

Note: Types of fossils

S.N.	Types of fossils	Formation process	Examples
1.	Entire organism or Intact fossils	Entire organism frozen into ice during Glaciation or encased into hardened resin of tree (Amber fossil) or tar.	Woolly mammoth and Insect exoskeleton found in Oligocene rock.
2.	Hard skeletal materials fossils	Hard materials or organisms were trapped in the sedimentary rock	Bones, shell and teeth
3.	Molds and Casts	Hard materials were trapped in sedimentary sand and clays that harden to form rock. The skeleton dissolves 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 sedimentary rock 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 that were rapidly baked and 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.

1. Evidence from Embryology

Embryology deals with study of early developmental stages of living beings before attainment of structure and size of offspring. Comparative embryological study of different animals shows that developmental stages of embryos of different lower and higher animals are more similar than their adult forms. This similarities of various early stages in development supported that they are evolved from common ancestor but adaptations to different environmental conditions and mode of life would modify the later stages of developmental processes. For examples,

a. Similarity in early embryonic Development in Triploblastic animals

All the triploblastic animals (Platyhelminthes to Mammals), zygotes undergo similar early developmental processes like cleavage, morulation, blastulation and gastrulation etc. Later, double layered gastrula develops the third germinal layer and from three germinal layers develop the body of entire organism. This similarities in early stages of embryonic development indicates that they are evolved from common ancestor.

b. Similarity in Development in Vertebrate Embryos

The comparative study of embryonic development stages of different vertebrate animals like fish, amphibia, reptile, bird and man show that the embryo of these animals possess **paired internal pharyngeal gill pouches, mid-dorsal stiff rod like notochord and simple tubular two chambered heart and similar arrangement of blood vessels** etc. The paired internal gill pouches joined up in adult fish to form the gill slits, involving in respiration. While in others, only perforation is developed. The notochord is replaced by vertebral column in adult stage of all vertebrates. During development of heart, it is two chambered and tubular shaped. Later in adult stage, it becomes two chambered in fish, three chambered in amphibia and reptile and four chambered in bird and man. This similarities in early stages of embryonic development indicates that they are evolved from common ancestor.

Note:

A. Van Baer principle or Recapitulation principle

This concept was given by Van Baer. It stated that **‘the development stages of an organism are similar to the developmental stages of its ancestors’**.

B. Biogenetic law

This concept was given by Ernst Haeckel in 1868 AD. It is modified form of Van Baer’s principle. It is stated that **“Every organism in its development repeats its evolutionary history” or “Ontogeny recapitulates the Phylogeny”**. Ontogeny means the study of the developmental stages of an organism and phylogeny means study of the characteristics present in the ancestor of an organism. During development of an organism, it passed through the stages present in its ancestor. For example, zygote stage of embryo of man represents the unicellular form of ancestor, the gastrula stage represents the diploblastic form of ancestor and embryonic stage with pharyngeal gill clefts and fish like vascular system represents fish like ancestor and so on.

2. 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 evolved 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 the 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

Serum is a plasma that lack blood cells and fibrinogen etc. The study of serum is called Serology. When the serum of an animal is injected to the tested animal, then the protein molecules present in serum act as antigens if they are absent in the blood stream of tested animal. The antigens stimulate the production of antibodies in tested animal's body. As a result, antigen-antibody reaction takes place, forming white precipitate. This reaction is called precipitation test or serological test and the precipitate is called precipitin. The amount of precipitin produces is depended upon the degree of recognition of antigens in the serum by the body of tested animal. If the large amount of precipitin is formed with diluted serum of one animal against the tested animal, they have close relationship. If the less amount of precipitin is formed with concentrated serum of one animal against the tested animal, 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.

3. Evidence from Genetics

Genetics is branch of biology which deals with variations and heredity of organism. The hereditary variation in an organism is brought by mutation and recombination of genetic materials like DNAs and genes. Recombination after hybridization yield new combination of genes. This all process creates the new genetic material which cause the evolution of new species from common ancestral stock.

Classification of Human:

Phylum- Chordata

Group- Craniata

Sub-phylum- Vertebrata

Division- Gnathostomata

Super class- Tetrapoda

Class- Mammalia

Sub class- Eutheria

Order-Primates

Sub order- Anthropeidea

Infra order- Catarrhini

Super family- Hominoidea

Family- Hominidae

Genus- *Homo*

Species- *sapiens*

Sub species- *sapiens*

Human evolution

From where and how man come to this earth is a question that remain unsolved by scientists for many years. The first attempted to explain the origin of man was made by T.H. Huxley in 1863 AD in his book “Man’s place in Nature”. He proposed that man was evolved from Apes.

A. Origin of Anthropoids

The anthropoid is the ancestors of new world monkey, old world monkey, apes and human. It was supposed to be evolved from Tarsiers about 36 million years ago. It was

intelligent and lead social life. From it, the new world monkeys were evolved little earlier than old world monkeys.

B. Origin of *Dryopithecus/Proconsul*

Dryopithecus is an ancestor of apes and human. It was evolved from anthropoids and existed about 24 million years ago, while old world monkey diverged along the separated line. From *Dryopithecus*, apes were evolved little earlier than human. The fossil of *Proconsul* (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.

Characters

- It had characteristics of both apes and man
- 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 Northern Siwalik Hill of India. They were supposed to be evolved from *Dryopithecus*.

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.

[Note: 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.]

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;

- a. *Australopithecus robustus* that lived about 4 million years ago
- b. *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;

- a. Java man (*Homo erectus erectus* or *Pithecanthropus erectus*)
- b. Peking man (*Homo erectus pekinensis* or *Sinanthropus pekinensis*)

Fossil of Java man was found in eastern Java province of Indonesia by Dubois in 1891 AD and fossil of Peking man 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 was 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.

a. *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.

b. *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.

A. *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.

B. *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 had cultivated plants and domesticated the animals. They brought the cultural revolution with their superior intelligence. Modern man passes through the following ages

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

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

Note:

Difference between New World Monkey and Old-World Monkey

New World Monkeys (Platyrrhini)	Old World Monkeys (Catarrhini)
1. They are native of South America.	1. They are native of Asia and Africa.
2. They have flat noses with widely separated and outwardly directed nostrils.	2. They have narrow noses with closely placed and downwardly directed nostrils.
3. They possess long prehensile tails.	3. They possess short and non-prehensile tails.
4. Their limbs are not used for grasping.	4. Their limbs are well adapted for grasping.
5. They have less developed brain and low cranial capacity.	5. They have better developed brain and higher cranial capacity.
6. They have primitive dentition. They consist of 3 premolars and 3 molars in each half of jaw.	6. They have dentition like man. They consist of 2 premolars and 3 molars in each half of jaw.
7. They have 3 cusps in molar tooth	7. They have 4 or 5 cusps in molar tooth
8. Examples; Marmosets, Spider monkeys.	8. Example; baboon, Proboscis monkey, Rhesus monkey.

Difference between Man and Apes

Apes	Man
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. Cranium or brain box is small. Cranial capacity of Gibbon is 100cc, orangutan is 395, Chimpanzee is 400 cc and Gorilla is 510cc	12. Cranium or brain box is large and cranial capacity is 1400 to 1450cc.
13. Examples, Gibbon, Orangutan, Chimpanzee and Gorilla	13. 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.