

Subject; Anthropology  
class note for - DSC - 1B (CC-2)  
unit - II: Theories of Human Evolution  
By - Dr. Som Prasad Giri

---

## Part III : Evolution

6

### Origin of Life and Evolution

---

Inquisitive thinkers of the ancient time speculated about the origin of life as well as appearance of man on earth. One such speculation, which is as old as human thought, is commonly known as the theory of spontaneous generation of life. It was believed that life originated spontaneously from inorganic components of the environment that existed since the formation of our planet. A series of physico-chemical processes took place and in course of time that produced living organisms from inert non-living matters. Aristotle (384-322 B.C.) observed that a piece of meat left in an open place can produce maggots. Again, frogs can be produced by muddy water. How could these be possible? These must happen spontaneously. Nobody raised any voice against this till the 17th century. But in that century an experiment was done by Francesco Redi (1626-1697) with two pieces of meat. One piece was kept in an open place, while the other piece was fully covered. After several days the two pieces were examined carefully. The first piece produced flies, but the second piece did not produce anything. His conclusion was that flies laid eggs on the uncovered piece of meat and therefore new flies were born. That did not happen in case of the covered piece and hence there were no flies. Thereby he tried to establish that living organisms are not generated spontaneously. On the other hand, Leeuwenhock (1632-1723) observed several microorganisms e.g., protozoa, sperm, fungi, bacteria using his single lens microscope. He believed in spontaneous generation of these microorganisms, which were not seen by anybody earlier. Again, though Louis Pasteur (1822-1895) did not totally discard the theory of spontaneous generation, yet provided ample evidences against this theory by doing several experiments.



In the present time also it is believed that life began spontaneously by chance because of mixing of different elements in varied proportions. The scientists do not know yet how this happened. They are still carrying on different types of experiments. When living organisms were being formed, the environmental condition on the earth was not the same as it is today. The atmospheric components of that time reacted with natural electric discharge, solar energy, volcanic heat and the like, as a result of which different carbon compounds were produced. These compounds are considered to be the basis for the formation of life. Under controlled conditions in the laboratories the scientists have created an atmosphere comparable to that which existed in the time of formation of life to understand how the materials were synthesized to produce substances believed to be the exclusive products of life. Different experiments have given different results and on that basis different views have been expressed as regards materialistic origin of living organisms and also the mechanism involved in this process. Attempts will be continued till the mechanism is fully understood and the scientists become successful in producing living substance in the laboratory.

Some thinkers believed in extra-terrestrial origin of life. Their idea was that the earth received ultra-microscopic germs of life from other planets and those were the basic seeds to produce life. On the other hand, to some others life had no beginning. Life has always existed in our planet.

For our convenience following R.S. Lull we can discuss the theories concerning origin of life and evolution of man under four broad categories, which are as follows : (a) theory of eternity; (b) theory of special creation (creationism); (c) theory of cataclysm or catastrophism and (d) theory of organic evolution.

**Theory of Eternity** : According to this theory universe is unchangable. The organism were there from the very beginning and these will always be there in their original forms. Only a very few men of science gave importance to this view.

**Theory of Special Creation** : According to this theory all kinds of life were created by a supernatural power, which



can be referred to as God, and that these forms of life have not been changed from the time of their creation. The Hebrews and also the Christian Church authorities supported this view for many centuries. To them the world is only a few thousand years old. As regards origin of man, god created Adam and Eve about 6,000 years ago and all human beings are descendants of them. The time of this creation was determined by Augustine (A.D. 354-430). Archbishop Ussher (1581-1656 A.D.) fixed the exact year of creation of man, and that was 4004 B.C. while Lightfoot determined the exact date and that is 23rd October 4004 B.C. The followers of this theory believed that all creations of God are arranged in a scale of Nature or the chain of Being. Man's position is at the top. Next to him come the apes and monkeys. The other animals and also plants are also placed in the scale.

According to the theory of special creation the world was created in six days. The earth was created on the first day. Animal and plant kingdoms were created on the third day. All the creatures that exist in the earth were created by the fifth and sixth days. Father Saurez (1548-1617) strongly advocated this theory.

**Theory of Cataclysm or Catastrophism :** Georges Cuvier (1769-1832), a French scientist proposed this theory. His observation was based on the fossil remains of varied organisms. He believed that the nature of forms of life was never the same, it was changed time to time. The earth experienced natural calamities several times and that destroyed the animal species. One was replaced by another increasingly higher form in terms of complexity of structure every time, when the earth settled after a great catastrophe. He did not believe in continuous evolution. To him contemporary species did not develop by modifications of these found in fossilized forms. According to him, in the first stage there were corals, molluscs and crustaceans. Then emerged the first plants, followed by the fish and reptiles. After that birds and mammals emerged. Finally, man appeared after the last geological revolution and that happened about five or six thousand years ago.

**Theory of Organic Evolution :** In the works of the ancient Roman and Greek philosophers and thinkers indica-



tions of their ideas of a certain continuity of living organisms and even of evolution are found. For example, Thales of Miletus (636-546 B.C.) believed that life originated in water and hence water may be regarded as the mother of life. He thought that man had evolved from fish, which came out of water and then developed to its present form in land. According to Pythagoras (570-496 B.C.) "nothing in the vast universe perishes, rather everything varies and changes shape". Empedocles (490-430 B.C.) considered the fossilized hippopotamus bones found in Sicily to be remains of extinct giants from which in later periods other types of animals developed. Attempt was made to explain the differences in cranial characters of the Persians, Egyptians, Scythians, Greeks, etc., from evolutionary point of view taking into account environmental factor by Herodotus (484-425 B.C.) Hippocrates (460-377 B.C.) also presented certain ideas about some sort of evolutionary mechanism.

Aristotle (384—322 B.C.) wrote, "Nature passes from lifeless objects to animals in an unbroken sequence, interposing between time beings which live and yet are not animals.....There are some animals such as monkeys and cynomorpha, which by reason of their ambiguous nature have both hands and feet, but those feet can be used as hands". His idea is comparable to the general conception of evolution. He believed in certain inborn power of the organisms to adapt themselves to the environment, as a result of which the organisms make progress and develop.

It may be mentioned that in the ancient Hindu religious thoughts also one gets indication of conception of evolution. The best example of it is the ten incarnations (Dash-awatar) of Lord Krishna. The first one is fish (Matshya) and it was believed by the western thinkers also that life originated in water. The next one was Kurma, an amphibian, Baraha represents the land-living animals. Nrishinha tells of a stage of half-man and half-animal. Even now a school of scientists believe that early man was short statured. Bamana, an incarnation of Lord Krishna, represents that type of early man. Ten incarnations tell us about cultural evolution as well. Parasurama had his axe, which is technically inferior to bow and arrow of Rama and therefore, Ram could defeat



Parasuram. This perhaps, could be compared with the food-gathering stage. Then came the food producing stage by domestication of animal (Lord Krishna in his childhood looked after cattle) and agriculture (Plough in the hand of Balarama).

In the Christian era, before Darwin, several scientists and philosophers expressed their respective views as regards evolution. Mention may be made of a few of them. Robert Hooks (1635-1707) gave stress on the study of fossil remains because these reveal the earth's past as well as living organisms. Similar idea was expressed by Leibniz (1646-1716), who said that the fossils could be connected with the living plants and animals. The animals are related to man. According to Edward Tyson (1688-1708) the position of the Pygmy is intermediate between ape and man. His observation was based on the study of comparative anatomy of man, ape and monkey. Maupertius (1698-1759) suggested a general theory of evolution. He was interested in the study of inheritance. He observed that hereditary materials are some sort of particles and are transmitted from the families of both the parents, which however could be changed by environmental effect. He considered the role of isolation and natural selection in evolution. Though some people want to give him credit as the first to propose the theory of evolution, yet it must be admitted that his thoughts did not get due recognition. Buffon (1707-1788) also failed to receive proper appreciation of the thinkers, though he pointed out that from one species another can develop, survival depends on adaptability, within a species change can take place and the like.

In this context the name of the classic work 'Systema Naturae' by Carl Linnaeus (1707-1778) in which a system of classification of the plants and animals, known as taxonomy was included. He placed man in the order of Primate along with apes and monkeys. He, however, did not suggest common ancestry of them. At first he held the view that each species was created specially and separately and species are unchangeable. Thus, his view may be regarded as a combination of the old beliefs and new thoughts.

Monboddo (1714-1790) also gave thought on the origin of the species and traced the evolution of man starting with monkeys. Bonnet (1720-1793) proposed a 'scale of beings' in



a continuous ascending order starting with minerals and ending with man. Goethe (1749-1832) expressed his view on evolution so convincingly that according to some he may be regarded as a predecessor of Darwin. Immanuel Kant (1724-1804) believed that man descended from the monkey. The contribution of Erasmus Darwin (1731-1802), Schopenhauer (1788-1860), Karl von Baer (1792-1876), Charles Lyell (1797-1875), etc., in understanding evolution can not be ignored. Again, the works of Malthus (1766-1834) influenced Darwin in formulating his theory of natural selection.

### LAMARCKISM

The theory of evolution put forwarded by Jean Baptiste Lamarck (1744-1829), commonly known as Lamarckism, mainly centres round the inheritance of acquired characters. Characters are acquired by use and disuse of different organs and evolution is the result of adoption of organisms to the environment. He wrote, ".....so does nature by means of heat, light, electricity and humidity, achieve the spontaneous or direct generation of organisms which exist at the beginning of both kingdoms, animal and vegetal, where their most simple forms are to be found". This indicates that he was in favour of spontaneous generation of life.

Lamarck's theory can be summarized in the following manner :

(1) As per need under different environmental conditions organism as a whole, or a part of it tend to change due to some internal forces.

(2) Organs are modified or new rudimentary organs are formed because of varied nature of use and disuse of the same. Continued use helps the organ to develop fully, while disused part starts diminishing until it finally disappears.

(3) The modified characters, thus acquired during the life time of an individual are inherited by the offspring.

Lamarck cited several examples in support of his theory. According to him originally the modern giraffes had short necks. They lived on grass and leaves of short trees. But when that type of food became scarce, the giraffes had to stretch their necks to reach leaves of tall trees. With the gradual stretching the necks were modified and became longer



and longer which helped them to adapt to the environment for their survival. The modified trait passed along from generation to generation and now the modern giraffes have very long necks. Those birds which started to live in an aquatic environment gradually acquired webbed feet for their survival. This character became hereditary. The ducks became unable to fly because they stopped using wings for flying and as a result the wings became weak. A kind of fish, called cave fish, lived for quite a long time in dark and that habit made them blind. Many examples like these could be given. The presence of certain rudimentary organs can also be explained according to this sort of principle advocated by Lamarck.

Lamarck applied the same thesis in case of human evolution as well. He wrote, "let us assume that a certain quadrumanous race which was highly perfected should lose the habit, acquired through environmental necessity or by any other cause, of climbing trees and grasping the branches with the feet as well as with the hands. If the individuals of this race, for a series of generations, should be obliged to use their feet exclusively for walking purposes and should cease to use their hands as feet, such quadrumana would undoubtedly be transformed eventually into bimana and their toe would no longer be separated or opposable since their feet would only be utilized for walking".

Lamarck's theory has been criticized by several scholars from different angles. Many scientists are not prepared to accept his theory, while others have accepted some of his views but rejected others. Whatever that might be, Lamarck deserves appreciation for opening new avenues of thought.

Lamarck gave emphasis on the accumulative inheritance of acquired characters and effect of environment or changed habit on the organism producing variations. But examples are there to contradict his idea of influence of environment in the inheritance of characters. There are some insects like worker bees, ants and wasps which do not procreate, because they are neuter and hence can not transmit changes. But they adopt themselves to the environment and their living condition. Again, the exoskeleton of some higher insects are so rigidly formed that it is impossible for environment or living conditions to change that external structure.



However, the teeth of mammals could be changed by a gradual wearing away. But that does not necessarily mean that that could modify the number of cusps.

Another example could be cited. In an experiment a certain variety of fly was bred in complete darkness for about sixty generations. Yet it had no effect upon their vision. This contradicts the loss of eye sight in cave-dwelling animals, mentioned above.

~~A~~ There is a school of thought called NEO-LAMARCKISM. The neo-lamarckians argue that time was not that sufficient to produce effect of external factors. But to them it may be pointed out that if the external factors do not influence the reproductive cells of the parents, their descendants will never inherit any modification. In the twentieth century science of genetics made a rapid progress and the findings do not give evidence to support Lamarckism as well as neo-Lamarckism.

**Uniformitarianism** : Charles Lyell (1797-1837) in his work 'Principles of Geology' presented a theory, known as Uniformitarianism. He did not accept the view of an unchanging earth. On the other hand, by studying rock layers and geological processes, he arrived at the conclusion that since the beginning of time some forces were operating to shape and reshape the earth. Fossil evidences give support to Lyell's view while those discredit catastrophism. Lyell did not accept the idea of Divine creation.

### DARWINISM

The theory of evolution proposed by Charles Darwin (1809-1882) is commonly known as Darwinism. With adequate evidences Darwin proved that species evolved from previously existing species; that means evolution had taken place. Secondly, he explained the mechanism of evolution presenting a theory, known as theory of natural selection. During his voyage (1831-1839) around the world aboard H.M.S. Beagle he not only observed events but also collected materials of varied natures on the basis of which he developed his theory of evolution.

In Brazil he marked that certain animal species of the southern part were slightly different from those of the northern part. The differences were so small that they did not form



different species, but could be called local variants. In Argentina he found fossils of huge creatures, the features of which resembled those of the living armadillos of that region. From this and other similar evidences he arrived at the conclusion that new species evolved from older species and therefore, both had some common characteristics. At a distance of about 900 kilometres west of Ecuador lies the Galapagos archipelago, from where he collected specimens of plants, animals, insects and reptiles. But the most important thing to which his attention was drawn that the finches inhabiting the islands differed greatly in the structure of their beaks. Some had stout beaks, others had small beaks; in some the beaks were straight, in others those were parrot like. Slender beaks were suited for eating small insects, large were for eating large seeds, while to the parrotlike for eating fruits, buds, etc. As regards slight differences among certain animal species in Brazil as well as in other places, Darwin thought that those were perhaps because of variation in climate and natural surroundings. But in the islands of the Galapagos archipelago, there was no climatic variation and the other natural conditions were more or less the same. How to account for this variation? At that time he had no answer.

Darwin had to work for about twenty years after his return from the voyage to develop his idea of evolution and also the mechanism involved in the process of evolution. During that period he observed more facts, collected more information and studied those from various angles. His studies on domesticated plants and animals gave him some clues. He observed that to get the desired type of pigeons; the breeders allowed mating among the selected pigeons only, and thereby they developed a new strain, which had demand in the market. By this process the breeders gradually eliminated the undesired type and increased the number of the new variety, which after several generations showed variation from the ancestral form. Darwin gave a serious thought on it. If the breeders of pigeons could develop a new variety, then why not the nature could bring more remarkable changes. Long continued process through different geological periods will be more effective. This led him to conclude that in domesticated as well as in natural populations individual variation occurred,



and that variation ultimately caused evolutionary changes. In the case of pigeons the selection was done artificially by the breeders, whereas in the case of natural populations some natural selective forces encouraged certain members of a species to reproduce more and discouraged others to do the same. This is what is called natural selection.

Darwin was highly impressed by the writings of an economist, Thomas Malthus (1766-1834), more particularly by his "Essay on Population" where he foresaw a "struggle for existence" among future humans, because of their ever growing numbers with a limited food supply. Darwin applied this principle to nonhuman populations. He observed that in natural condition most organisms tend to increase their numbers. Because every breeding pair did not reproduce only two to replace them, but many more. However, all the offspring did not survive. Some were killed by predators, some died because of inborn fatal disorders, some could not survive till the time of reproduction because of their inability to procure food in the world of competition, where resources were limited, and the like. He noted that in each generation the number of those who were better-adapted slightly increased, because of selective pressure. Individuals with unfavourable characteristics were gradually eliminated and they were replaced by favoured individuals. The favourable traits were passed on gradually from generation to generation. After several generations those favourable traits became the common characteristics of the surviving individuals. This process produce major evolutionary changes.

Darwin put his findings in the form of theories in his monumental work "On the Origin of Species" published in 1859. Another naturalist Alfred Wallace (1823-1913) who worked in Malay archipelago, also independently arrived at more or less the same conclusion and developed his own theory, which he communicated to Darwin in 1858. At the instance of Charles Lyell and Joseph Hooker the works of Darwin and Wallace were jointly placed in the meeting of the Linnean Society of London, held on 1st July 1859 for consideration of the learned members of the Society. The society noted discovery of both the authors and was convinced that both developed the concept of evolution independently.



that the primrose plants of a garden were not of equal height. The branches were of different formations. The same was true in case of flowers and leaves. From 1886 to 1888 he observed many more different characters of primrose. Some plants survived for two years, others for three years. Then he noted appearance of a new type of primrose different from the existing variety. That means a new type evolved. That encouraged him to carry on different experiments. He came to certain conclusions, which may be summarized as follows :

A new characteristics may suddenly evolve spontaneously without passing through an intermediate form. The new one is evolved from an earlier form. The new characteristic immediately becomes permanent. In this way any new form may develop from the old one. This phenomenon is called mutation. The new trait passes from one generation to another. As a result a new type of organism may evolve.

For example, it is said that O blood group of humans was the original one. As a result of mutation A and B blood groups evolved from O group. However, some believe that B is a mutant form of A, which evolved from O.

**Synthetic Theory or Neo-Darwinian Theory** : Darwin talked about variation among individuals of the same species and natural selection of the best-adapted individuals that form the population. But he could not explain how variation occurs, what are the forces behind it. Further, his idea of inheritance was not very clear.

The first question was answered by the mutation theory of Hugo de Vries. It is said that mutation provides the raw materials for evolution and it is the source of all variations. As regard inheritance Mendel's Laws explain the basic processes. There was difference between Darwin and Mendel in respect of the unit of study, which to the Darwinian school of evolution is the whole population, while Merdelian geneticists put more weight on the individuals. This conflict continued upto the early 1930s, when population genetics opened a new dimension. The scientists shifted their emphasis to the population and that population is an interbreeding group, having relatively smaller number of individuals and the members of the group are exposed to the same environment.



This sort of population is now known as the Mendelian population. A population shares a common gene pool. Biologists with the help of modern statistical methods and experiments started working on such a population to understand the evolutionary processes involved in that population and the effects of those processes. On the basis of their findings population geneticists developed the idea that evolution is a change in gene frequencies in the gene pool of a population over certain time period. Through the process of natural selection the frequency of advantageous genes increases and these survive in a given environment to reproduce. It could be said that at present this is the modern concept of evolution. This theory is called the synthetic theory of evolution, because in this theory the basic concepts of natural selection theory, Mendelism, mutation theory and population genetics have been synthesized. This is also called the Neo-Darwinian theory as the theory of natural selection of Darwin has been developed giving it a new dimension incorporating the basic ideas of the other theories, more particularly that of population genetics. In recent years population genetics has established the mechanism by which most differences between natural populations are inherited through multiple factors or polygenic inheritance. This has minimized the effects of mutation. Further, it has shown that the selective value of any single gene is influenced by other genes with which it is associated. Population geneticists drew attention to the extremely complex inter-actions between an organism and the environment under which it lives. That means, natural selection is not a simple process as it was thought earlier.

Thus, from the middle of the 20th century the approach to the study of physical anthropology was changed. The change was brought mainly by the synthetic theory of evolution. Physical anthropology was mainly descriptive in nature till that time. The new physical anthropology started developing with the attempt to study the mechanism of human evolution.

### **Evidences for Evolution of Man**

Darwin did not accept the view that each species was independently created. According to him species evolved through changes. This principle is applicable to man as well. That means man has descended from nonhuman ancestors.



Some more primitive forms were the common ancestors of man and apes. Darwin wrote that that common ancestor was "a hairy, tailed quadruped, probably arboreal in habits." The common ancestor again evolved from earlier forms of organisms. In support of this whole evolutionary scheme there must be some evidences. Let us examine those evidences of evolution.

**Anatomy** : The study of comparative anatomy provides evidences in support of human evolution. The anatomy of vertebrates, mammals, primates and apes are in that order of increasingly similar to the anatomy of man. As regards anatomy of monkeys, apes and man, Dobzhansky has observed that "every bone of the human skeleton is represented by a corresponding bone in the skeleton of apes and monkeys". In structures also similarities are there (Fig. 6.1). Detailed information on the anatomy of man and his closest relatives, the living primates will be available in chapter 3. It may be noted that all the vertebrates, which include birds, fishes, amphibians and mammals have a heart, liver, urinary system and nervous system.

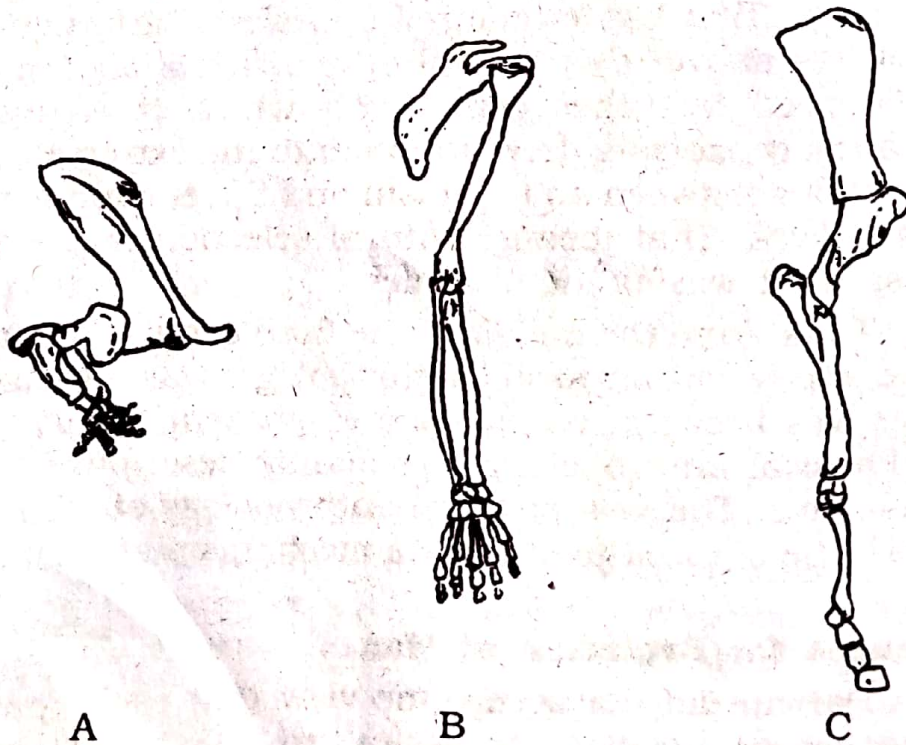


Fig. 6.1. Bones of Upper Limb of (A) Amphibian (B) Man, and (C) Horse



**Embryology** : Embryology is another source of evidence to support evolution. Embryos of different animals very closely resemble each other at their early stage. One is not easily distinguishable from another at that stage. Differentiation starts only when they start to mature. This phenomenon is known as Baer's Law. The embryos of different animals start developing to take different forms as per the animals. Following Ernest von Haeckel this may be described as the ontogeny (individual development of a given embryo) is governed by its phylogeny (that is, the evolutionary development of the species to which the embryo belongs). For example, the embryo of fish and also that of man at their early stages have similar gill arches. In case of fish it develops to gills through which fishes breathe, while in man that arch eventually changes and develops to certain features useful to man. This gives evidence that at a very distant past ancestor of man had gills. The presence of gill arches in the human embryo simply repeats an ancestral form of life.

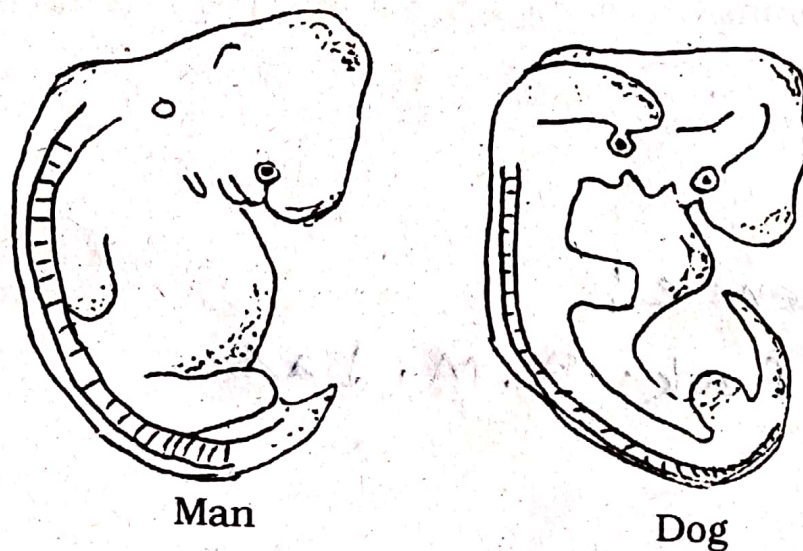


Fig. 6.2. Embryo : Man and Dog

**Vestiges** : Vestiges are useless rudimentary organs or structures present in living organisms. This type of organ supplies another evidence for evolutionary development. For example, at the lower end of the vertebral column of man, there are small round masses of bone; that could be regarded as the vestigial remains of tail bones. In other words, this indicates that at one time the ancestral line of man had tails.



**Fossil remains** : Fossil remains of various species provide very reliable evidence for evolution. Fossil remains of man and his near relatives have been described in chapter 9 and 10.

**Physiology, Biochemistry and Genetics** : In recent years several works have been done on physiology, biochemistry and genetics and the findings reinforced the relationship of man with other animals, which provide evidence for evolutionary development. Man and several other animals have similar body functions, which are performed in similar manners. Some of these are reproduction, digestion, respiration etc. The studies on blood chemistry reveal that the reaction between antiserum and blood serum of man and that with blood of an ape is similar. But when the same test is done, taking blood of monkey instead of an ape, the results are less alike, indicating that man is more closely related to apes than to monkeys. In this way several experiments have been done taking into consideration some other biochemical materials to ascertain the position of man in relation to other higher primates, or in other words to trace the evolutionary line.

Reference:

Book: B. M. Das

□ □ □