EVOLUTION

1. Evolution

It is the sequence of gradual changes from simple life forms to complex forms, i.e. from primitive organisms that lived over million of years ago to new organisms that exist today.

2. Origin of Life

Our earth originated about 4.6 billion years ago, whereas the origin of life on earth occurred 4 billion years after its formation. The Big-Bang theory (given by Abbe Lemaitre in 1931) explains about the origin of earth as a terrible explosion resulting in the formation of universe or cosmos.

3. Ancient Theories for Origin of Life

- Special Creation It states that God has created life.
- Cosmozoic Theory It states that life arose from the spores or panspermia which came from outer space.
- Spontaneous Generation Theory According to this, life originated from abiotic substances spontaneously. Therefore, this theory is also called as theory of abiogenesis or autobiogenesis.
- Louis Pasteur rejected the theory of spontaneous generation. He demonstrated that life evolved from pre-existing life by his swan-neck flask experiment.
- Theory of Chemical Evolution It was given by Oparin and Haldane. According to them, first form of life came from pre-existing, non-living organic molecules (e.g. RNA, protein, etc.).

4. Miller and Urey's Experiment

(Evidence of Chemical Evolution)

Stanley Miller (1953) performed a simple experiment under the guidance of Harold Urey. They collected water vapour, hydrogen, methane and ammonia (2 : 2 : 1 ratio) in a flask and provided an electric discharge by tungsten electrode.

The amino acids such as glycine, alanine, etc., were formed in their experiment. This experiment, proved that C, H, O and N in various forms can give rise to complex compounds.

5. Evidences for Evolution

A. Palaeontological evidences come from the study of fossils. The fossils are the remains of past organisms preserved in sedimentary rocks.

(i) Fossil Records/Inscriptions are the remains or impressions of the hard parts of ancient plants and animals on rocks and mountains. The process by which animals or plants become a fossil is called fossilisation. 'Study of fossils' is called palaeontology.

(ii) Age Determination of Fossils Fossils' age can be calculated by methods like uranium lead method and radioactive carbon dating methods, etc.

B. Comparative anatomy and morphological evidences These show the similarities and differences among the organisms of today and those that existed many years ago. This can be the achieved by the study of following

(i) Homologous organs are those having same structural design and origin but different functions, e.g. forelimbs of some animals like whales, bats and cheetah, mouth parts of various insects, etc.

(ii) Analogous organs are those which are anatomically different but functionally similar, e.g. wings of butterfly and birds. Analogy is based on convergent evolution.

Note • Divergent Evolution It refers to the development of different functional structures from a common ancestral stock (homology) in order to adapt to different environmental conditions.

• Convergent Evolution Development of similar morphological characters (analogy) in the organisms of different lineages at same geographical regions is called convergent evolution.

C. Biochemical evidences (Molecular evidences) suggest that the similarities in proteins and genes performing a common function among diverse organisms indicates a common ancestry.

D. Embryological evidences suggest that some organisms that show common descent in embryological patterns, This was first observed by von Baer and later reinterpreted by Haeckel in the form of recapitulation or biogenetic law stating that ''ontogeny repeats phylogeny''.

E. Biogeographical evidences suggest that the species restricted to a region develop unique features. Also, species present in separated regions show similarity of ancestry.

This can be explained with the help of adaptive radiation. It is an evolutionary process in which an ancestral stock gives rise to new species adapted to new habitats and new ways of life, e.g. Darwin's finches, marsupials of Australia and placental animals in Australia.

6.Biological Evolution

It refers to the origin of first living cell from non-living chemical complexes. Mechanism of Evolution Various theories were put forward by scientists to explain the evolutionary mechanism.

7. Theories of Evolution

(i) Lamarckism or Theory of Inheritance of Acquired Characters Lamarck published a book named 'Philosophie Zoologique' in 1809 to propose this theory. It states that each organism acquires many characters in his lifetime from the environment he lives in. These acquired characters are inherited by the offspring to form a new species gradually. Any organ which is used more, slowly enlarges in size and the organ which is not used, degenerates, e.g. degeneration of legs of snake, elongation of neck in giraffe. This theory was highly criticised.

(ii) Modern Lamarckism August Weismann in 1892 proved using genetics and theories of inheritance that acquired characters, present in genotype of an individual are transmitted to next generation by inheritance. This theory was named as Theory of Continuity of Germplasm.

(iii) Darwinism or Theory of Natural Selection Darwin concluded that the fitness of individual ultimately refers to its reproductive fitness. Thus, those organisms which are better or adapt well will survive more in nature. This is called natural selection. He also explained that different species descending from common ancestor get adapted into different habitats. This is called branching descent. Therefore, natural selection and branching descent are two important concepts of Darwinism. Darwin along with Alfred Wallace jointly propounded the 'Theory of natural selection' in 1958. It was based on following factual observations

(a) Limited natural resources, stable population (except for seasonal fluctuations).

(b) Variations (in sexually reproductive animals).

(c) Reproductive isolation, etc.

● Industrial Melanism An example of evolution by natural selection was observed in peppered moths (Biston betularia) in 1859 in England. Before industrialisation, white-winged moths were more in number compared to dark-winged moths. After industrialisation, dark-winged moths increased in number, as they were able to camouflage themselves from predators on tree trunks turned darker due to air pollution (soot and dust particles). The white-winged moth population declined due to easy detection by predators. Thus, in a mixed population, better adaptable species are selected by nature to grow while others are eliminated.

● Chemical Resistance The excessive use of chemicals leads to development of resistance in microbes to such chemicals. These microbes are selected naturally due to favourable variation.

(iv) Mutation Theory of Hugo de Vries He studied and carried out experiments on a plant, evening primrose (Oenothera lamarckiana). He proposed the mutation theory of evolution on the basis of his observations. de Vries proposed that evolution can also occur due to sudden large changes occurring in a population which caused speciation and called it saltation (single step large mutation).

(v) Modern Synthetic Theory of Evolution Modern synthetic theory is actually a form of modern Darwinism. It states that the origin of species is based on the interaction of genetic variation in a population, natural selection and reproductive isolation.

8. Hardy-Weinberg Principle

According to it, the allele frequencies in a population are stable and remain constant from generation to generation. This is called genetic equilibrium. It is expressed as p q p^2+q^2 = 2 1 [binomial expansion, i.e. $(p + q)^2$]

9. Agents of Evolutionary Change

There are following basic mechanisms through which biological evolution takes place

(i) Genetic drift (Random drift) is a change that occurs in allelic frequencies by chance.

Sometimes due to changes in allele frequency in new population, some different species are formed. This is called founder effect and the original drifted population is called founder.

(ii) Gene Flow It is the movement of alleles from one population to another.

(iii) Natural Selection It occurs due to the inheritance of variations. It leads to the survival of those who best fit in an environment. It can be of three types, i.e. stabilisation, directional and disruptive.

(iv) Genetic Recombination During gametogenesis, crossing over in meiosis leads to new combination of genes.

10. Account of Evolution

The cellular forms of life first appeared on earth around 2000 million years ago (mya).

A. Evolution of Plants

- Plants appeared first on lands before animals.
- Bryophytes were the first plants to colonise land followed by vascular plants.
- Vascular plants (pteridophytes and gymno- sperms) first originated in Silurian period.
- Herbaceous lycopods and arborescent lycopods evolved from Zosterophyllum of Palaeozoic era.
- Psilophyton is the common ancestor for horsetails, ferns and gymnosperms.

B. Evolution of Animals

- Animals evolved around 500 mya and the first animals were invertebrates.
- Jawless fish and amphibious fish with stout and strong fins were found on earth around 350 mya..
- The Jurassic period is called age of reptiles, i.e. around 200 mya.
- Mammals appeared in Triassic period and the first mammals were like shrews.

11. Human Evolution

The fossil evidences indicate that origin of man occurred in Central Asia, China, Java and India (Shivalik hills).

The human evolution took place as follows

Human Ancestors	Time of Origin	General Feature
Dryopithecus	20-25 mya	Ape-like, hairy, ate soft fruits and leaves. Arms and legs of same length, large

		brain.
Ramapithecus	14-15 mya	More man-like, walked more erect, teeth like modern man.
Australopithecus (The first ape man)	3-4 mya	Probably lived in East African grasslands and ate fruits, hunted with stones, weapons, brain capacity was 400-600 cc.
Homo habilis (Handy man)	2 mya	first hominid, i.e. human being- like, brain capacity 650-800 cc, did not eat meat.
Homo erectus (Java man)	1.5 mya	Fossils found in Java in 1891, brain capacity 900 cc, probably ate meat.
Homo sapiens neanderthalensis (Primitive man)	1,00,000- 40,000 years ago	Known as Neanderthal man. Fossils found in East and Central Asia, brain size 1400 cc, used hides to protect body, buried their dead. They became extinct 25,000 years ago.
Homo sapiens (Modern man)	000 years ago (ice age)	Arose in Africa, developed cave art around 18,000 years ago, agriculture started around 10,000 years back and thus, human settlement and civilisation started.