UNIT - IV

4.2.1 CONCEPT AND EVIDENCES OF EVOLUTION. (direct and indirect)

CONCEPT OF EVOLUTION -

The term evolution is derived from two latin words - e = from; volver = to roll and means the act of unfolding. It is a slow or gradual change in the characteristics of a population of animals or plants over successive generations. It accounts for the origin of existing species from ancestors unlike them. It is a continous process by which species of organisms arise from earlier life forms and undergo change over time through natural selection. Organic evolution implies that "The present complex and highly organised living beings have evolved from simpler and less organised living beings of past by gradual modifications accumulated through successive generations over millions of years".

The basic concept of organic evolution envisages continuity of life with constant modification. It suggest that:

1. Environmental conditions in nature are ever changing.
2. Organisms have an inherent tendency of changing in response to the changing environmental conditions. This is called adaptability or adaptations.
3. Such adaptive changes in organisms are inherited by the offspring and lead to evolution.
4. Since changes in the organisms are inherited are due to adaptation, new species are always better

adapted to different environments, diversify and evolve along several divergent lines.

6. All the present day species had a common ancestor at some or other time of their evolution.

7. Individuals migrate from their place of origin to varied geographical areas and gradually adapt to different environmental conditions. This results in the formation of several new species from ancestral species (Divergent Evolution)

8. Organisms from varied regions also migrate to a common habitat and modify to adapt to that habitat. As a result organisms from distantly related groups develop common features. This is Convergent Evolution.

9. Evolution is a very complex and extremely slow process. It is not possible to see one type of animals changing to other, but presence of intergrading organisms support the concept of evolution.

~~CONCEPT OF EVOLUTION~~

EVIDENCES OF EVOLUTION

Evidences of evolution confirm that evolution does occur and simple living forms gradually modify into complex forms. These evidences have proved beyond any doubt the evolution is a dynamic process producing changes in the living forms. The different evidences which support the idea of evolution are:

1. EVIDENCES FROM PALAEONTOLOGY
2. " " MORPHOLOGY and COMPARATIVE ANATOMY.
3. " " EMBRYOLOGY.
4. " " BIOCHEMISTRY AND PHYSIOLOGY
5. " " CYTOLOGY
6. " " GENETICS.
7. " " BIOGEOGRAPHY.
8. " " Taxonomy

The evidences from Palaeontology (fossil records) provide direct evidence of organic evolution and give the details of evolutionary relationships of many lines of descent, while different biological disciplines like comparative Anatomy, taxonomy, embryology, physiology, biochemistry, genetics and biogeography provide indirect evidence, in support of biological evolution.

1. PALAEONTOLOGICAL EVIDENCES

The most convincing evidence that evolution has occured comes from fossil record of ancient creatures. The study of ancient life is called as palaeontology. Fossils are the remains or impressions of organisms preserved in past.

Formation of Fossils – The animals or plants are only preserved and fossilized when they are suddenly buried in the soft silt of water, lava, ice or sand. When an organism dies, its body decomposes soon or later. Harder parts such as shell, bones are more resistant. These hard parts are also destroyed by bacteria, fungi combined with environmental agents like water, wind and temperature. However under special conditions some parts may get preserved to form fossils.

Conditions of fossilization

1. Possession of hard parts – Organisms having hard parts are more likely to become fossilised. These hard parts include bones, teeth, shells etc.
2. Escape from immediate destruction by the work of atmosphere, mechanical forces such as wave action or crushing and biological agents such as predators, scavengers and decomposers.
3. Immediate burial in a medium capable of retarding decomposition – Organisms are preserved if they are immediately buried in lava, volcanic ash or dust, in ice, oil rich soil, resin of plants (amber), in swamp, huge piles of sand, or under water in layers of silt piling one above the other.

Types Of Fossils.

1. Entire organism preserved – Organisms may be preserved intact in a medium that protects them from decay. Millions of years ago insects such as bugs, aphids, may-fly etc got entangled in resin of pine trees. The resin hardened and changed to amber, preserving minute details of insects. A few animals are known to have been preserved in snow. For e.g. woolly mammoth
2. Original hard parts. Hard parts like shells, skeleton, exoskeleton or spicules of invertebrates got preserved & fossilized.
3. Skeleton preserved – The skeletons of vertebrates make perfect fossils because they could be well preserved in their original shape and structure
4. Altered hard parts of organism preserved: Sometimes the original hard parts of an organism get completely altered due to various factors
   i) Carbonisation – Occasionally the disintegrating soft parts of body leave a thin film of carbon. Due to carbonisation, have been obtained exact body outlines of extinct reptiles such as Ichthyosaurs and other organisms as jelly fishes, worms etc.
   ii) Petrifaction – When mineral rich water penetrates through the pores left behind by decomposition of organic matter of harder parts, the minerals get deposited in these pores, this process is called as fossil petrifaction.
   iii) Mineralisation – Sometimes certain specific structures of fossil remains are replaced by specific minerals. This process is called as mineralisation. Some common replacing minerals are, calcium carbonate, silica, carbonate of calcium and magnesium, iron sulphide, iron silicate etc.

5. Traces of organisms preserved - They include impressions or marks in hard media.

(i) Moulds and casts - A mould is an impression of hard parts and if moulds are filled with mud minds a cast of the original object is produced

(ii) Tracks and trails - Tracks are footprints or impressions of feet of passing animals which were covered by sediments before they got eroded. Footprints of Dinosaurs have been seen in Triassic rocks. Trails are irregular marking of animals like worms or snails due to crawling

(iii) Burrows and boring - Some animals live in burrows, tubes and holes in the ground, wood or rocks. Such burrows have been found in sedimentary rocks of ancient past. They belong to molluscs, worms and sponges.

(iv) Gastroliths and coprolites - Gastroliths are hard stony pieces found from stomach of ancient reptiles and fishes. Coprolites are faeces of ancient animals. Their study tells us about food and feeding habits of fossil forms.

IMPORTANCES - The study of fossils has great significance.

1. They help in rebuilding past.
2. They help in understanding prehistoric forms and process of evolution
3. They help in determining the age of rocks
4. They are used as indicators for prehistoric climate.
5. They are used to detect petroleum reserves, coal seams.

EVIDENCES FROM MORPHOLOGY AND COMPARATIVE ANATOMY.

Morphological studies of various organ systems of vertebrates indicate that these are constructed on same basic plan. The minor differences seen in some forms are the adaptive modifications to the diverse mode of living. They can be studied in two different heads.

1. Homologous Organs - are the organs having common origin and are built on same fundamental pattern, but performed varied functions and have different appearance
   eg: limb structures of Vertebrates - (refer practical for detail)
   eg: 2. Homology in insect's legs - legs in mole cricket, grasshopper, honey bee, water beetles are used for digging, jumping, collecting pollen & swimming, but in all these cases legs are formed of similar five podomeres
2. Analogous Organs - are the organs which have same appearance and function but their structural details are totally different; their basic structure & origin is different
   eg1: fins of fishes and flippers of whale have same appearance & function but their structure is different
   eg2: wing of insect and wing of bird (refer practical for detail)
3. Vestigial Organs - are rudimentary organs, which might have been large and functional in ancestors. They are often undersized, degenerated and nonfunctional
   eg: in man are vermiform appendix, auricular muscles of external ear. wisdom teeth, Canines in man, Body hair, mammary gland in male etc.

4. Atavism or Reversion - is the reappearance of those ancestral characteristics in an organism, which do not occur normally
eg 1. Tail in man - Sometimes baby is born with short fleshy tail devoid of bed vertebrae and is removed by doctors without harm
eg 2. mammary glands - more than one pair of nipples in males
5. Connecting links - are living organisms having characters of two different groups of animals
eg 1 - Lung fish - (connecting bony fishes and amphibians)
eg 2. egg laying mammals (connecting reptiles and mammals).

EVIDENCES FROM EMBRYOLOGY.

Von Baer in early 19th Century noticed remarkable similarity among vertebrate embryos, whose adults are markedly different. ~~Ernst Haeckel~~ He observed that embryos of higher animals repeat many of the stages through which embryos of higher animals have passed. This is called as Recapitulation theory. It indicated the some of the developmental stages of an organism are similar to some of the developmental stage of its ancestors. Ernst Haeckel in 1866, modified the concept into "biogenetic law", which states that Ontogeny recapitulates phylogeny i.e. in its development, the individual passes through stages like the adult stages of its ancestors. Acc to biogenetic law fertilized egg can be compared to single celled flagellate and blastula to colonial protozoan. Haeckel stated that the ancestor of all coelenterates and higher animals were gastrula like organism with two layers of cell with central cavity created by blastopore to outside.

One of the best example of recapitulation is comparison of vertebrate embryo. During early stage all look very alike. All have pharyngeal arches and pharyngeal cleft. At later stage they have limb bud perimeedia for limbs and they all have embryonic tail. Later each embryo develops features that indicated fairly clearly its definite relation.

EVIDENCES FROM BIOCHEMISTRY AND PHYSIOLOGY

1. Protoplasm - Analysis of protoplasm of different organism like, bacteria, blue green algae, plants and animals shows that it has same biochemical constitution. It mainly consists of proteins, carbohydrates, fats, water etc. This suggests that the most fundamental property of living things is remain intact, while variations in certain essential respects produced the variability according to needs of different forms.
2. Chromosome Chemistry - The chromosome of all living organism basically consists of nucleic acids (DNA and RNA) and proteins (histons and protamines). This ~~is~~ suggest a common origin of living beings.
3. Enzyme Similarity - A large number of ~~plants~~ animals contain common enzymes. For eg. trypsin and amylase are found from sponges to mammals.
4. Hormone similarities - Hormone similarities are also found in all vertebrates. For eg. thyroid hormone is commonly found in all vertebrates and this hormone from one class of organism can be substituted for another class of organism.

5. Phosphagens - play important role in muscle contraction and are sources of energy for resynthesis of ATP, once they are broken down. In muscles of most vertebrates, the phosphagen is creatine phosphate, while in most invertebrates it is arginine phosphate. Hemichordates, the most primitive chordates, have both the phosphagens, the creatine phosphate as well as arginine phosphate. Such situation is also found in echinoderms and on morphological grounds echinoderms have been considered close to ancestor of chordates.

6. Excretory Product Analyses - The excretory product of primates is uric acid, in amphibians and most fishes is urea and in most invertebrates is ammonia. Vertebrate evolution has been marked by the successive loss of enzymes for the stepwise degradation of uric acid. It was observed that the chick embryo in early stage of development excrete ammonia, later it excrete urea and finally at uric acid. The enzyme uricase, which catalyzes first step in the degradation of uric acid in early chick embryo but disappears in later stages of development.

7. Comparative Serology - The antibodies formed against one antigen, can also react with antigens of other source, provided the latter is chemically similar to first antigen. Antibodies containing serum is known as antiserum. Antiserum of antigen of one animal can be tested with the antigens of other animals in order to show their relationships. The test can be interpreted that if precipitate results with more diluted antigen of one animal against the test animal, then the former is more closely related to the latter, if

precipitate results with less diluted antiger of that animal, than it is distantly related to the test animal. Serological tests among different primates ~~that~~ like man, ape, old world monkey and a ~~lemur~~ lemur, the amount of precipitate of serum proteins would decrease in descending order; suggesting man is more closely related to man than other organisms.

CYTOLOGICAL EVIDENCES- All living organisms have basic unit of structure and function is cell. This reflects basic relationship among all living organism. The cell is similar organelle; with same structure and function. All cells have similar protoplasm. The cell division process are also similar. The genetic material in all eukaryotes is DNA. These similarities indicate evolution of all organisms from common ancestor.

EVIDENCES FROM GENETICS - Animals have many genetic similarities. DNA and RNA's are present in all cells, they have same composition and play same role. The genetic code is essentially similar in case for all animals. The same laws of heredity apply equally to all animals, though with slight modification. All these genetic similarities lend evidence to evolution of all present living forms from some ancestral form.