EVOLUTION

Evolutionary Biology-The study of history of life forms on earth.

Evolution is a process that results in irreversible slow and gradual heritable changes in population spread over many generations leading to diversity of organisms on earth.

Origin of life

- Steller (Stars) light started its journey millions of years ago & trillions of kilometres away.
- The Universe (cluster of galaxies) is almost 20 billion years old.
- The **Big Bang theory** states that a huge explosion (unimaginable in physical terms) occurred, the universe expanded, temperature came down and hydrogen and helium were formed later. The galaxies formed due to condensation of gases under gravitation.
- Earth is about 4.5 billion old contains water vapour, methane, carbon dioxide and ammonia released from molten masses covered the surface.
  - UV rays from the sun broke up water molecule into H_2 and O_2 and lighter H_2 escaped.
  - Oxygen combined with ammonia and methane to form water, carbon dioxide and others.
  - Ozone layer formed, as it cooled, the water vapour fell as rain for many years to fill depression and form oceans.
  - Life appeared 500 million (about **4 billion** years back) years after the formation of earth.

Theories of Creation of Earth

(i) **Theory of Special Creation/ Connotation** God created life.

a) All living Organism were created as it is.
b) Diversity was always same and will be same in future.
c) Earth is about 4000 years old.

(ii) **Theory of Panspermia/Cosmic** by early Greek thinkers
Spores (units of life) were transferred to different planets including earth developed into living forms.

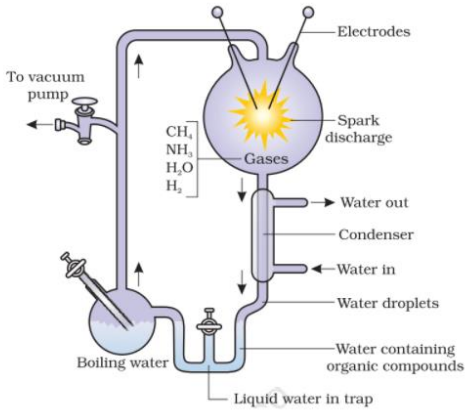
(iii) **Theory of Spontaneous Generation (Abiogenesis)**
Life originated from decaying and rotting matter like straw, mud, etc.

(iv) **Theory of Biogenesis**
Louis Pasteur rejected Theory of Spontaneous Generation and demonstrated that life came from pre-existing life. In his experiment, he kept killed yeast cells in pre-sterilised flask and another flask open into air. The life did not evolved in the former but new living organisms evolved in the second flask.

(v) **Theory of Chemical Evolution** - Oparin-Haldane of England
Life originated from pre-existing non-living organic molecules and that formation of life was preceded by chemical evolution.

Miller's experiment

(i) SL Miller and HC Urey in 1953 provided experimental evidence for chemical evolution.
(ii) He took a closed flask containing CH_4, H_2, NH_3 and water vapour at 800°C and created electric discharge.
These conditions were similar to those in primitive atmosphere.
(iii) After a week, formation of amino acids were observed. Complex molecules like sugars, nitrogen bases, pigments and fats were seen in the flask by other scientist.
(iv) Analysis of the meteorite also revealed the presence of similar compounds.
(v) Chemical evolution of life was more or less accepted.



Origin of First Cell

(i) First non-cellular life forms originated 3 billion years ago.
(ii) These molecules were like RNA, protein and polysaccharides.
(iii) Cellular life form first evolved about 2000 million years ago.
(iv) These were single-celled formed in aquatic environment.
(v) This form of abiogenesis, i.e. the first form of life arose slowly through evolutionary forces from non-living molecules It is accepted by many scientists.

Evidences of evolution come from

(i) **Palaeontology** - study of fossils (remains of organisms preserved in sedimentary rocks)
(a) Arrangement of sediments one over the other during the long history of earth indicates different era.
(b) Different aged rock sediments contain fossils of different life forms.
(c) Some organisms appear similar to modern organisms.
(d) The study showed that life forms varied over time and certain life forms are restricted to certain geological time-scale Hence, new forms of life have evolved at different times in the history of earth,

(ii) **Comparative anatomy and morphology**- Comparative differences of external and internal structure among the organisms of today and those that existed years ago.

I. (a) Homologous organs. Divergent evolution due to adaptations to different needs. – Same Structure different function. Indicates common ancestry. **Eg-**

- Forelimbs of some animals like whales, bats and cheetah such as humerus, radius, ulna, carpals, metacarpals and phalanges.
- Vertebrate hearts or brains
- Thorns and tendrils of Bougainvillea and Cucurbita.

II. Analogous organs- Convergent Evolution – Different Structure but same functionally. Eg:

- Wings of Insect, Pterodactyl, Bird & Bat.
- Eyes of Octopus and mammals
- Flippers of penguins and dolphins.
- Sweet potato (root modification) and potato (stem modification).

III. Vestigial organs- provide evidences for organic evolution.
Non-functional & remanent organs of the organism, which were functional in their ancestral.
(a) Human body -tail bone (coccyx), wisdom teeth, nictitating membrane, vermiform appendix, etc.
(b) Hip girdles and bones of the hind limbs in some whales and certain snakes
(c) Wings of flightless birds

(iii) **Biochemical/Physiology**-
(a) The metabolic processes in organisms are similar with same new materials and end products.
Eg: Energy released by oxidation is stored in ATP which then powers the energy requiring process.
(b) Molecular homology is the similarity among animals at the molecular level.
Eg: Human DNA differs in only 1.8% of its base pairs from chimpanzee DNA and there is no difference between the two in the amino acid sequence for the protein cytochrome-c.

(iv) **Biogeographical evidences** The species restricted to a region develop unique features. Also, species present in far separated regions show similarity of ancestry.
This can be explained with the help of following processes:
I. Adaptive radiation - Ancestral stock gives rise to new species adapted to new habitats and new ways of life. Examples - Darwin's finches :These were small black birds, which Darwin in his Ship HMS Begal voyage and observed the following in Galapagos island.
(a) Many varieties of finches in the same island.
(b) All varieties of finches had evolved from original seed-eating finches.
(c) There was alternation in beaks enabling some to become insectivorous and some vegetarian.