

## **Evolution of Life**

**Evolution** is a “Gradual, orderly and irreversible changes from one condition or form to another condition or form”.

### **Types of evolution**

#### **A. Inorganic evolution**

Inorganic evolution is the changes take place in inorganic matters

#### **B. Organic evolution**

Gradual, orderly and irreversible process of development of complex and diverse form of life from the pre-existing simple form of life is called organic evolution.

### **Patterns or types of Organic evolution**

#### **a. Divergent evolution**

Process of development of different functional structures in a group of organisms that were form from a common ancestor. It is also called as Adaptive radiation. For example; hand in man, wings in birds and fore limbs in frog etc.

#### **b. Convergent evolution**

Process of development of similar functional structures or adaptational features in a group of organisms that were not form from a common ancestor. It is also called as Adaptive convergence. For example, gill in fishes and gills in crustaceans.

#### **c. Progressive evolution**

Process of development of complex and diverse forms of organisms from simple forms of organisms.

#### **d. Retrogressive evolution**

Process of development of simple forms of organisms from complex forms of organisms.

#### **e. Parallel evolution**

Process of development of quite similar characters or features in two different forms of organisms independently, although they were developed from related ancestral lines. For example, development of running habit in horse and deer.

### **Evidences of Organic evolution**

There are many evidences to support the organic evolution of living organisms on the earth. They are following:

- 1. Evidence from Morphology and Comparative Anatomy**
- 2. Evidence from Paleontology**

### **3. Evidence from Biochemistry**

#### **1. Evidence from Morphology and Comparative Anatomy**

The study of morphology and comparative anatomy of a group of animals or plants reveals that certain structural features are basically similar. These similarities support the origin of these animals or plants from common ancestor.

##### **A. Evidence from morphology**

A comparative study of the morphological structures of different groups of plants and animals provides a clue for organic evolution. All the organisms of same taxonomic group have similar morphological characters and this similarity provides the evidence of common ancestry of this group of organisms. For example, all the animals under cat family like tiger, leopard, wild cat etc. look similar in their appearance.

##### **B. Evidence from Comparative Anatomy**

The anatomical features like homologous organs, analogous organs, vestigial organs, connecting links and atavism etc. provide the evidence of organic evolution.

###### **i. Evidence from Homologous organs**

Those organs in a group of organisms, which are different in function and appearance but similar in embryonic origin and internal structure are called homologous organs. For example; fore limbs of different vertebrates like man, whale, bird and horse etc. are not similar in their appearance and function. Man uses his arms for grasping, fore limbs of horse use for running, wings of bird use for flying and flippers of whale use for swimming. But the anatomical study reveals that the structure of forelimb of all these animals possess the same sets of bones (humerus, radius and ulna, carpals, metacarpals and phalanges), muscles and similar arrangement of blood vessels and nerve fibers etc. Thus, all these vertebrates were originated from a common ancestor but each organ modified differently to adjust in different environments during course of evolution. This evidence supports the occurrence of divergent evolution. The more similarities in the homologous organs between animals means they have more closer relationship between themselves.

###### **ii. Evidence from Analogous organs**

Those organs which are functionally similar but different in internal structure and embryonic origin are called Analogous organs. For example, the wings of insect and birds, eyes of squid and fish etc. are similar in their function but they are different in origin and basic internal structural pattern. This evidence supports the occurrence of convergent evolution. Different unrelated organisms live in similar environment developed similar functional structures during course of evolution which increased the chance of survival and reproductive potential in that environment.

###### **iii. Evidence from Vestigial organ**

Those organs which are functionless and incompletely developed in present generation but may be fully developed and functional in their ancestors are called rudimentary or vestigial organs. Due to the environmental changes and changes in habit of animals during course of evolution, number of organs are degenerated and functionless which were well developed and functional in their ancestors. Thus, present of vestigial organs provide the evidence in favor of common ancestry. There are about ninety vestigial organs in human body. Like, nictitating membrane, canine teeth, coccyx vertebrae, set of caudal muscles, auricular muscles, wisdom teeth and vermiform appendix etc. For examples;

- Vermiform appendix -Vermiform appendix present in caecum of large intestine of mammals. It is well developed in herbivorous and helps in digestion of cellulose but in carnivorous, it is completely absent. In human it is greatly reduced and functionless. This may be changed in dietary habit of man during course of evolution, vermiform appendix became disused and it remained as vestigial form. This provide evidence that modern man was evolved from herbivorous ancestor.

#### iv. Evidence from Connecting links

Intermediate group of organisms which possess the characteristic of two different classes or phylum called connecting link. For examples;

- *Peripatus* is connecting link between annelidan and arthropodan.
- *Neopilina* is connecting link between annelidan and Mollusca.
- Prototherian like, platypus, spiny anteater etc. are connecting link between reptile and mammal.
- The connecting between the reptile and bird is *Archeopteryx*

All these connecting links in nature supports that evolution of the complex organisms take place from the simple organism and evolution from one form to another form is not occurred suddenly but through the intermediate groups like connecting link.

[**Note: Birds are glorified reptiles.** Justify this statement.

The connecting between the reptile and bird is *Archaeopteryx*, which was existed in Jurassic period. It possessed the characters of both reptile and bird.

S.N.	Reptilian characters	Avian characters
1.	Body and hind limbs covered with scales	It looks alike the terrestrial bird of sized about a crow
2.	Bones were not pneumatic types	Body covered by flight feathers
3.	Jaws bear peg like homodont types of teeth	Jaws modified into beak
4.	Tail long and tapering like typical dinosaur	Tail bears elongated tail feathers which were arranged in two lateral rows
5.	Wings bear three clawed digits	Fore limbs modified into wings with three digits

6.	Carpals and metacarpals were free	Tibia and fibula bones were separated
7.	Sternum poorly developed and without keel	Girdle and limb bones were similar to bird

The fossil of *Archeopteryx* showed that birds were evolved from reptilian ancestor through the intermediate group. Birds are better developed in their organization to adjust in aerial mode of life than their ancestor. Thus, **Birds are glorified reptiles.]**

#### v. Evidence from Atavism

Sudden appearance of some ancestral characters in some individual which are completely disappeared or presence in vestigial form is called atavism. For examples in human, presence of large canine, thick hair on the body, presence of more pair of nipples in thorax and presence of short tail etc. The reappearance of all such features indicates relation of human and remote far ancestor which had these features and favor the evolution from common ancestor.

## 2. Evidence from Paleontology

Paleontology is branch of science that deals with study of fossils. Fossils are any form of preserved remains thought to be derived from a living organism. Like, remnants, trace, impression and cast of organisms or entire organism that lived in past on the earth. During formation of fossils, soft parts of death organisms disintegrated and hard parts of their body settle at the bottom and buried by sand or mud particles that formed the sedimentary rock. Thus, the dead bodies of organisms preserved in rock as the fossils and this process continued along with formation of the new strata or layers of sedimentary rock. The older fossils preserved at lower most strata of the sedimentary rock, while new fossils preserved at upper strata of rock. The studied of fossils revealed that fossils found in upper most layer or stratum of sedimentary rock are complex and diverse form of organisms. But, when descend down, fossils present are more and more primitive form of organisms and lower most stratum contains most simple and primitive form of fossils of organisms. Thus, the studies of fossils support that pre-existing simple organism formed complex and diverse forms of organisms on due course of time which may be favored by constantly changing environment. For example,

### Evolution of Horse (*Equus*)

The fossil record of horse showed that the evolution of horse started during the Eocene epoch some 60 million years ago. The earliest fossils of ancestor of horse were *Hyracotherium* found in Europe and *Eohippus* found in North America. Later, the environment began to change into dry grass covered plains and they started to live on hard ground. To adjust the new environment, they changed their morphological structure for attaining speed in open grass and getting food along with gradual increased in size. In this evolution, numbers of distinct intermediate stages were found but most dominant intermediate stages from each geological period are *Mesohippus*, *Merychippus*, *Pliohippus* to modern horse (*Equus*).

S.N.	<i>Eohippus</i>	<i>Mesohippus</i>	<i>Merychippus</i>	<i>Pliohippus</i>	<i>Equus</i>
1.	It was lived about 60 million years ago in Eocene epoch.	It was evolved from <i>Eohippus</i> about 40 million years ago in Oligocene epoch.	It was evolved from the <i>Mesohippus</i> about 25 million years ago during Miocene epoch.	It was evolved from <i>Merychippus</i> about 11 million years ago in Pliocene epoch.	It was evolved from <i>Pliohippus</i> about one million years ago in Pleistocene epoch.
2.	It was about the size of fox with 28 cm height.	It was about 60 cm in height.	It was about 100 cm in height.	It was about 108 cm in height.	It is about 150 to 160 cm in height.
3.	It had short head and neck.	It had somewhat elongated muzzle.	It had long neck	It had long muzzle along with elongated jaws and diastema	It has long muzzle with elongated jaws and diastema and increased the mobility of neck
4.	The teeth had short crown, adapted for grinding soft vegetation.	Canine teeth were lost. Molar teeth had low crown.	Molar teeth had long crown, suited for chewing the grass.	Molar teeth had long and ridged crown having cement for grazing.	Molar teeth are long crown and complex enameled ridges which are suitable for grazing.
5.	Limbs were short and fore limbs had four digits and hind limbs had three digits. The third digit was longer than others and all the digits touched the ground.	They had only three functional digits in each limb. The middle digit was longer than other and all the digits touched the ground.	Each limb had three digits but middle digit was longer and only touched the ground.	They had long legs with reduced and splint like second and fourth digits.	Only third digit persists in each limb while second and fourth digits become splint and hidden beneath the skin. Legs are long and only hoof touch the ground for swift running.

[**Note:** The important changes in evolution of modern horse are following;

- Increase in size and length of limbs and feet
- Reduction of lateral digits
- Increase in length and thickness of the third digit
- Metacarpals and metatarsals are fused
- Straightening and stiffening of the back
- Better development of brain and sense organs
- Increase in width of incisor teeth
- Replacement of premolar by molar
- Increase in tooth length
- Increase in crown height of molars
- Increase lateral support of teeth by cement
- Increase of mobility of neck]

### Note: Determination of the Age of fossil or rock

Radioactive dating method is usually used for estimation of age of fossils or rock. The radioactive substances are present in rock and they emitted electron from their outer rings to form some stable non-radioactive isotopes in a specific period of time. By calculating the amount of non-radioactive isotopes or substances in rock, age of rock can be estimated. There are two methods usually used to estimate the age of fossils. They are,

- i. **Uranium-Lead technique or Radioactive clock technique**
- ii. **Carbon dating method**

### Note: Types of fossils

S.N.	Types of fossils	Formation process	Examples
1.	Entire organism or Intact fossils	Entire organism was frozen into the ice during Glaciation or encased into the tar or the hardened resin of tree (Amber fossil) or	Woolly mammoth, Insect exoskeleton found in Oligocene rock.
2.	Hard skeletal materials fossils	Hard materials trapped by the sedimentary sand and clays which form the sedimentary rock	Bones, shell and teeth
3.	Molds and Casts	Hard materials were trapped in the sedimentary sand and clays that harden to form rock. The skeleton was dissolved, leaving its impression as mold of organism and then mold was infilled with fine materials which harden to form a cast.	Gastropod from Jurassic period
4.	Petrifaction or Permineralized	Gradual replacement of part of dead organism by the water carried mineral deposits. Slow infilling as organism decomposed producing fined detail.	Silica; replacement of Echinoderm
5.	Impression	Impression of remains of organism in fine grained sediment on which they died	Feather of Archeopteryx
6.	Imprints or trace fossils	Foot prints, trails, tracks, burrow and tunnels of various organism made in mud were rapidly baked infilled with sand covered by further sediments	Dinosaur foot prints
7.	Coprolites	Fecal pellets preserved from decomposition, later compressed into sedimentary rock	Cenozoic mammalian remains.

### 3. Evidence from Biochemistry

The composition of body and the presence of different enzymes and hormones in different animals are similar. These similarities support that they are related to one another and descended from common ancestor. For examples;

**a. Protoplasm similarities**

Protoplasm is composed of water, nucleic acid, protein, carbohydrates and lipids etc. which is same in all the living beings. This evidence suggests the common origin of living beings. During the evolution the most fundamental property of living beings has been retained constantly while different variation developed according to needs of different forms.

**b. Similarity of Enzymes and Hormones**

Same enzymes and hormones present in different vertebrate animals. Like stomach of frog and man secrete same enzyme pepsinogen for digestion of protein. Enzymes like trypsin, amylase, and lipase etc. are found in different animals with same functions. Similarly, thyroxine hormone secreted from thyroid glands of both man and frog helps in regulation of metabolism process in body. Thus, this similarities of hormones and enzymes in different vertebrate animals showed their origin from common ancestor.

**c. Comparative Serology**

Study of serum of an animal is called Serology. Serum is amber colored protein rich liquid or plasma that lack blood corpuscles and fibrinogen etc. Protein molecules present in serum, act as antigen when injected into the blood stream of tested animal that lack these proteins. Then, tested animal body produces antibodies against the antigen molecules and antigen-antibody reaction takes and produces white precipitate. The precipitate is called precipitin and reaction is called precipitation test or serological test. The amount of precipitin production is depended upon the degree of recognition of antigens in serum by the tested animal body. If precipitin is formed with diluted form of serum of one animal against the tested animal, then they have close relationship with each other. If precipitin is formed with concentrated form of serum of one animal against the tested animal, then they have distance relationship with each other. The serological study provided evidence of common ancestry and degree of relationship between the animals. The serological test showed that human beings are more closely related with apes than monkeys.

**d. Chromosome chemistry**

The chromosomes of all the living organisms have similar constituents that is they are made of DNA, RNA and protein molecules like histone proteins and protamine etc. These constituents are arranged in almost identical manner in all chromosomes. Such similarities in composition of chromosome pointed out the common ancestry of living organisms.

**Theories of Evolution**

Many theories have been put forward to explain the mechanism of evolution of living beings. Some of the theories of evolutions are as following;

- 1. Theory of Inheritance of Acquired characters or Lamarck's theory or Lamarckism**
- 2. Theory of Natural Selection or Darwin's theory or Darwinism**
- 3. Modern Synthetic theory**
- 1. Theory of Inheritance of Acquired characters or Lamarck's theory or Lamarckism**

It was the first theory that attempted to explain the process of organic evolution of organisms. It was postulated by French biologist Jean Baptiste Lamarck (1744-1829 AD) in his book 'Philosophie of Zoologique' published in 1809 AD. It is also called theory of Inheritance of Acquired characters. This theory consists of following postulates

**a. Tendency of grow**

Every organism has tendency to grow of size up to a certain limit due to internal force of life. The limit of growth of its parts of body or whole body is determined by the life itself.

**b. Environmental Effect or Formation of New organs**

Environment in which the living organisms live influence them and this influence leads to change in their habits. Then, the organs of an organism become modified in appropriated way in direction response to a changing environment. This results the formation of a new organs.

**c. Effect of Use and Disuse organs**

The efficiency and development of an organ is directly proportional to its use that is the more frequently and continuously use of organs become more strengthen, develop and enlarge but disuse organs become gradually disappear or vestigial during course of evolution.

**d. Inheritance of Acquired characters**

All the changes happened during the life time of organisms are called acquired characters. These characters are inherited and go on accumulation through generation after generation. Finally, in the long course of time the off springs are entirely different from their ancestor. In this way new species is evolved from common ancestor.

**Examples of Lamarck's theory**

**a. Formation of web between toes in water birds**

The ancestors of present water birds were the terrestrial birds. Due to scarcity of foods or struggle to find the foods on land, they migrated into the water in search of food. Then, their toes became spread in order to move in water. The skin extended between the toes and form webs for swimming.

#### **b. Loss of limbs in snakes**

The ancestor of snake crawled through thick bushes and grasses. Thus, they stretched their body to pass through them and the body became elongated. For passing through the narrow spaces, the limbs were not use and finally disappeared by continuous disuse of organs. Thus, the snake lost their limbs.

#### **c. Formation of long necked Giraffe**

The present long necked giraffe had evolved from short necked animal. When grasses became scarce, they began to eat the leaves of trees. As tree became big and grew up, the animal required a continuous effort to reach the leaves of trees. Then, they stretched their neck and fore limbs and increased the length of these parts. That transmitted to their off springs in each succeeding generation. As a result, long necked giraffe with long legs were evolved.

### **Criticism or Drawback or Objection of Lamarckism**

Lamarck's theory does not stand longer because it failed to explain the exact mechanism of evolution.

1. The main objection of this theory was assumption of inheritance of acquired characters. Acquired characters can bring changes in body or somatic cells but not in germ cells and only germinal variations inherited to the offspring. For examples;
  - a. The powerful muscles acquired by athletes are not inherited to his/her off springs.
  - b. Boring of nose and ear in women have been practiced for centuries in various parts of world, however their babies have no any trace of hole in nose or ear.
  - c. Eyes which are being used continuously and constantly developed defects instead of being improved.
2. According to Lamarckism, organism have tendency to evolved towards greater complexity but highly developed flowering plants are usually very small in size.
3. The desire or need of animal alone cannot lead to formation of new organs.

#### **[Note: Weismann experiment**

German biologist **August Weismann** conducted an experiment on mice to test Lamarckism. He cut the tails of mice for 20 successive generations to see if this has any effect on tail length. It was found that the length of tails in offspring were more or

less same. Thus, he concluded that acquired characters were not inherited and proposed theory known as **Germ plasm theory**.

### **Germ plasm theory**

German biologist **August Weismann** proposed the **Germ plasm theory**. According to this theory, “**There are two types of cells in an organism; Somatic cells and Germinal cells or Germ cells. The effect of environment and use and disuse of organs affect only somatic cells which are not inherited, whereas the changes in germinal cells are only inherited**”.]

### **Neo-Lamarckism**

Modified form of Lamarckism in the light of recent researches is called Neo-Lamarckism. It is stated that

- Environment influences the organisms that cause the variation in them.
- Some of variations acquired by an individual can be passed to its off springs.
- Only those variations are inherited which affect germ cells
- Some somatic variations are also inherited if somatic cells gave rise to germ cells
- Internal force and appetency do not play role in evolution.

### **2. Theory of Natural Selection or Darwin’s theory or Darwinism**

Charles Robert Darwin proposed the theory of Natural Selection published in his book of title “The Origin of Species by Natural Selection” in 1859 AD. The theory of Natural Selection has following postulated;

[Note: Charles Robert Darwin was a famous naturalist who was born on 12 February 1809 AD at Shrewsbury, England. At age of 22, he went voyage for about 5 years on a famous ship H.M.S. Beagle and he collected a large volume of evidences for the fact of origin of species from South America and Galapagos Island.]

#### **A. Over population of off springs**

All the living organisms have a capacity of rapid increased in their numbers by reproduction and caused the over population of offspring. Such reproductive potential of living organisms may be easily observed in the nature. For examples

- *Paramecium* reproduces 3 times in 48 hours. If the rate of reproduction remains same and all offspring will survive, their volume at end of 9000<sup>th</sup> generation would be equal to 10000 times the volume of the earth.
- A single pair of English house sparrow would be ancestor of over 275 billion of individuals within 10 years if all descendants were survived and reproduced at their natural rate.
- In case of slow breeding animals like elephants, a pair of elephants could have 28 million of descendants in absence of any check in 800 years.

## **B. Struggle for existence**

Although all the living beings have enormous power of fertility to increase their numbers, population of organisms remain more or less constant over a period related to the length of their life cycle. This is due to the availability of foods, water and other resources like shelter, suitable climate, breeding area and mate etc. that can support only a limited number of organisms. To survive and continue the generation, an organism must be competed for its existence with other organisms or its environment. There are three different types of struggles. They are;

- i. Intra specific competition or struggle**
- ii. Inter specific competition or struggle**
- iii. Environmental competition or struggle**

The competition between the organisms or individuals of the same species for suitable space, foods, water and mate etc. is called intra specific competition.

### **ii. Inter specific competition**

The competition between the organisms of different species is called inter specific competition. This type struggle occurs due to similar requirements of these organisms.

### **iii. Environment competition**

The competition between the organisms with adverse environmental conditions like heavy rainfall, drought, heat, cold, natural calamities etc. for survival is called environment competition.

## **C. Variation and Heredity**

The competition among the organisms has forced them to change themselves according to the needs to utilize the natural resources for survival and reproductive success. Such changes are called variation. The variations are two types; useful variations and harmful variations. The harmful variations make the organisms unfitted in the struggle for existence and caused their elimination from competition. The useful variations are quite significant and make them fitted in their environment. These variations are inherited to the offspring. It is called as heredity.

## **D. Natural selection or Survival of the fittest**

The useful variations are inherited to the offspring, making the organisms better adapted to their environment. They have an advantage over the organisms having harmful variations. Those organisms, which have harmful variations will decline and eliminate. This process is known as survival of the fittest or natural selection. This process leads to increase the population of those species which possess useful variations and ensure the survival of that species.

## **E. Origin of new species**

Due to continuous natural selection, in due course of time offspring produced will be entirely different from their ancestors and look like a separate sub species. These new sub species again adapted in the changing environment and the variation of one group may occur in one way and other group in different way. Thus, two or more new species may be originated from single ancestral species. In this way, new species is originated by the process of variation with heredity and natural selection over the vast geological time to produce all the living organisms of today.

Examples:

### **A. Origin of long necked giraffe**

The origin of present day long necked giraffe can be explained on the basis of Darwinism in following way;

It is believed that giraffe had originally long neck. As the leaves on the lower branches of tree become scarce, the giraffes were forced to reach the leaves on higher branches of trees. Then, the animals with comparatively longer neck became more fitted, because they could reach the leaves on higher branches and had better chances of survival. But those with comparatively shorter neck were not selected by the nature. Thus, longer neck animals fed comfortably and reproduced continuously.

### **B. Industrial Melanism**

Two species of Peppered moths occurred in city of England; light-colored peppered moths (*Biston betularia*) and dark-colored peppered moths (*Biston carbonaria*). Before industrialization of city, light-colored moths were dominated because they were easily blended with the light background of lichens covered tree trunks. But dark-colored moths were very rare because they could not escape from their enemies and the dark body color become disadvantageous for them at that time. After industrialization, atmosphere became polluted and soot from industries got deposited on the tree trunks making them darker in shade. Then, the population of dark colored moths were dominated while light-colored moths were rare. But, in recent years due to decrease of environment pollution, the deposition of soot on the tree trunks started declining. So, the tree trunks again become lighter in color. Therefore, the dark colored forms again become conspicuous and were easily preyed by their enemies. Hence, the light-colored forms again started increasing in number, as they are found today. This is an example of industrial melanism in favor of Natural selection.

### **C. Sickle cell anemia**

Sickle cell anemia is disease, caused by genetic disorder. In this disease, the RBCs become sickle shaped and disintegrated. Then, the percentage of haemoglobin is decrease drastically resulting severe anemia. It is because the haemoglobin synthesized is defective and controlled by its recessive homozygous gene. So, homozygous person having this defect die at early age. It not only happens in this but also in heterozygous condition. The cells containing defective haemoglobin become

sickle shaped and are not able to transport oxygen. The person bearing this gene is mostly reported from the areas where malaria is very common. It is supposed that when an RBC in heterozygous person becomes sickle shaped, it kills the malaria parasite. Therefore, heterozygous persons can cope better with malarial infection and live relative normal lives than those people which have normal haemoglobin. The process of natural selection thus maintains the abnormal form in the region where malarial infection is common.

#### **D. Resistance of mosquito to DDT**

Mosquitoes spread the parasites which cause malaria to human. It was found that an insecticide known as Dichloro-Diphenyl Trichloroethane (DDT) was very effective in killing the mosquitoes, but a few numbers of mosquitoes survived. These surviving mosquitoes had unique ability of resistance to DDT. With the repeated spray of DDT, the susceptible mosquitoes were killed. The resistance mosquitoes (which were originally present in small population) started multiplying very fast. Therefore, the population of resistance mosquitoes increased enormously and hence DDT brought about genetic change and gave a direction for the evolution of DDT resistant mosquitoes.

#### **Criticisms or Drawbacks or objections of Darwinism**

- i. Mutation is the process by which sudden large variation occurred in the organisms. It is now proved that mutation has powerful role in evolution. But Darwin ignored this process and regarded only Natural Selection as the main caused of evolution of new species.
- ii. Darwin's theory did not explain between the heritable and non-heritable variations.
- iii. It did not explain the origin of variations, which must be present before any selection.
- iv. Natural selection is not a creating force or initiating force but only directing or controlling factor in evolution. Since it operated only after variations have appeared. It accounts for preservation rather than origin of favorable variations.
- v. Darwin's theory neither explained how selection is brought nor the origin of harmful variations
- vi. It is not always the case that useful variations are selected. Useful variation can develop to such extent that it may lethal for the individual.
- vii. It explained the survival of fittest but not arrival of the fittest.
- viii. This theory did not explain the occurrence of vestigial organs in animals.

#### **3. Neo- Darwinism or Modern Synthetic theory**

Neo- Darwinism is modified form of Darwinism. Darwin and contemporaries were unaware of cytology, molecular biology and genetics which could help to explain the theory of evolution. This information is now available, which is utilized to explain the

process of evolution. At present, the most accepted theory of evolution is put forward which is mainly based on the framework of Darwinism blended with genetics, molecular biology and cytology. It is based on following facts:

### **I. Gene mutation**

Sudden heritable change in a gene due to change of Nitrogen-base sequence is called gene mutation. It is able to change the phenotypes of organism and can produce drastic changes. Most of the mutant genes are recessive to normal genes and only express their characters in homozygous condition.

### **II. Chromosomal mutation/aberration**

The heritable change in structure and number of chromosomes is called chromosomal mutation which caused phenotypic and genotypic variation in an organism. The change in structure of chromosome due to breaking down and reattachment of chromosome or addition of extra chromosome by deletion or duplication or rearrangement is called chromosomal aberration.

### **III. Genetic recombination**

Genetic variation causes by reshuffling or interchanging of genes during sexual reproduction is known as genetic recombination. This causes the production of new genotypes from already existing genes.

### **IV. Genetic drift**

Any alteration in gene frequency of a small size population which are suddenly isolated from the original population by a chance is called genetic drift or Sewell effect. Loss or elimination of genes of certain traits when the population of particular species migrates or dies of natural calamity. This changes the basic characteristics of a species in new generation and such population starts differing from the original population to become distinct stock or different race.

### **V. Natural selection**

Natural selection brings about evolutionary changes by favoring different reproduction of genes and differential reproduction of genes produce change in gene frequency from one generation to the next. Natural selection also creates new adaptive relation between population and environment by favoring some gene combination and rejecting other. This process constantly molds and modifies the gene pool. Hence, it guides the population towards adaptation.

### **VI. Reproductive Isolation**

Isolation of organisms of a species into several groups or population under different physiological or geographical factors is supposed to be most significant reason that responsible for evolution. Geographical factors include high mountains, river, ocean and dessert etc. that prevent the interbreeding between individuals of related or same

species. This helps in maintaining the individuality of species because it does not allow the inter breeding of organisms of different species. This phenomenon is called reproductive isolation. Similarly, migration and hybridization also help to increase the genetic variability to population of a species.

## VII. Speciation

The population of a species present in the different environment which are separated by geographical and physiological barriers, accumulated different genetic variation due to mutation, chromosomal aberration, genetic recombination, genetic drift, hybridization, natural selection etc. Population become different morphologically and genetically from each other. Then, they become reproductively isolated and help in formation of new species is called speciation.

[Note: Theory of Mutation: **Phenotypic variation arise due to Sudden and distinct changes in germplasm or hereditary material (like gene or chromosome) of an organism.** Mutation is two types; gene mutation or point mutation and chromosomal mutation. This process was first discovered by Dutch botanist **Hugo de Vries (1886-1887).**]

### Human evolution

Classification of Human

Phylum- Chordata

Group- Craniata

Sub-phylum- Vertebrata

Division- Gnathostomata

Super class- Tetrapoda

Class- Mammalia

Sub class- Eutheria

Order-Primates

Sub order- Anthropoidea

Infra order- Catarrhini

Super family- Hominoidea

Family- Hominidae

Genus- *Homo*

Species- *sapiens*

Sub species- *sapiens*

## **Human evolution**

The first attempted to explain the origin of man was made by T.H. Huxley in 1863 AD, in his book title "Man's place in Nature". He proposed that man was evolved from Apes. The place of man's origin was supposed to be considered in Central Asia but the fossils of prehuman ancestors have widely been recorded from Asia, Africa and Europe.

### **History of Human evolution**

#### **A. Origin of Anthropoids:**

The anthropoids i.e., ancestors of new world monkey, old world monkey and hominoids were supposed to be evolved from Tarsiers about 36 million years ago. They were intelligent and lead social life. From them, the new world monkeys were evolved little earlier than old world monkeys.

#### **B. *Dryopithecus/Proconsul*:**

About 24 million years ago, ancestor of apes and man was evolved from anthropoids while old world monkey diverged along the separated line. From *Dryopithecus*, apes evolved on two families while family Hominidae which included human evolved little later than apes. The fossil of *Proconsul* or ape man was recorded from early Miocene rock around the Lake of Victoria in East Africa. The fossil of *Dryopithecus* was recorded from rocks of Asia and Africa. It exhibited some characteristics of apes and man.

#### Characters

- It had rounded fore head like man but it possessed large canine teeth like apes
- It was arboreal and used all its limbs for locomotion but its fore limbs were comparatively shorter and weaker than hind limbs.

#### **C. *Ramapithecus*:**

The earliest known direct ancestor of man was Genus *Ramapithecus*. They existed about 14 million years ago and their fossils were found in both Africa and in Northern Siwalik Hill of India. They were supposed to be evolved from *Dryopithecus*. [Fossil of *Ramapithecus* had been found in South western part of Nepal near Dang Valley and believed to be lived about 11 million years ago.]

#### Characters

- They had partially erect body posture.
- They had curved and deep jaw with an arch plate
- They had small sized canine teeth and feeding habit similar to man.

#### **D. *Shivapithecus*:**

The fossil of *Shivapithecus* was similar to *Ramapithecus* and existed about 10 million years ago in Siwalik Hill of India.

### **E. *Australopithecus*:**

*Australopithecus* was first man like ancestor who existed about 5 million years ago in open grassland of Africa. Its fossil was found in South Africa by Reymond Dart in 1924 AD. It had two species; *Australopithecus robustus* that lived about 4 million years ago and *Australopithecus africanus* that lived about 2.5 million years ago.

Characters

- It had erected body posture with bipedal locomotion
- It had small bone about 3.5 to 5 feet tall height.
- It had brain capacity of about 350 to 450 cc resembling to cranial capacity of apes.
- It was Carnivorous in feeding habit
- Simian gap was absent
- It had heavy eyebrow ridge

### **F. *Homo habilis*:**

It was direct ancestor of modern man who existed about 2 million years ago and probably evolved from *Australopithecus africanus*. Its fossil was discovered by R. Leakey in Africa.

Characters

- It had fully erect body posture with bipedal locomotion.
- It had large cranial capacity about 700 cc.
- It had prominent and heavy eye brow ridges with protruded jaws.
- It used stone tools for hunting.
- It had small canine teeth.
- It was carnivorous in feeding habit

### **G. *Homo erectus*:**

It was lived about 1.7 million years ago. It had two species; *Homo erectus erectus* or *Pithecanthropus erectus* and *Homo erectus pekinensis* or *Sinanthropus pekinensis*. The common name of *Pithecanthropus erectus* is Java man and its fossil was found in eastern Java province of Indonesia by Dubois in 1891 AD. The common name of *Sinanthropus pekinensis* is Peking man and its fossil was found in cave near the Peking, central China by W.C. Pie. Java man is considered as next descendant of *Australopithecus*.

Characters

- *Homo erectus* were supposed to be transitional form between the primitive man and wise man
- They believed to migrate Asia and Europe.
- They had cranial capacity about 900 to 1200 cc.

- They possessed small canine teeth
- They were omnivorous in feeding habit.
- They invented and used the fire.
- They progressed with time
- They used stone tools for hunting.
- They had the erect body posture with 5 feet tall height.
- They had heavy eye brow ridges with slanting fore head.

#### **H. *Homo heidelbergensis*:**

Its fossil was found in pit near the Heidelberg of Germany. It lived about 5 lakhs years ago and supposed to be one of descendants of *Homo habilis*. It was later either disappeared or evolved into Neanderthal man. It was not included into direct evolutionary line for modern man.

#### Characters

- It had large and heavy jaws without chin
- Teeth were moderated size and similar to modern man.

#### **I. *Homo sapiens neanderthalensis* (Neanderthal man):**

It is supposed to be primitive form of modern man. Its fossils were discovered in Neander Valley of Germany.

#### Characters

- They lived about 70,000 to 30,000 years ago.
- They extended from Europe to Asia.
- They had cranial capacity as large as the modern man. They had cranial capacity about 1550 cc.
- They had the erect body posture but stooped shoulder and bent knee.
- They were about 5 to 6 feet tall.
- They possessed sloping fore head with heavy eyebrow ridges and long and narrow face.
- They were omnivorous in feeding habit.
- They lived in cave but hut like dwelling.
- They used animal hides as clothes.
- They used fire and exported in making tools and weapons.
- They buried the body of their dead members.
- They disappeared about 30,000 years ago.

#### **VIII. *Homo sapiens fossilis* (Cro-Magnon Man):**

It was appeared about 34,000 years ago. The fossils of this period and onward were identical to skeleton of modern man. *Homo sapiens fossilis* was considered as early form of modern man. The fossil of it was discovered from Cro-Magnon rock of France by Mac Gregory in 1868 AD.

## Characters

- They resembled to modern man in size and appearance.
- They had the erect body posture with bipedal locomotion and about 5 to 6 feet tall
- They had cranial capacity about 1600 cc.
- Teeth were closed together like modern man.
- They were omnivorous in feeding habit.
- They were great hunter and used stone tools, spears, bow and arrow and other weapons.
- They were inhabited in caves of Europe and left behind beautiful pictures of animals that they hunted.
- They had superior intelligent and lived at same time as Neanderthal man that may be caused of their extinction.

### IX. *Homo sapiens sapiens* (Modern man):

Modern man was believed to be evolved from Cro-Magnon man but it has cranial capacity of about 1450 cc. It was distributed about 10,000 years ago after end of Glacial period. They migrated in three directions and spread all over the globe and become dominant species.

- a. Westward migration: Developed into present days White Race or Caucasian people found in Europe, South west Asia and North Africa.
- b. Eastward migration: Developed into present days Mongoloid Race found in China and Siberia.
- c. Southward migration: Developed into present days Negroid race found in India, South Africa and Malaysia.

They changed from cave dwelling and hunting life to crop raising life. They cultivated plants and domesticated the animals. They brought the cultural revolution with their superior intelligence. Modern man passes through the following ages

- Paleolithic age- Age of tools of stones and bones and cave painting.
- Mesolithic age- Age of animal husbandry, development of language, reading and writing
- Neolithic age: Age of development of agriculture, manufacture of pottery and clothes.
- Bronze age- Age of development of bronze and proto-writing.
- Iron age- Age of today.

In due course of time modern man developed into *Homo sapiens futurialis* in future

### Note: Difference between Man and Apes

<b>Apes</b>	<b>Man</b>
1. They are semi arboreal	1. Man is terrestrial.

2. Their fore limbs are longer than hind limbs	2. Hind limbs or legs are more powerful, stout and developed than fore limbs
3. During locomotion, their body posture is slightly bent or semi-erect and take help from their fore limbs	3. During locomotion, body posture is erect and fore limbs are free.
4. Back bone forms simple curving	4. Back bone form 'S' shaped curving
5. Fore head and skull are flat	5. Fore head is large and protruded. The skull is dome shaped
6. The eye brow ridges are heavy and protruded	6. The eye brow ridges are thin and not much protruded
7. The lower jaw is heavy. Teeth are large, chin rounded and not very prominent.	7. The lower jaw is small. Teeth are small, chin flat and prominent.
8. Simian gap presents between incisor and canine teeth	8. Simian gap absents between incisor and canine teeth
9. Head balance on heavy shoulder and found buried	9. Head is erect and balance on neck
10. The neck muscles are attached to the back of the skull, hence the movement of the head on neck is limited.	10. The neck muscles are attached below the skull, hence the movement of head on neck is wide range
11. Both hands and feet are used for grasping things	11. Only hands are grasping types.
12. During the locomotion, soles do not touch the ground, only the outer ridges of hind and fore limbs touch the ground	12. During the locomotion, soles except bridge of feet touch the ground.
13. Cranium or brain box is small. Cranial capacity of Gibbon is 100cc, orangutan is 395, Chimpanzee is 400 cc and Gorilla is 510cc	13. Cranium or brain box is large and cranial capacity is 1400 to 1450cc.
14. Examples, Gibbon, Orangutan, Chimpanzee and Gorilla	14. Example, human, <i>Ramapithecus</i>

### **Homology or Similarities between Apes and Man**

#### **a. Similarity in Chromosomes**

The similarity in number of chromosomes, DNA content and the banding patterns of chromosomes indicates the common ancestry of apes and man. The number of chromosomes is 46 in a diploid cell of man and 48 in diploid cell of apes (gorilla, chimpanzee, and orangutan). The total amount of DNA in a diploid cell of man and apes is almost similar and the banding pattern of human chromosome number 3 and 6 are almost identical with that of similar chromosomes of apes. This clearly suggested that these two have common origin.

### **b. Similarity in Blood Proteins**

By blood protein tests or serological tests, it has been proved that man is closely related with apes than monkeys.

### **c. Similarity in Blood Groups**

Human has four blood groups that is blood group A, B, AB and O. The blood group A and B are also found in apes but not in monkeys. This indicates that human beings are more closely related to apes than monkeys.

### **d. Similarity in Haemoglobin**

There is about 99% of haemoglobins of man and gorilla are similar. This evidence suggested that these two groups are closely related with each other.