Heredity And Evolution

Heredity

Sexual reproduction

- The mode of reproduction that involves two individuals; one male and one female.
- They produce sex cells or gametes which fuse to form a new organism.

Genes

- Gene is the functional unit of heredity.
- Every gene controls one or several particular characteristic features in living organisms.

Heredity

The process by which the features of an organism is passed on from one generation to another is called heredity.

- The process is done by genes, which define the characters the organism.

Mendel's work

- Gregor Johann Mendel, known as 'Father of Genetics', was an Austrian Monk who worked on Pea plants to understand the concept of heredity.
- His work laid the foundation of modern genetics.
- He made three basic laws of inheritance - The Law of Dominance, The Law of Segregation and The Law of Independent Assortment.

Dominant traits

The traits that express themselves in an organism in every possible combination and can be seen are called Dominant traits.

- In Mendel's experiment, we see that tall trait in pea plants tends to express more than the short trait.
- Therefore, the tall trait of the plant is said to be dominant over the short trait.

Recessive traits

A trait which is not expressed in presence of a dominant allele is known as recessive.

So, recessive character/trait is present in an organism but cannot be seen if a dominant allele exists.

Monohybrid cross

- When only one character is considered while crossing two organisms, then such a cross is known as monohybrid cross.
- The ratio of characters, arising out of this cross, at F2 generation is called monohybrid ratio.
- E.g., If tall plant (TT) is crossed with a dwarf plant (tt), we get 3 tall:1 short plant at the end of the F2 generation.
- So, 3:1 is monohybrid ratio.
- Here, the height of the plant is considered at a time.

Dihybrid cross

- When two characters are considered while crossing two organisms, then such a cross is known as a dihybrid cross.
- The ratio of characters, arising out of this cross, at F2 generation is called dihybrid ratio.
- E.g., If a plant with round and green pea is crossed with a plant with wrinkled and yellow pea,
- The first generation plants would all have round and green pea.
- On crossing the same for an F2 generation, we would observe four combinations of characters in the ratio of 9:3:3:1.
- Thus, 9:3:3:1 is the dihybrid ratio.

Inheritance

In Biology, inheritance pertains to the transfer of traits from one generation to another.

Laws of Mendel

Law of Dominance says that a gene has two contrasting alleles and one always expresses itself in the organism.

It is called the dominant gene and it expresses in any possible combination.

Law of Segregation says that traits get segregated completely during the formation of gametes without any mixing of alleles.

Law of Independent Assortment says that the traits can segregate independently of different characters during gamete formation.

Sex determination

- The process of determining the sex of an individual based on the composition of the genetic material is called sex determination.
- In different animals, sex of an embryo is determined by different factors.
- In humans, sex determination happens on the basis of the presence or absence of Y chromosome.
- XX is female and XY is male
- An ovum always contains X chromosome.
- An Ovum, upon fusion with Y containing sperm, gives rise to a male child and upon fusion with X containing sperm gives rise to girl child.

Traits

> Traits are characteristic features of an organism, manifested in a physical form that is visible or in a physiological aspect of the organism.

Acquired characters

- The traits that are acquired by an organism over the period of its lifetime are termed as acquired characters.
- These characters may or may not get transferred to the next generation.

Inherited characters

- The traits that are inherited from the parents are called inherited characters.
- These traits always get transferred to the next generation, but depending on the dominance or recessiveness it may or may not be expressed.
- Examples are height, skin colour, and eye colour.

Variation

Genetic variations

> The differences in the DNA sequences among every organism leading to the diverse gene pool are called genetic variations.

These differences lead to different/varied physical characters or biochemical pathways.

Natural selection

It is the phenomenon by which a favourable trait in a population of a species is selected.

- Changing natural conditions exert equal pressure on all the existing species.
- The species/organisms which are better adapted to the changing conditions survive and reproduce i.e. selected by nature and species/organisms which cannot adapt perish i.e. rejected by nature.

Speciation

Genetic drift

Natural selection can play an important role in deciding the traits that survive in a population. However, random fluctuations in gene variants are seen on many occasions. This phenomenon is known as genetic drift.

> Thus, genetic drift is a change in the frequency of an existing allele in a small population.

Genetic drift may cause a gene variant to disappear from the population and thus reduce genetic variation.

Speciation

> It is the process of formation of a new species from existing ones due to several evolutionary forces like genetic drift, isolation of populations, natural selection etc.

Speciation leads to diversity in the ecosystem and the diversity and diversity lead to evolution.

Gene flow

Gene flow is the transfer of genes from one population to the next.

Population

A population is a community or a group of animals, plants or any living organism that can reproduce with each other and have fertile, viable offsprings.

Charles Darwin

- Charles Darwin also called **"Father of Evolution"** was an English Naturalist and Biologist.
- Five years expedition in a ship called HMS Beagle to Galapagos Island helped him write his theory of evolution.
- In 1859 he published a book called Origin of Species, in which he put his theory of evolution in detail.

Evolution and Fossils

Evolution

> Evolution is a tangible change in the heritable characteristics of a population over several generations.

These changes can give rise to a new species or the species might change themselves to become better adapted to the surrounding environment.

Origin of species

- After a successful expedition on HMS Beagle, Charles Darwin wrote a book on what he observed at the Galapagos Islands.
- In the booked named 'The Origin of Species', he wrote a detailed theory of evolution which was mostly based on Natural Selection.

Origin of life - Haldane's theory

- JBS Haldane was a British Scientist who theorized that life originated from organic and lifeless matter.
- His theory was proved to be correct by Urey and Miller's experiment.
- It was called the theory of abiogenesis.

Evolutionary evidence- fossils

- There are plenty of pieces of evidence to support the theory of evolution.
- Fossils happen to be the biggest of them.
- Fossils are the preserved remains of ancient animals or plants that died millions of years ago.
- The fossils help us understand the anatomy and even physiology of these organisms and understand how evolution worked and led to the formation of organisms that we see today.

Formation of Fossils

Fossils are important pieces of evolutionary evidence and are formed by following steps:

- Organisms die and they get buried in mud and silt.
- The soft tissues of the body get quickly leaving behind the hard bones or shells
- Over time sediments build over it and harden into rock
- As the bones decay, mineral seep in to replace the contents cell by cell, process called as petrification
- If bones decay completely, it leaves behind the cast of the animal.

Evolutionary relationships

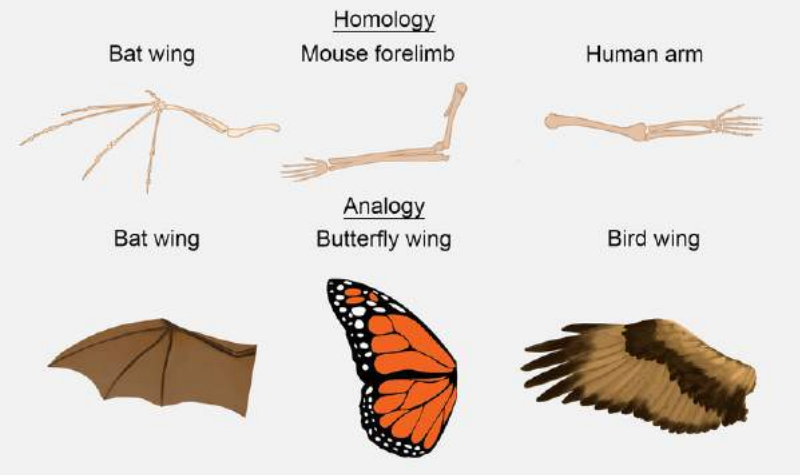
Evolutionary relationships of animals can be deduced by studying the homologous organs and analogous organs.

Homologous organs are those which have a similar structure but different function.

- Wings of birds and forelimbs of mammals: they have similar structure but are modified to suit different functions
- A tendril of pea plant and spine of barberry plant: both are modified leaves, but perform different functions.

Analogous organs are those which have a similar function but a different structure and origin too.

- Wings of bats, birds and wings of insects: both are used for flying, but structurally are very different
- Leaves of opuntia and peepal: both perform photosynthesis, but leaves of Opuntia are modified stem whereas peepal leaves are normal leaves.



Homologous and Analogous organs

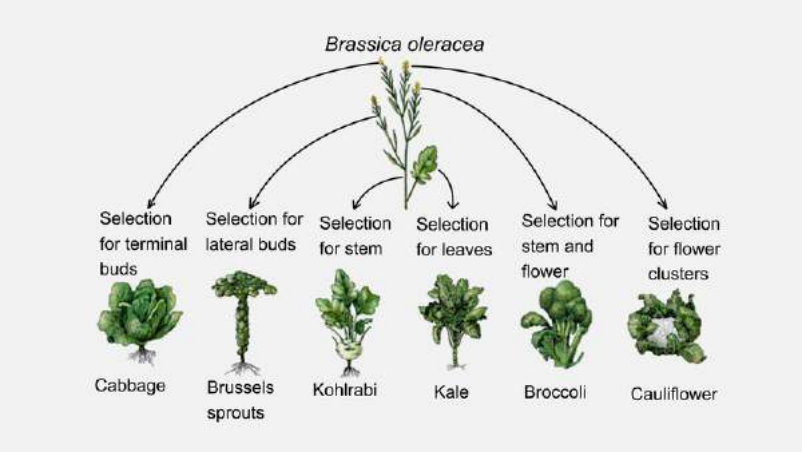
Evolution by stage

Evolution is a slow process and does not happen overnight.

- There are several stages in the evolution of almost every animal that we see today.
- Complexities do not evolve suddenly, but evolve bit by bit and may have limited use at certain stages.
- This gradual evolutionary process is called evolution by stages.

Artificial selection

- Sometimes a single species can evolve into several different species due to artificial selection.
- E.g. the cabbage family. A single ancestor in the cabbage family gave rise to several different species due to the selection of different traits.



Artificial selection in the cabbage family

Molecular phylogeny

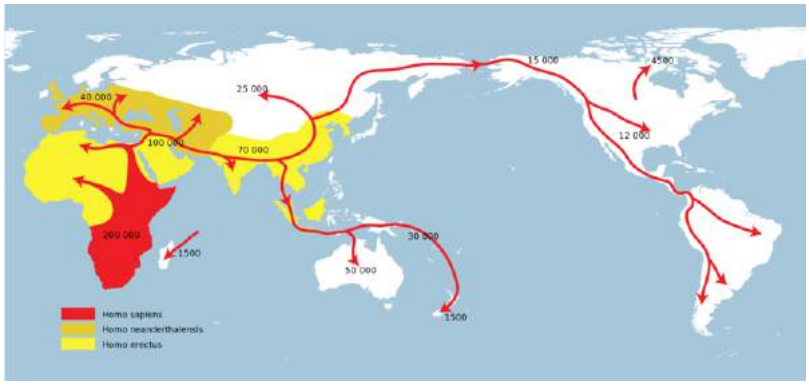
- The evolutionary relationship among different biological species is called phylogeny.
- It gives rise to an evolutionary tree.
- In molecular phylogeny these relationships are studied at the hereditary molecular level, mainly using DNA sequences.
- It involves the analysis of DNA composition and gene comparison between different species.

Human Evolution

Human evolution

- Humans are known to belong to the primate family.
- Humans today have a very close genetic connection to chimps and other primates.

- While the complete evolutionary process of Humans from Primates is still a mystery, a larger picture of human evolution has been formed.
- Some of the ancestors of Humans include Dryopithecus, Ramapithecus, Australopithecus, Homo erectus, Homo sapiens neanderthalensis, Cro-magnon man, and finally us, the Homo sapiens.
- **Human evolution traces back to Africa**. Then they migrated all over the world.



Migration of Early Humans