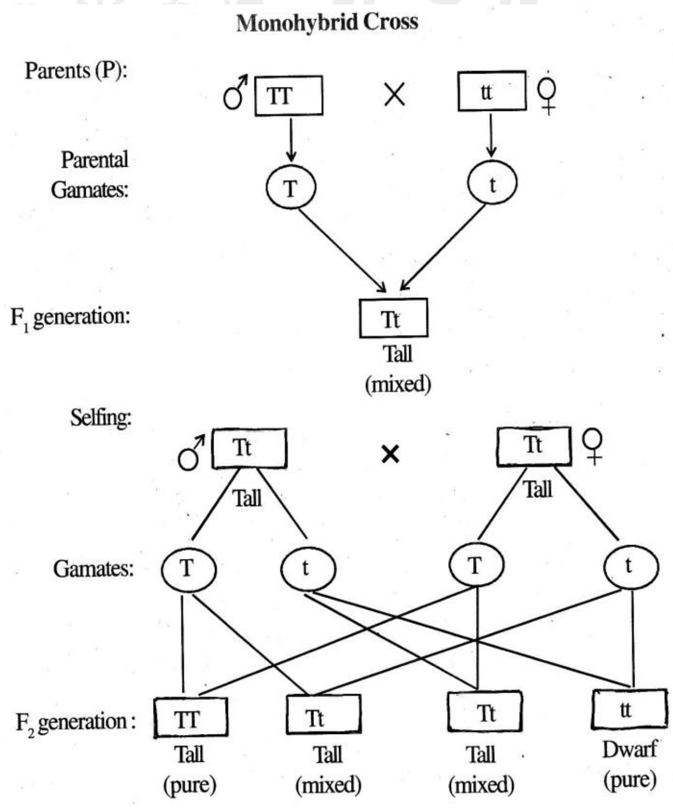
CLASS X
BIOLOGY
CHAPTER 16
HEREDITY AND EVOLUTION

SOLUTIONS

- **Heredity** is the passing/transmission of genetic traits/characters from parents to their offspring either through sexual or asexual reproduction from one generation to the next generation.
- **Variation** is the differences among individuals of a species in a population.
- **Evolution** is the change in characteristics of a species over several generations and relies on the process of Natural Selection.
- Unlike asexual reproduction, variations, arising during sexual reproduction as well as through **mutation,** can be inherited and showed small differences between members of the same species.
- Variations may lead to increase survival of the individuals and selection of variants by environmental factors forms the basis of evolutionary processes.
- **Variations** arising from mutation can be inherited.
- **Genetics** is the branch of science which deals with heredity and variation.

MENDEL'S CONTRIBUTION



- **Mendel, the father of Genetics,** selected **garden pea** (*Pisum sativum*) for his experiments because a **number of contrasting visible characters** such as round and wrinkled seeds, tall and dwarf plants and so on are found. Moreover, in pea plants the petals entirely enclosed the reproductive structures where self-pollination is a rule. It can also be cross-pollinated experimentally.
- He performed cross pollination in which anthers are removed from female parent before they are ripened and dusted over the pistil of another flower.

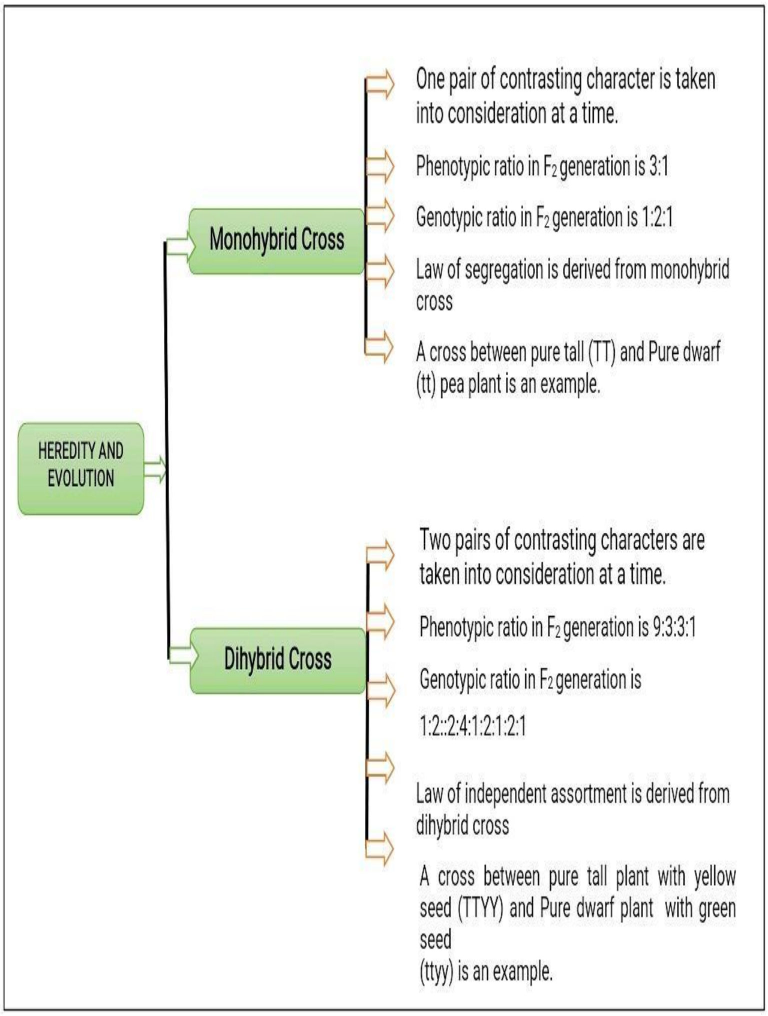
- The progeny of the cross is called F_1 generation and the parental traits which are transmitted unchanged in the F_1 generation is called **dominant trait** whereas traits that remain hidden in F_1 but reappear in F_2 generation is called **recessive trait**.

MENDEL'S LAWS OF INHERITANCE

- **Carl Correns** formulated laws of inheritance: ***Law of segregation*** *and* ***Law of independent assortment.***
- Mendel performed **monohybrid** and **dihybrid cross**.

FIRST LAW /LAW OF SEGREGATION: *Allelic genes in a hybrid do not blend or contaminate each other but segregate and pass into different gametes. It is derived from Monohybrid cross.*

SECOND LAW/LAW OF INDEPENDENT ASSORTMENT: *The segregation in one pair of allele is independent of the segregation in any other pair of allele*



- Test cross is used to find out an unknown genotype of an organism.

THE ORIGIN OF LIFE

- **A.I.Oparin and J.B.S.Haldane** first proposed the theory of Chemical origin of Life.
- The sea would have been the home of first life on earth. Miller and Urey assembled a mixture of gases, such as ammonia (NH_3), Methane (CH_4) and hydrogen sulphide (H_2S) all believed to be present in primitive atmosphere in a closed flask at a temperature just below 100°C.

- Electric sparks were passed through the mixture and simulate lightening. They found the formation of mixtures of amino acid at the end of the week which was converted to self-replicating DNA and nucleic acid. Thus, life is originated through chemical evolution from in-organic molecule.

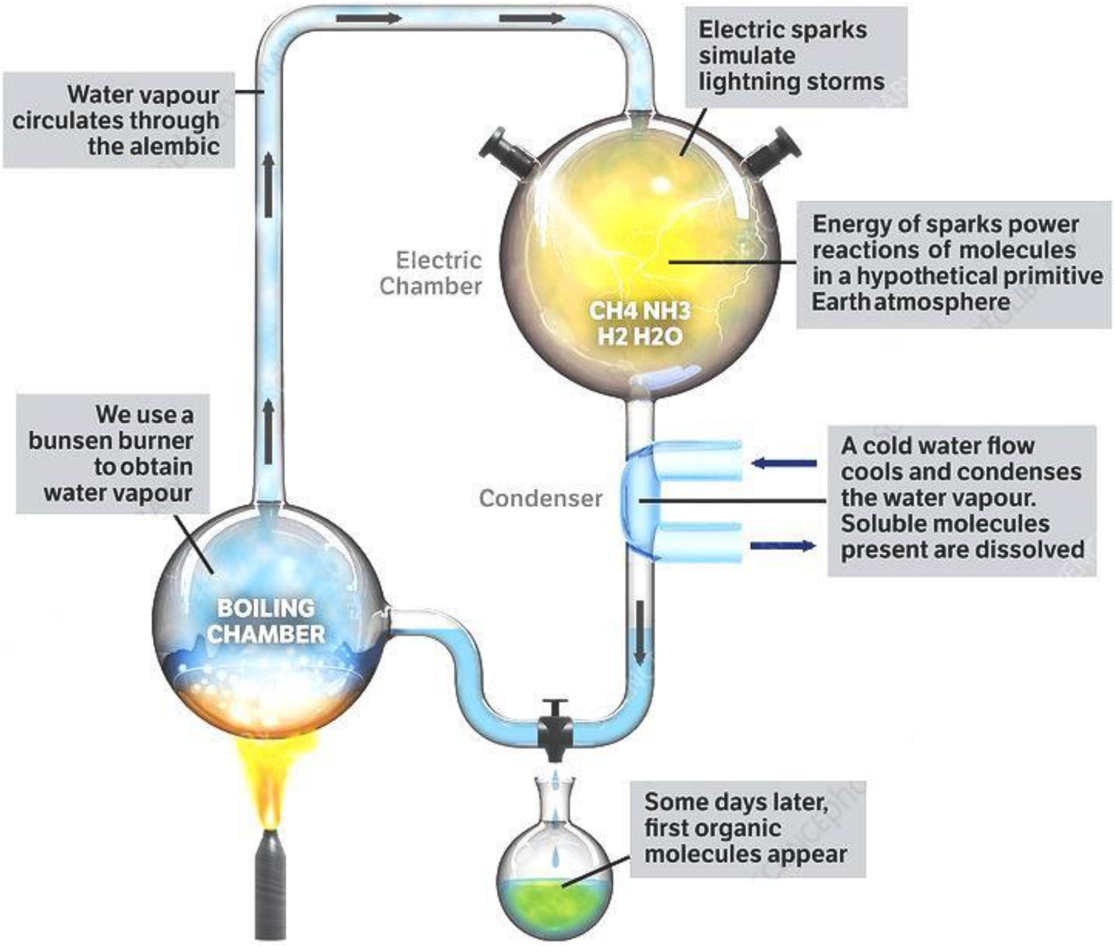


Fig: Illustration of Miller-Urey's Experiment

- In primitive condition, amino acids are converted to DNA which is capable of self-replication. Thus life is originated from inorganic molecules through the formation of complex organic molecules and once living organism is formed, more living organisms would arise.

EVOLUTION: It involves chemical evolution and organic evolution. Chemical evolution deals with origin of life while organic evolution is the evolution in living organism through intermediate forms.

1. **Lamarckian theory of inheritance of acquired characters - J.B. Lamarck (1809)**
2. **Theory of natural selection - Charles Darwin and Alfred Russel Wallace (1858)**
3. **Mutation theory - Hugo de Vries (1901)**

- **August Weismann (1834-1914)** disapproved Lamarck's theory of acquired characters. He formulated the Germplasm Theory of Inheritance. If the tails of a group of mice are surgically removed, the offspring of those tailless mice will have tails because changes in the non-reproductive tissues cannot be passed on to the DNA of the germ cells. So, the removal of the tails cannot change the genes of the germ cells of the mice.

THEORY OF NAURAL SELECTION: The theory of organic evolution by natural selection proposed by Charles Darwin is one of the most accepted theories of organic evolution and can be explained in the following lines:

Over production of offspring and a consequent struggle for existence: There is a struggle for existence due to limited resources and the survivors are better adapted to the limited resources of the environment.

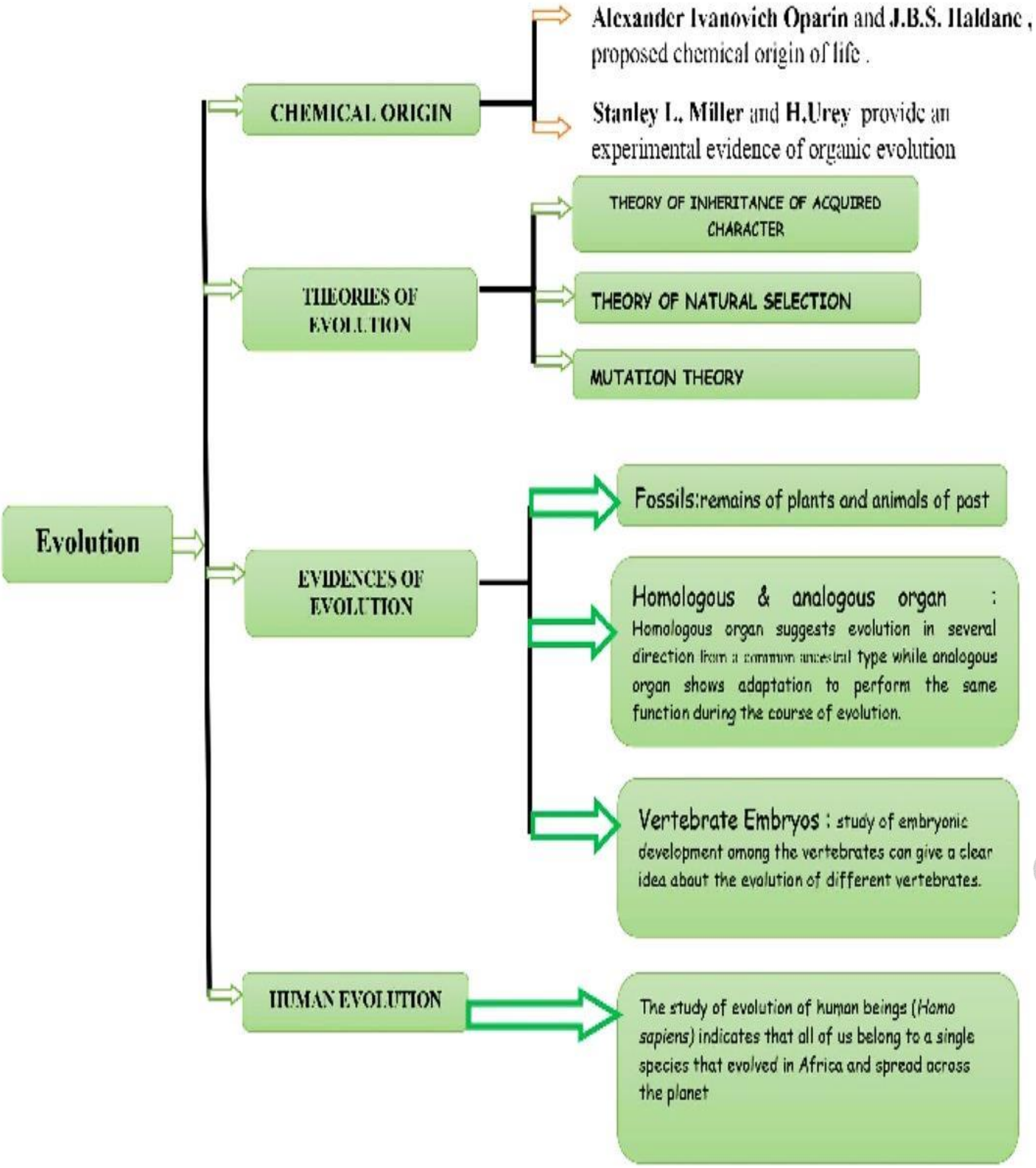
Variations and their inheritance: Only the variations in the right direction survive and these variations are transmitted to the offspring.

Natural selection: The survival of fittest and proliferation of only those organisms which are most suitably adapted to the environment and most successful in mating is known as natural selection.

Formation of new species (speciation): The evolution of a new species from the pre-existing one is known as speciation. It takes place when variation is combined with geographical isolation.

EVIDENCES OF EVOLUTION

FOSSILS: They provide evidences in favour of organic evolution as follows:



- The study of fossils helps us to understand life forms of the past.
- It enables us to trace the origin and trend of evolution of several groups of plants and animals.

HOMOLOGOUS AND ANALOGOUS ORGANS:

- **Homologous organs** have similar basic embryonic origin though they may or may not perform the same function whereas **analogous organs** have different embryonic origin, appear similar and perform same function.

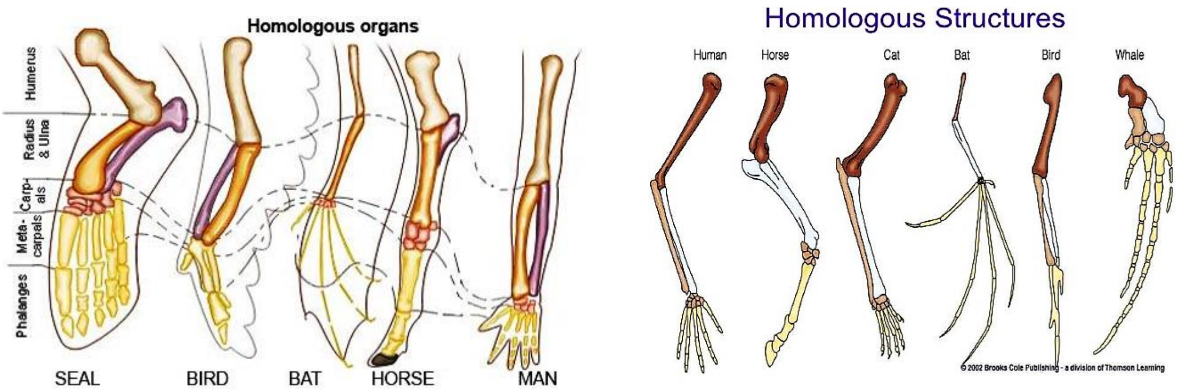


Fig. Homologous organs (same embryonic origin but same or different functions)

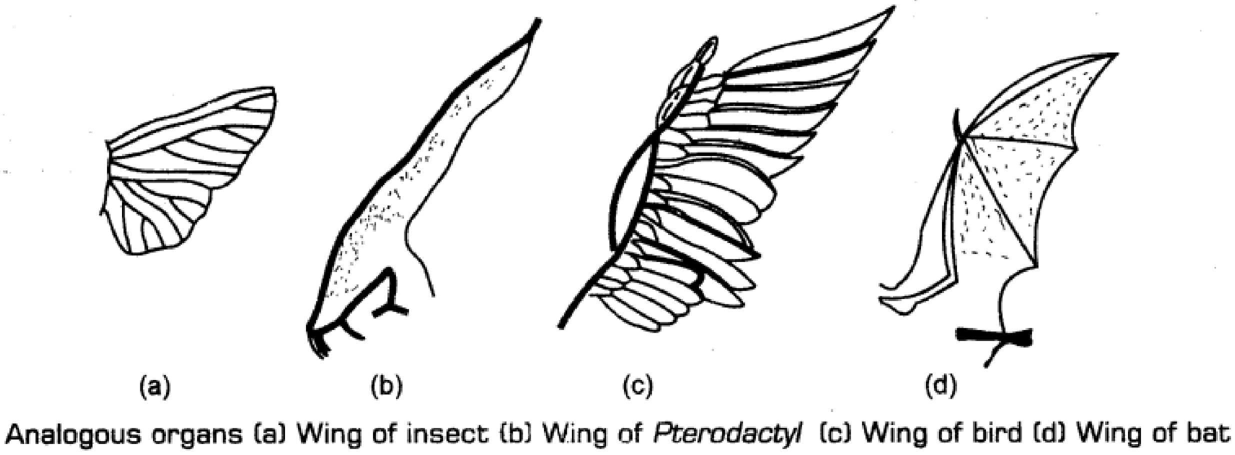


Fig. Analogous organs (different embryonic origin but same function)

- Homologous organ suggests evolution in several directions from a common ancestral type while analogous organ shows adaptation to perform the same function during the course of evolution.

RESEMBLANCE AMONG VERTEBRATE EMBRYOS:

- There is a close relationship among the early embryonic stages of vertebrates that can give us a clear idea about the evolution of different vertebrates.

HUMAN EVOLUTION

- The study of evolution of human beings (*Homo sapiens)* indicates that all of us belong to a single species that evolved in **Africa (~3,00,000 years ago)** and spread across the planet.
- They slowly migrate from Africa to West Asia, then to Central Asia, Eurasia, South Asia, East Asia.
- They travelled down to Indonesia and the Philippines to Australia. They didn't go in a single line but went forwards and backwards.
- In **India, the earliest fossil remains of *Homo sapiens*** was discovered in **Bhimbetka near Bhopal.**

SOME IMPORTANT GENETICAL TERMS

- **Heredity:** The transmission of traits/characters from the parents to their offspring.
- **Genetics:** The study of heredity and variation.
- **Gene:** A segment of DNA molecule that provides information for one trait/character.
- **Traits/Characters** of an organism are controlled by genes.
- **Allele/Allelomorph:** Alternate form of the same factor/gene.
- **Phenotype:** Characters that can be seen through eye. e.g. Tall and dwarf plants
- **Genotype:** Genetic constitution of an individual. e.g. TT - tallness, tt - dwarfness.
- **Homozygote:** True breeds or organism with homozygous allele at one or more loci; TT for tall
- **Heterozygote:** Hybrid; Tt for tallness
- **Dominant:** The character which appears in F_1 generation is called dominant character.
- **Recessive:** The parental character which remains hidden in the F_1 generation but reappears in F_2 generation is called recessive character.
- **Back Cross:** It is a cross between F_1 offspring and one of its parents.
- **Test Cross:** A cross between an F_1 offspring and its recessive parent.

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