global cooling. This is also supported by the fact that warm water marine species were the most severely affected by this **glaciation.**

3-**Permian–Triassic extinction event** (End Permian): (250 Ma) the Earth's largest extinction that killed 57% of all families, 83% of all genera and 90- 96% of all species. (53% of marine families, 84% of marine genera, about 96% of all marine species and an estimated 70% of land species, including insects). The evidence of plants is less clear, but new taxa became dominant after the extinction. The "**Great Dying**" had enormous evolutionary significance: on land, it ended the primacy of mammal-like reptiles. The recovery of vertebrates took 30 million years, but the vacant niches created the opportunity for archosaurs to become ascendant. In the seas, the percentage of animals that were sessile dropped from 67% to 50%. The whole late Permian was a difficult time for at least marine life, even before the "Great Dying".

The collapse of ecosystem may be related to the enhanced **volcanism** at the end of Late Permian. The magmas intruded carbonates and sulfate-rich sedimentary rocks, which released large amounts of CO_2 and SO_2 when heated and the toxic cocktail of sediment- and magma-derived gases probably contributed to the extinction.

4- **Triassic-Jurassic transition**: (200 Ma) About 23% of all families, 48% of all genera (20% of marine families and 55% of marine genera) and more than half of all species went extinct. Most non-dinosaurian archosaurs and most of the large amphibians were eliminated, leaving dinosaurs with little terrestrial competition. **Sea level changes**, marina anoxia, climatic changes, release of toxic compounds and acidification of seawater.

5-**Cretaceous–Paleogene extinction event:** K–T extinction, abbreviation of Cretaceous–Tertiary extinction, also called K–Pg extinction or Cretaceous–Paleogene extinction, (65 Ma) About 17% of all families, 50% of all genera and 75% of all species became extinct. In the seas it reduced the percentage of sessile animals to about 33%. The majority of non-avian dinosaurs became extinct during that time. Mammals and birds emerged as dominant land vertebrates in the age of new life. Proposed that **asteroid** was 10 km in diameter, releasing energy equal to 2 million times the most powerful nuclear bomb.

Effects: dust cloud lasting several years (blocking photosynthesis), blocked insolations, firestorms, and greenhouse effect

-Now suggested that a sixth one, caused by increased anthropogenic pressure on the environment. Mass Extinction/Loss of Biodiversity under the ruric of ‘Environmental Collapse’. The core causes of this mass extinction called “**HIPPO”: H**abitat loss, **I**nvasive species, **P**ollution, **P**opulation, **O**verharvesting.

The causes of extinction are continuously being researched and discovered. Causes of extinction can be separated into two categories: natural factors and human activities.

NATURAL CAUSES OF EXTINCTION

1- Climatic: Heating and Cooling

The effect that climate has on extinction is very big. The biodiversity of earth can't keep up with the rapid changes in temperature and climate. The species are not used to severe weather conditions and long seasons, or changing chemical of their surroundings. As more species die, it is only making it more difficult for the survivors to find food. The warmer climates we are used to present-day are perfect for diseases and epidemics to thrive.

2- Changes in Sea Levels or Currents

The changes in sea levels and currents are a result, in part, of the melting freshwater. The denser, saltier water sinks and forms the currents that marine life depends on. Ocean floor spreading and rising also affects sea level. A small rise in the ocean floor can displace a lot of water on to land that is already occupied. The gases from the volcanic activity can also be absorbed by the water, thus changing the chemical composition, making it unsuitable for some life.

3-Asteroids

Asteroids hit the earth with extreme force. The impact site is completely destroyed and the reverberations can be felt around the world.

4-Cosmic Radiation

Is radiation being emitted from outer space and the Sun. It is hypothesized that being exposed to too much cosmic radiation can mutate genes, which can potentially weaken a species gene pool in the future (Gene pool is all the genes of a particular species or population). Since the radiation comes from space and the Sun, it is extremely difficult to avoid the radiation. A supernova remnant is one source of cosmic radiation.

5- Acid Rain

Acid rain forms when sulfur dioxide and/or nitrogen oxides are put out into the atmosphere. The chemicals get absorbed by water droplets in the clouds, and eventually fall to the earth as acid precipitation. Acid rain increases the acidity of the soil which affects plant life. It can also disturb rivers and lakes to a possibly lethal level.

6-Disease / Epidemic

Each species has defense mechanisms like immunities and the ability to fight disease. With the changing climate and landscape certain species are losing their ability to fend off disease. They are becoming more susceptible to disease and epidemics, which can lead to their extinction.

7- Spread of Invasive Species

Invasive species invade foreign territory. They use resources that the other species depend on. Once competition gets too great, the survival of the fittest plan will begin, and one of the species, usually the natural one, will die off.

Natural factors also include: **volcanic eruptions, earthquakes, glaciations.**

Natural factors usually occur at a slower rate than human factors and therefore cause a lower extinction rate. Human activities occur at a faster rate and cause higher extinction rates. Human activities are mostly responsible for the present extinction rates.

HUMAN CAUSES OF EXTINCTION

1- Increased human population

This high extinction rate is largely due to the exponential growth in human numbers: from about 1 billion in 1850, the world's population reached 2 billion in 1930, and more than 7 billion in 2013(7.151 in July 2013), and it is expected to reach about 10 billion by 2050. As a result of increasing human populations, habitat loss is the greatest factor in current level of extinction. For example, less than one-sixth of the land area of Europe has remained unmodified by human activity.

2- Species introduction

Introduced species is a significant cause of biodiversity loss. It is also referred to "exotic, non native species", include organisms that are brought to a region where they previously had never been found. Introduced species are often dangerous to native species because they are free of predators, diseases, or resource limitations that may have controlled their population in their native habitat.

3- Destruction / Fragmentation of Habitat

Habitat degradation is currently the main anthropogenic cause of most species extinctions. The main cause of habitat degradation worldwide is the conversion of forested land to agriculture, urban sprawl, logging, mining and some fishing practices close behind. The degradation of a species habitat may alter the fitness landscape that the species is no longer able to survive and becomes extinct. This may occur by direct effects, such as the environment becoming toxic or indirectly, by limiting a species' ability to compete effectively for diminished resources or against new competitor species.

4- Climate Change / Global Warming

A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Climate variability and change affects birdlife and animals in several ways;

- Birds lay eggs earlier in the year than usual.
- Plants bloom earlier and mammals are come out of hibernation sooner.
- Distribution of animals is also affected; with many species moving closer to the poles as a response to the rise in global temperatures.
- Birds are migrating and arriving at their nesting grounds earlier, and the nesting grounds that they are moving to are not as far away as they used to be, and in some countries the birds don't even leave anymore, as the climate is suitable all year round.

Global warming is the increase in the average temperature of air near earth surface and oceans since the mid-20th century and its projected continuation. The global surface temperature increased by 0.74 ± 0.18°C (1.33 ± 0.32 °F) during the last 100 years. Most of the observed temperature increase has been caused by increasing concentrations of greenhouse gases, which result from human activities such as the burning of fossil fuel and deforestation.

Global dimming, a reduction of sunlight reaching the surface as a result of increasing atmospheric concentrations of human-made particulates, has partially countered the effects of warming induced by greenhouse gases.

5- Over-harvesting / poaching

Overharvesting is responsible for depletion or extinction of hundreds of species and the endangerment of many more, such as whales and many African large mammals. Most extinction over past several hundred years is mainly due to over-harvesting for food, fashion, and profit.

6- Environmental pollution

Pollution is the introduction of contaminants into the natural environment that causes adverse change. Pollution can take the form of chemical substances or energy, such as noise, heat or light.

TYPES OF ENVIRONMENTAL POLLUTION

Air pollution: Air pollution is the introduction of particulates, biological molecules, or other harmful materials into the Earth's atmosphere, causing disease, death to humans, damage to other living organisms such as food crops, or the environment.

- Types of air pollutants:
  - Primary pollutants - products of natural events (like fires and volcanic eruptions) and human activities added directly to the air
  - Secondary pollutants - formed by interaction of primary pollutants with each other or with normal components of the air

Major Classes of Air Pollutants:

- **Carbon oxides** (CO & CO2)
  - sources = incomplete combustion of fossil fuels
    - transportation, industry, & home heating
  - CO2 is an important greenhouse gas
  - CO (carbon monoxide)
    - the most abundant pollutant know to affect human health
    - combines with hemoglobin & may create problems for infants, the elderly, & those with heart or respiratory diseases
- **Sulfur oxides** (mainly SO2, or sulfur dioxide)
  - source = combustion of coal & oil (esp. coal)
    - SO2 released in the U.S. comes from:
      - utilities 69.5%
      - industrial manufacturing processes 12.7%
      - industrial combustion 11.6%
      - transportation 3.7%
      - other sources 2.5%.
  - can react with gases in atmosphere to form sulfuric acid ('acid rain')
  - 20 million tons released in U.S. every year

- Exposure to SO_2 can cause impairment of respiratory function, aggravation of existing respiratory disease (especially bronchitis), and a decrease in the ability of the lungs to clear foreign particles. It can also lead to increased mortality,
- **Nitrogen oxides** - NO (nitric oxide) & NO_2 (nitrogen dioxide)
  - source = motor vehicles & industry (burning fossil fuels)
  - can react with other gases in atmosphere to from nitric acid (HNO_3) ('acid rain')
- **Volatile organic compounds** (hydrocarbons) - methane, benzene, propane, & chlorofluorocarbons (CFC's)
  - source = motor vehicles (evaporation from gas tanks), industry, & <u>various household products</u>
  - 18 million tons released each year in U.S.
  - Concentrations of many VOCs are consistently higher indoors than outdoors. A study by the EPA, covering six communities in various parts of the United States, found indoor levels up to ten times higher than those outdoors-even in locations with significant outdoor pollution sources, such as petrochemical plants.
- **Suspended particulate matter**
  - solid particles (e.g., dust, soot, & asbestos) & liquid droplets (e.g., pesticides)
  - sources = power plants, iron/steel mills, land clearing, highway construction, mining, & other activities that disturb or disrupt the earth's surface
  - act as respiratory irritants; some are known carcinogens (e.g., asbestos)
  - can aggravate heart/respiratory diseases

- **Toxic compounds**
    - trace amounts of at least 600 toxic substances (such as lead and mercury) produced by human activities
        - Mercury is an element that occurs naturally in the earth's crust. Most people and wildlife can generally tolerate the extremely low levels of this naturally occuring substance. sources of mercury = burning coal and waste (such as medical wastes)

Effects of Air Pollution on Human Health

- Much evidence links air pollutants to respiratory & other diseases in humans
- Examples of air pollution-related diseases:
    - Pulmonary irritation & impaired lung function:
        - chronic bronchitis
        - emphysema
    - Cancer
    - Systemic toxicity:
        - Lead
        - Mercury
    - Increased susceptibility to disease

Effects of Air Pollution on other animals & plants:

- Wild & domestic animals probably affected in the same ways as humans
- Plants damaged by ozone, sulfur dioxide, & acids:
    - ozone - weakens pine needles & makes them more susceptible to insects & diseases
    - sulfur dioxide - suppresses growth
    - acid - damages leaves & needles & also removes nutrients

Acid Precipitation

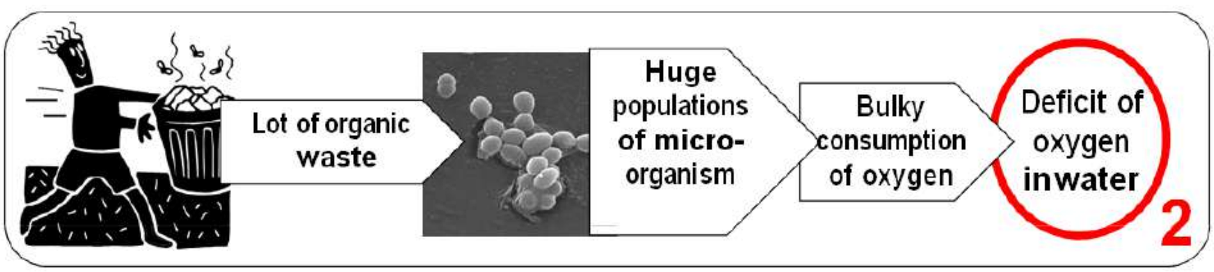
Where do acids come from?

- Nitric oxide & sulfur dioxide released primarily from electric power plants & motor vehicles
- SO_2 + water vapor + ozone ---> H_2SO_4
- NO + sunlight + O_2 ---> NO_2 + various atmospheric gases ---> HNO_3

SOURCES OF AIR POLLUTION

1. Emissions from Power stations
2. Emissions from Industrial Processes
3. Vehicular Emissions
4. Emissions from Burning of Solid Waste
5. Emissions from Natural Sources such as Volcanic Eruptions & Forest Fires

WATER POLLUTANTS refers to the contamination of water bodies. These may include lakes, rivers, oceans, aquifers and groundwater.
include insecticides and herbicides, chemical fertilizers, food processing waste, pollutants from livestock operations, volatile organic compounds (VOCs), heavy metals, chemical waste and others.



soil pollutants soil pollution refers to the deposition of solid or liquid waste materials on land or underground in a manner that can contaminate the soil and groundwater, threaten public health, and cause unsightly conditions and nuisances. are hydrocarbons, pesticides, solvents and heavy metals.

SOURCES OF SOIL POLLUTION

1. Domestic Solid Waste (Garbage, Rubbish, Trash)
2. Construction and Demolition Waste
3. Agricultural Waste
4. Industrial Waste

NOISE POLLUTION

1. Noise is generally defined as unwanted sound.
2. Sound affects man physically, psychologically and socially
3. Noise may be continuous or intermittent and may be of high frequency or a low frequency

LIGHT POLLUTION

Threats to birds

The effect of light in the form of fire or lamps attracting migratory and non-migratory birds at night, especially when foggy or cloudy, has been known since the 19th century and was and still is used as a form of hunting . The reasons for disorientation of birds through artificial night lighting are not well known. Experts suggest that the navigation of birds using the horizon as orientation for the direction is disrupted by lighting and sky glow.

IMPACTS ON PLANTS

Plants use darkness in many different ways. The management of their metabolism, their development and their life programmes are affected. Plants measure and react to night length which means the duration of darkness. For this reason short-day plants require long nights. temporarily during a long night, it reacts and interprets as if it had experienced two short nights, instead of one long night with a disruption. As a consequence its flowering and developmental patterns possibly will be entirely disrupted:

SOURCES OF ENVIRONMENTAL POLLUTION

- Fossil Fuel Sources of Environmental Pollution

In modern industrialized societies, fossil fuels (oil, gas, coal) transcended all imaginable barriers and firmly established themselves in our everyday lives. Not only do we use fossil fuels for our obvious everyday needs (such as filling a car), as well as in the power-generating industry, fuels (specifically oil) are also present in products as all sorts of plastics, solvents, detergents, asphalt, lubricating oils, a wide range of chemicals for industrial use, etc.

Combustion of fossil fuels produces extremely high levels of **air pollution** and is widely recognized as one of the most important environmental pollution. Fossil fuels also contribute to **soil contamination** and **water pollution**. For example, when oil is transported from the point of its production to further destinations by pipelines, an oil leak from the pipeline may occur and pollute soil and subsequently groundwater. Also, when oil is transported by tankers on ocean, an oil spill may occur and pollute ocean water. Power-generating plants and transport are probably the biggest sources of fossil fuel pollution.

Fossil fuel combustion is also a major source of carbon dioxide (CO_2) emissions and perhaps the most important cause of global warming.

- Other (Non-Fossil Fuel) Sources of Environmental Pollution

Among other pollution sources, **agriculture** (livestock farming) is mentioning as the largest generator of ammonia emissions resulting in air pollution. Chemicals such as pesticides and fertilizers are also widely used in agriculture, which may lead water pollution and soil contamination as well.

Trading activities may be another source of environmental pollution. For example, it’s been recently noted that packaging of products sold in supermarkets and shops is too excessive and generates large quantities of solid waste; also

residential sector is another significant source of pollution generating solid municipal waste that may end up in landfills or incinerators leading to soil contamination and air pollution.

THE ROLE OF HUMAN IN BIODIVERSITY

The human have been playing an important role in biological diversity through a variety of technologies that have affected negatively or positively in biodiversity, including hybridization and genetic engineering.

Genetic Engineering is a process of artificially modifying plant or animal cells by cutting and splicing DNA from one cell into another for the purpose of transferring desirable qualities that will make a crop resistant to herbicides, insects, or to enhance food value. When genetic engineers insert a new gene into any organism, there is “position effects”. These effects can lead to unpredictable changes in patterns of gene expressions and genetic functions. The protein product of the inserted gene may carry out unexpected reactions, producing new toxins and allergens, loss of biodiversity in seed and crops, or damaging health effects from manipulated food crops.

A genetically modified organism (GMO) is an organism whose genetic material has been altered using the **genetic engineering** techniques generally known as **recombinant DNA** technology. Genetically Modified (GM) crops today have become a common source for genetic pollution. Genetic erosion in agricultural and livestock biodiversity is the loss of genetic diversity, including the loss of individual genes, and the loss of particular combinations of genes (i.e. of gene complexes). Genetic erosion coupled with genetic pollution may be destroying unique genotypes, creating a hidden crisis which could result in a severe threat to our food security.

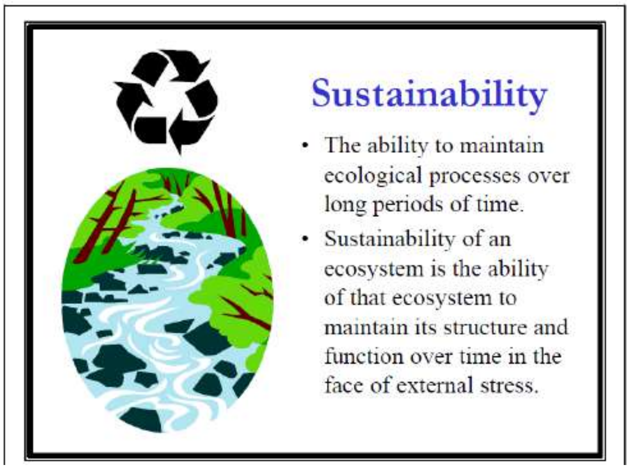
Genetic Use Restriction Technology (GURT)

Known as "**terminator technology** or **suicide seeds**", it is designed for restricting the use of genetically modified plants by producing sterile seeds, thereby avoiding the problem of escape into non-target fields as well preventing farmers from freely harvesting seeds that have been developed by biotech companies at considerable costs. "Terminator seeds" are a weapon of mass destruction and an assault on our food sovereignty. GM technology is a serious and immediate threat to our life security and livelihoods, our food security, health of the environment and the people. We recognize that this is being only to promote the interests of agri-business corporations.

Lecture 9	Evolution and Biodiversity

SUSTAINABILITY

The United Nation defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."In ecology the word describes how biological systems remain diverse and productive over time. For humans, sustainability is the potential for long-term maintenance of well being, which has environmental, economic, and social dimensions.

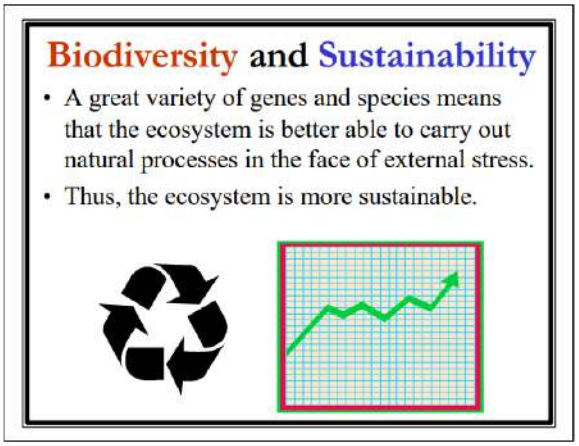


Biodiversity conservation is unlike any other sustainable development issue, because loss of biodiversity is irreversible. Simply put, extinction is final; there is no second chance. Whereas with other issues, such as ozone depletion and climate change, there is the capacity, albeit highly contested among scientists, for the biosphere to recover, there is no recovery from extinction.

Another way of saying this is that we are dependent on nature for food, water, energy, waste disposal, and other life support service. We can not deplete resources or create wastes faster than nature can recycle them if we hope to be here for the long term. Development means improving people's lives. **Sustainable development** then means progress in human well- being that can be extended or prolonged over many generations rather than just a few years. Long-lived and healthy wetlands and forests are examples of sustainable biological systems.

Biodiversity and Sustainability

• The biodiversity of an ecosystem contributes to the sustainability of that ecosystem.
• Higher/ more biodiversity = more sustainable.
• Lower/ less biodiversity = less sustainable.
• High biodiversity in an ecosystem means that there is a great variety of genes and species in that ecosystem, thus means that the ecosystem is better able to carry out natural processes against external stress and the ecosystem is more sustainable.



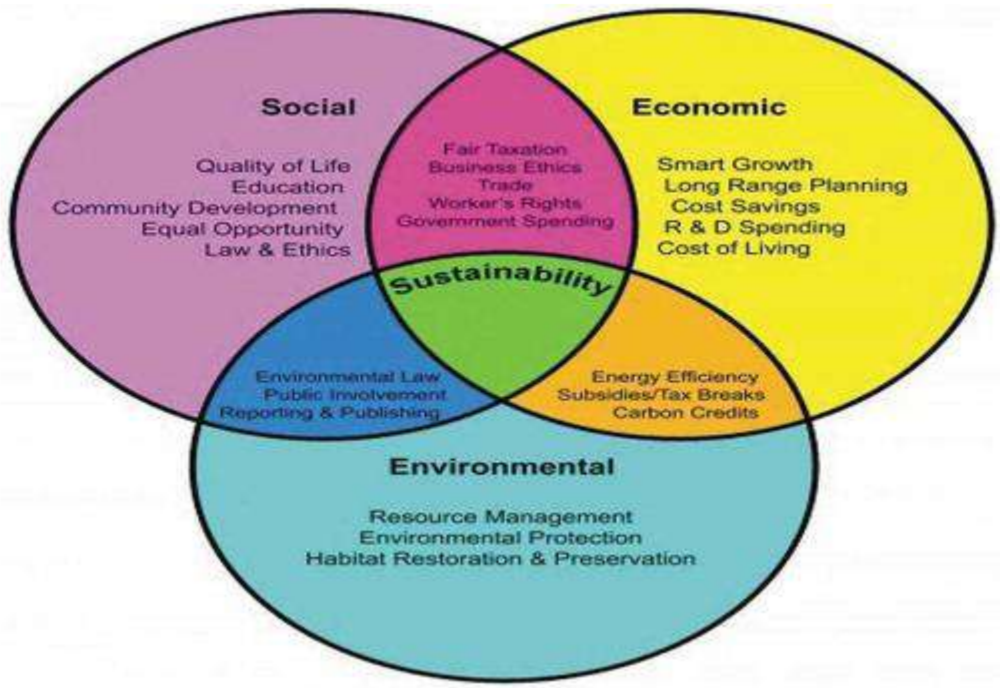
Lecture 9 Evolution and Biodiversity

The more sustainable an ecosystem is, the better it is for the environment and for people which use ecosystems as sources of food, medicine and economy.

It is important to realize, however, that the benefits that biodiversity supplies to humanity are delivered through populations of species residing in living communities within specific physical settings, through complex ecological systems, or ecosystems. In addition to the production of ecosystem goods, such as seafood, wild game, forage, timber, biomass fuels and many pharmaceuticals, to name a few, ecosystems provide all human beings with the following critical functions for life:

- purification of air and water;
- mitigation of droughts and floods;
- generation and preservation of soils and renewal of their fertility;
- detoxification and decomposition of wastes;
- pollination of crops and natural vegetation;
- dispersal of seeds;
- cycling and movement of nutrients;
- control of the vast majority of potential agricultural pests;
- maintenance of functional diversity;
- protection of coastal shores from erosion by waves;
- protection from the sun's harmful ultraviolet rays;
- partial stabilization of climate;
- moderation of weather extremes and their impacts;and
- provision of aesthetic beauty and intellectual stimulation

In order to perceive Sustainability, someone has to take into account three main areas of influence, the so called "Three Pillars of Sustainability" and the corresponding aspects which are the Social, Economic and Environmental aspect. This three aspects are interconnected and if they are combined and applied in real world situations they can create a steady base for a sustainable world from which everybody can benefit. "*Natural resources are preserved, the environment is protected, the economy is not harmed and the quality of life for our people is improved or maintained".*



Environmental Sustainability

In order to achieve environmental sustainability, natural environment should retain its total functionality and utility for a long period of time. It is preferable that actions taken should encourage a balance in our natural environment while simultaneously promote positive growth rates. Any actions that disrupt the balance of the environment should be avoided but if they occur they should be limited to a lesser extent. Environmental impacts of any action or decision should be taken into account. There is a variety of issues related with environmental sustainability from pollution to the management of natural resources. The main purpose of Environmental Sustainability is to minimize the impact of human activities to the environment and furthermore encourage the restoration and preservation of our natural habitat.

Economic Sustainability

Economic sustainability is the ability of an economy to support a defined level of economic production indefinitely. Economic value can be created out of every project or decision. Economic sustainability refers to decisions that are made in the most prudent way possible with respect to the other aspects of sustainability. True sustainability is not promoted when only the economic aspects are considered. On the large scale the usual approach used to be “business as usual” which meant than profit was the only concern and aim of firms. However, when good business practices are incorporated with the social and environmental aspects of sustainability, the result is significantly more positive. Economic sustainability consists of many things. From "smart growth" to subsidies or tax breaks for green development. It is important though to reinforce and promote it with education programs, research and informing the public. Also, much emphasis should be placed on other areas such as reducing unnecessary spending.

Social Sustainability

Social Sustainability relies on decisions and projects that promote the general improvement of society. Generally, the social aspect of sustainability supports the concept of intragenerational justice, which means that future generations are entitled with the same or greater quality of life as current generations. This concept also encloses many other socially related issues such as environmental law, human and labor rights, health equity, community development via public involvement and participation, social capital, support justice and responsibility, cultural competence, community resilience, and human adaptation. The social dimension of sustainability is equally important as the other two pillars.

If it is not taken into serious consideration it can lead to the collapse of the whole process of sustainability as well as the society itself.

Sustainable development is a combination of these three pillars and it cannot be achieved properly if any one of them is not “functioning” properly. If anyone pillar is weak then the system as a whole is unsustainable.

Biodiversity: the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species.

what is mean by the term biodiversity?

- bio = life
- diversity = variety
- biodiversity = variety of life on this planet

ENVIRONMENTAL BALANCE

Environment (from the French *environner* : to encircle or surround) can be defined as (1)The sum of all living and non-living things that surround an organism, or group of organisms, or (2)The sum total of all surroundings of a living organism, including natural forces and other living things, which provide conditions for development and growth as well as of danger and damage. Environmental components consists of:

1- Abiotic factors (light, soil, water, air, weather, temperature…).

2- Biotic factors (plants, animals, fungi, humans…).

In natural conditions, the environment with all the diversity of interactions that exist able to balance the situation. This balance may last for several reasons, namely that existing components are involved in the action-reaction and act according to the conditions of balance, transfer of energy (energy flow), and biogeochemical cycles can take place.

Environmental balance can be disturbed if there is a change in the form of reduction or loss of function of some component parts that can break the chain of cause in ecosystems. Such conditions can be occurred by human interference with any activity that sometime goes beyond limits. The most important factor is the pollution problems in addition to other factors.

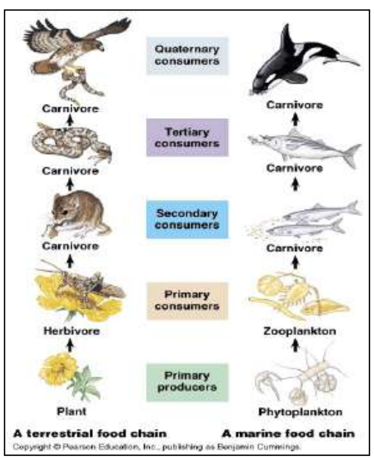
Food chains, food webs, and trophic levels link species

An organism's feeding status in an ecosystem can be expressed as its trophic level. Green plants form the first trophic level, the **producers**. **Herbivores** form the second trophic level, while **carnivores** form the third and even the fourth trophic levels. Ecological communities with higher biodiversity form more complex trophic paths.

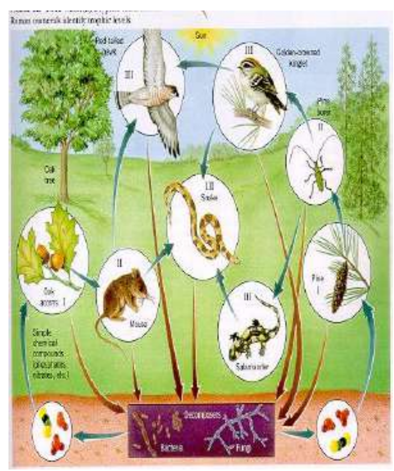
Food chain: is the path by which energy passes from one living thing to another.

Food web: is a graphical description of feeding relationships among species in an ecological community. Food web links at least two food chains together. The more links in a food web, the more stable it is.

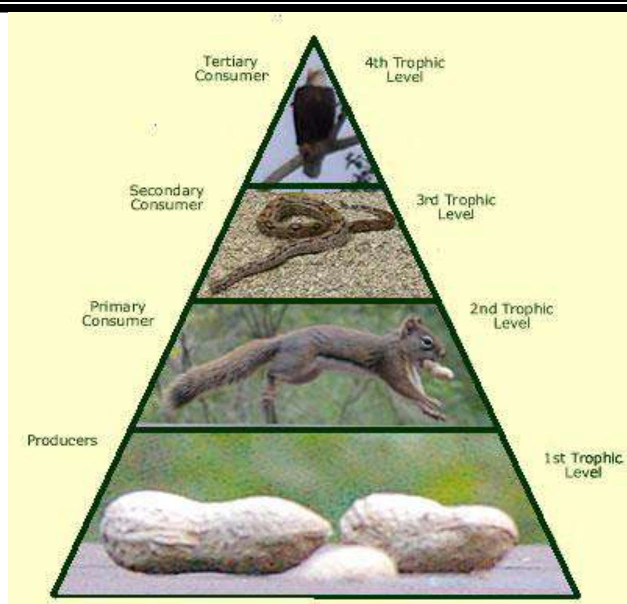
Ecological Pyramids: is a graphical representation designed to show the number of organisms, energy relationships, and biomass of an ecosystem.



Food chains



Typical terrestrial food web



Ecological pyramid

The three basic ways that organisms get food are as **producers, consumers** and **decomposers**.

Producers (autotrophs) are typically green plants or algae. Plants and algae do not usually eat other organisms, but pull nutrients from the soil and manufacture their own food using photosynthesis. For this reason, they are called primary producers .In this way, energy from the sun that usually powers the base of the food chain. An exception occurs in deep-sea hydrothermal ecosystems, where there is no sunlight. Here primary producers manufacture food through a process called chemosynthesis.

Consumers (heterotrophs) are animals which cannot manufacture their own food and need to consume other organisms. Animal that eat **producers** (plants) are called herbivores, while animals eat other animals are called **carnivores**, and animals that eat both plants and other animals are called **omnivores**.

Decomposers (detritivores) break down wastes, dead plant and animal materials and release it again as energy and nutrients in to the ecosystem for recycling. Decomposers, such as bacteria and fungi (mushrooms), feed on waste and dead matter, converting it in to inorganic chemicals that can be recycled as mineral nutrients for plants to use again.

Biological interactions

Are the interactions between organisms in a community. In the natural world no organism exists in absolute isolation, and thus every organism must interact with the environment and other organisms. An organism's interactions with its environment are fundamental to the survival of that organism and the functioning of the ecosystem as a whole.

Relationships between species

Type	Effect on X	Effect on Y
Amensalism	harm	no effect
Commensalism	no effect	benefit
Competition	harm	harm
Mutualism	benefit	benefit
Neutralism	no effect	no effect
Parasitism	harm	benefit

Positive relationships

Symbiosis is the living together of two unrelated species. The term symbiosis can be used to describe various degrees of close relationships between organisms of different species. Sometimes it is used only for cases where both or one organisms benefit without any harmful effect to each other.

Commensalism (+ 0)

Commensalism is a type of symbiosis in which one organism benefits and the other organism is neither benefited nor harmed. It occurs when one organism takes benefits by interacting with another organism by which the host organism is not affected. A good example is a remora living with a shark. The remora benefit from the shark are transport, protection and also feeds on materials dropped by the shark, while the shark is not affected in the process as remoras eat only leftover food and doesn't deplete the shark's resources.

Neutralism (0 0)

Neutralism describes the relationship between two species which interact but do not affect each other. It describes interactions where the fitness of one species has absolutely no effect whatsoever on that of the other. True neutralism is extremely unlikely or even impossible to prove. When dealing with the complex networks of interactions presented by ecosystems, one cannot assert positively that there is absolutely no competition between or benefit to either species. Since true neutralism is rare or non existent, its usage is often extended to situations where interactions are merely insignificant or negligible.

Mutualism (+ +)

Mutualism is a form of symbiotic relationship between different species where both species benefit from the relationship. There are two types of mutualism: obligate mutualism and facultative mutualism. In obligate mutualism the interacting species are interdependent and cannot survive without each other. The fungus and a photosynthetic partner, either alga or a cyanobacterium that combine to form lichen are obligate mutualism. In the more common facultative mutualism the interacting species derive benefit without being fully dependent. Many plants produce fruits that are eaten by birds, and the birds later excrete the seeds of these fruits far from the parent plant. While both species benefit, the birds have other food available to them, and the plants can disperse their seeds when the uneaten fruit drops.

Negative relationships

Predation (+ -)

Predation is an interaction between species in which one species uses another species as food. It is a process of major importance in influencing the distribution, abundance, and diversity of species in ecological communities. Generally, successful predation leads to an increase in the population size of the predator and a decrease in population size of the prey. These effects on the prey population may then ripple out through the ecological community, indirectly changing the abundances of other species. One example of such indirect effects of predation involves the trophic cascade. As the name implies, a trophic cascade occurs when the effects of predation "cascade" down the food chain to affect plants or other species that are not directly eaten by the predator. Typically, a trophic cascade involves a predator feeding on herbivores and reducing their abundance, which then releases plants from grazing pressure and increases the biomass of vegetation. In addition to such ecological effects of predation, which occur on time scales of one or a few generations of the organisms involved, predation has also played, and continues to play, a major role over evolutionary time in molding the phenotypes of many species. Cannibalism is simply predation on another individual of the same species.

Predation and population dynamics

In many cases predation has a strong influence on the population sizes of predator and prey. In general, increasing the population size of prey will result in a corresponding increase in the population size of the predator because the predator has more food. Similarly, prey populations are expected to decline as the population size of a predator increases because of increased predation pressure. Because the population response of one species to a change in the other requires time for the population to grow, predator-prey interactions sometimes result in population cycles, the simplest explanation of these cycles is that the predator's drives the changes in the prey population (by catching and killing its members) and the prey (as the predator's food supply) drives the predators population changes, but a lag between the population responses of predator and prey cause the two cycles to be out of phase with one another.

Parasitism (+ -)

Parasitism is a relationship in which one organism - the host - is the source of food and / or shelter for another organism, the parasite. In this relationship, all of the benefits go to the parasite; the host is harmed by the relationship. An example is a human and a tapeworm living in the intestines. World-wide, the most serious cause of human death by a parasite is malaria. Traditionally parasite referred to organisms with life stages that needed more than one host (e.g. *Taenia solium*). These are now called **macroparasites** (typically protozoa and helminths). The word parasite now also refers to **microparasites,** which are typically smaller, such as viruses and bacteria, and can be directly transmitted between hosts of the same species. Unlike predators, parasites are generally much smaller than their host; both are special cases of consumer-resource interactions. Parasites show a high degree of specialization, and reproduce at a faster rate than their hosts.

Amensalism

Amensalism is a relationship in which a product of one organism has a negative effect on another organism. It is specifically a population interaction in which one organism is harmed, while the other is unaffected, and not benefited. There are two basic modes:

1. Antibiosis (0 -) Usually this occurs when one organism exudes a chemical compound as part of its normal metabolism that is detrimental to another organism.

The bread mold *Penicillium* is a common example of this; *Penicillium* secretes penicillin, a chemical that kills bacteria. A second example is the black walnut tree (*Juglans nigra*), which secrete juglone, a chemical that harms or kills some species of neighboring plants, from its roots. This interaction may still increase the fitness of the non-harmed organism though, by removing competition and allowing it access to greater scarce resources.In this sense the impeding organism can be said to be negatively affected by the other's very existence, making it a +/- interaction. Antibiosis or allelopathy also explains similar interactions.

2.Competition (- -)

Competition is another kind of antagonistic relationship within a community, in which the fitness of one is lowered by the presence of another. Limited supply of at least one resource (such as food, water, and territory) used by both usually facilitates this type of interaction. Competition is one of many interacting biotic and a biotic factor that affect community structure.

Competition among members of the same species is called **intraspecific** competition, while competition between individuals of different species is known as **interspecific** competition. Competition is not always a straightforward, direct interaction either.

According to the competitive exclusion principle, species less suited to compete for resources should either adapt or die out and according to evolutionary theory, this competition within and between species for resources plays a critical role in natural selection.