CHAPTER- 07

EVOLUTION

Evolutionary biology is the study of history of life forms on earth. The evolution of life on earth, different changes in flora and fauna around earth that co-exist along with human beings also forms parts of evolution.

Origin of Life

The origin of life is considered unique events in the history of universe. Huge cluster of galaxies comprises the universe. Galaxies contain stars and clouds of dust and smoke.

Big Bang Theory attempts to explain the origin of universe. According to this theory, a huge explosion occurs that forms the different galaxies.

In solar system of Milky Way galaxies, earth has been supposed to be formed about 4.5 billion years ago. There was no atmosphere in early earth. Water vapour, methane, carbon dioxide and ammonia released from molten mass covered the earth surface.

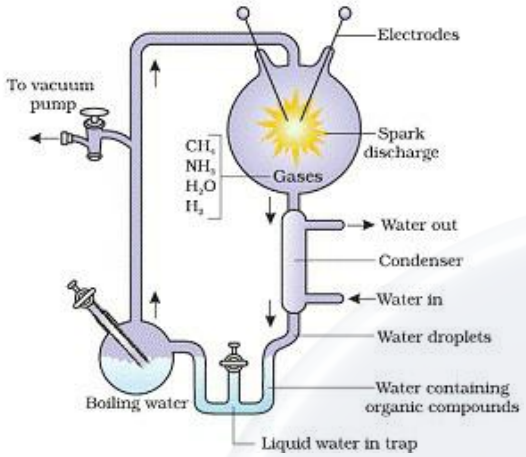
UV rays from sun splits the water into hydrogen and oxygen. Life appeared 500 million years after the formation of earth.

There are different theories regarding the origin of life on earth-

- Some scientist believes that life comes from other planets. Early Greek thinker thoughts that unit of life is called spores transferred from other planets.
- According to other theory, life comes out of dead and decaying matters like straw and mud. This theory is called theory of spontaneous origin.
- Louis Pasture experimentally proved that life arises only from pre-existing life. Spontaneous theory of origin of life is dismissed after that.
- Oparin and Haldane proposed that the first form of life could have come from pre-existing non-living organic molecules like RNA and protein etc. The formation of life preceded by chemical evolution. At that time condition on earth were- high

temperature, volcanic eruption, reducing atmosphere containing CH4and NH3.

Miller experiment of Origin of Life- S.L. Miller in 1953, conducted an experiment to show the origin of life on earth in the physical environment similar to condition prevails at that time.



Miller created similar condition of temperature and pressure in laboratory scale. He created electric discharge in a flask containing CH4, H2 and NH3 and water vapour at 8000C.

He observed formation of amino acids in flask after 15 days of electric discharge. Similar experiment by other scientist found formation of sugars, nitrogen bases, pigments and fats.

Analysis of meteorite content also reveals similar compounds that reveal that similar process are occurring elsewhere in the space. This experimental evidence about the origin of life is called chemical evolution of life.

Experimental representation of Miller's experiment

The first non-cellular forms of life could have originated 3 billion years back. They could have been giant molecules like RNA, Protein, and Polysaccharide etc.

The cellular form of life was probably single cell and originates in water medium. The theory that first form of life arose slowly through evolutionary forces from non-living molecules is called biogenesis.

Evidence of Evolution: Evidence that evolution of life forms has taken place on earth have many proofs as mentioned below-

1. Paleontological evidence- different aged rock sediments contain fossils of different life

forms that probably died during the formation of particular sediment. Fossils are remains of hard parts of life-forms found in rocks .The study showed that different form varied over time and certain life forms are restricted geological time span. Hence, new forms of life have arisen at different times in history of earth.

2. Homologous organs- those organs that perform different function but have similar origin and structure are called homologous organs. For example human, cheetah, bat and whales share similarities in pattern of bones of forelimbs although these forelimbs perform different functions in these animals. In these animal similar structure developed along different directions due to adaptation of different needs. This is called divergent evolution.

Homologous structures	**Analogous structures**
Similar in anatomy	Dissimilar in anatomy
Doing dissimilar functions	Doing similar functions
Develop in related animals	Develop in unrelated animals
Inherited from a common ancestor	Not inherited from common ancestor
Similar developmental pattern	Developmental pattern is not similar
Similar structure and Origin	Dissimilar in structure and origin

3. Analogous structures-they are not anatomically similar organs but perform similar function. For example eyes of mammals and octopus or flippers of penguin and dolphins. This is due to similar habitat that resulted in similar adaptive features in different groups of organisms. This that of evolution is called convergent evolution.

4. Biochemical evidences - similarities in proteins and genes performing a given function among diverse organisms give hints to common ancestry. These biochemical similarities

point to the same shared ancestry as structural similarities among diverse organisms.

DIVERGENT EVOLUTION	CONVERGENT EVOLUTION
1. Development of different functional structures from a common ancestral form is called divergent evolution.	Development of similar adaptive functional structures in unrelated groups of organisms is called convergent evolution.
2. Homologous organs show divergent evolution.	Analogous organs show convergent evolution.
Examples.: Darwin's Finches, Australian Marsupials, locomotion in mammals.	examples. Australian Marsupials and Placental mammals, various equatic vertebrate and wings of insect bird and bat.

Evolution by natural selection- Industrial melanism
A case of natural selection was seen in England in 1850s, i.e., before industrialisation in a peppered moth (Biston betularia). This moth had two forms: grey colour and black colour (Carbonaria). In the early part of the nineteenth century , before industrialization only the grey coloured forms of moths were present; the dark forms were rare. The grey coloured moths were seen on the tree trunks covered with lichens and so they were able to escape from their enemies. Later on in 1920, due to the development of industries, post industralization, the lichens were killed and the tree trunks looked dark due to the deposition of industrial soot. Birds, now were able to spot these moths and feed upon them. So the grey coloured moths were eaten by the birds and the dark coloured moths escaped from the birds. Then now the coal is replaced by the industries and oil and electricity is used. This has reduced the soot production and ultimately less deposition of soot on the tree trunks. These tree trunks have, now, again become grey in colour. Consequently, grey coloured moths have again increased in number. This example clearly brings out the action of natural selection.

Evolution by anthropogenic action - Resistance of mosquitoes to pesticides.

When DDT was introduced to control mosquitoes it was tremendously successful. Most of the mosquitoes were sensitive to DDT and were therefore killed. In that population of mosquitoes, few mosquitoes became resistant to DDT and survived. They multiplied and now almost total population of mosquitoes became resistant to DDT.

Same pattern has been observed in bacteria which are multidrug resistant due to excess use of drugs and medicines.

Adaptive Radiation- the process of evolution of different species in given geographical area starting from a point and radiating to other areas of geography (habitat) is called adaptive radiation. Darwin's finches represent one of the best examples of adaptive radiation. Australian marsupials, each with different from other evolved from one ancestral stock, but all within Australian island continents.

When more than one adaptive radiation appeared to have occurred in an isolated geographical area (representing different habitats), we can call this convergent evolution e.g Placental mammals and Australian marsupials.

Biological Evolution – the nature select for fittest and fitness is based on characteristics which are inherited. Some organisms are better adopted to survive in otherwise hostile environment. Fitness is the end result of the ability to adopt and get selected by nature.

Lamarck had said that evolution of life form had occurred but driven by use and disuse of organs. He gave the example of giraffe to evolve their neck by foraging leaves on tall trees and had to adapt by elongation of their necks.

Branching descent and natural selection are the two key concepts of Darwinian Theory of Evolution .Darwin theory of natural selection was based on certain observations like-

- Limited natural resources.
- Over population
- Competition for resources
- Struggle for existence
- Survival of the fittest.

Mechanism of Evolution

Hugo deVries based on his work on evening primrose brought forth the idea of mutation. Mutation is the large difference arising suddenly in a population.

Mutations are random and directionless while Darwin variations are small and directional. Hugo deVries believed that mutation causes speciation and hence called saltation (single step

large mutation).

Difference Amongst Lamarckism, Darwinism and Mutation Theory

Properties	Lamarckism	Darwinism	Mutation Theory
Vital force	The theory believes that every organism has an internal vital force that tends to increase its size upto a certain limit.	Darwinism does not believe in internal vital force.	No internal vital force is involved.
Conscious Reaction	Animals with well developed nervous system react consciously to any change in environments	Darwinism does not involve any conscious reaction.	No conscious reaction is believed to take part in the process of evolution.
Appetency	The theory considers appetency or desires on the part of animals an important force in the development of modifications.	It is not a constituent of the theory.	Appetency in not involved.
Use and Disuse	The organs put to more use are believed to develop more while organs not used begin to degenerate.	The theory is silent about use and disuse of organs.	The theory is silent about it.

Inheritance of Acquired Characters	The characters acquired by an organism during its life are believed to get transferred the next generation.	According to Darwin, all the living cells produce minute particles or pangenesis, which pass into germ cells for transmission to the offspring.	Only those variations are transferred to the offspring which originate in germ cells or in the cells which form germ cells.
Struggle for Existence	The theory does not clearly spell out struggle for existence in relation to high biotic potential.	Organisms produce more offspring than the available food and space so that a struggle for existence ensues amongst them.	The theory believes in the struggle for existence.
Origin of Variations	Variations appear in organisms in response to change in environment, conscious reaction, desire r use and disuse of organs.	Variations appear automatically.	Variations appear due to change in genetic make up.
Continuous Variations	The theory is silent about them though it believes in a continuous modification of organs in a particular direction.	It is based on the origin and selection of continuous variations.	The theory is based on discontinuous variations or mutations.
Natural Selection	The theory does not take into account natural selection or survival of the fittest.	Darwinism is based on natural selection or survival of the fittest.	Mutations theory believes in natural selection or survival of the fittest.

Progress of Evolution	Evolution is a continuous process which moves in a direction governed by environment and appentency.	Evolution is a continuous process, the direction of which is governed by nature.	Evolution is a jerky process, the direction of which is unpredictable though ultimately it is governed by nature.

Hardy- Weinberg Principle- in a given population, frequency of occurrence of alleles or genes can be finding out. These frequencies remains fixed and even remain the same through generation. This fact was represented by Hardy-Weinberg principles using algebraic equation.

This principle states that allele frequencies in a population are stable and is constant from generation to generation. The gene pool remains constant. This is called genetic equilibrium and sum total of all the allelic frequencies is 1.

Binomial expansion of (p+q)2 = p2+2pq+q2=1 where p and q represent the frequency of allele A and allele a in a population . The frequency of AA individuals in a population is simply p2 . This is simply stated in another ways, i.e., the probability that an allele A with a frequency of p appear on both the chromosomes of a diploid individual is simply the product of the probabilities, i.e., p2 . Similarly of aa is q2 , of Aa 2pq. Hence, p2+2pq+q2=1.

When frequency is measured, the actual value varies that indicates the extent of evolutionary changes. Change of frequency in a alleles (Hardy-Weinberg equilibrium) in a population resulted due to evolution.

The factors that affect Hardy-Weinberg equilibrium are-
• Gene migration or gene flow.
• Genetic drift
• Mutation
• Genetic recombination
• Natural selection.

During genetic drift ,sometimes change in alleles frequency is so different in a sample of population that they become a different species. The original drifted population becomes

founder and that effect is called founder effect.

Brief Account of evolution

About 2000 million ago first cellular form of life appeared on earth.

- Slowly single-celled organisms became multi-cellular forms and by the time 500 mya, invertebrates were formed and active.
- Jawless fish evolved around 350 mya.
- Organisms started to invade from water to land. Fish with stout and strong fins could move on land and go back to water These animals called lobefins evolved into the first amphibians.
- Later, these amphibians evolved into reptiles. They lay shelled eggs. Then reptiles of different shapes and sizes dominated on earth , fish like reptiles e.g. Ichthyosaurs and the land reptiles e.g dinosaurs. The biggest of them was Tyrannosaurus rex.
- Some of the reptiles evolved into birds and later some of them to mammals. Mammals were viviparous and more intelligent in sensing and avoiding danger .