



Knowledge Cloud

- *Zosterophyllum* is a genus of vascular land plants which diverged from Tracheophytes in the Silurian Period. These were dominant in Silurian and Devonian Period.
- The lycopods (arborescent and herbaceous) are the tracheophytes which originated from *Zosterophyllum* genus. The lycopods are the oldest extant (living) vascular land plants. It is clear from the sketch that the arborescent lycopods were dominant during Paleozoic era but most of them became extinct by the end of Paleozoic era.
- Like *Zosterophyllum*, *Rhynia* is also a genus of vascular land plants. *Rhynia*-like plants gave rise to other genus *Psilophyton*. *Rhynia* genus has got extinct from the earth.
- *Psilophyton* is a genus of extinct vascular land plants of Devonian period and is thought to be a part of the group from which modern ferns and seed plants (gymnosperms and angiosperms) evolved.
- The angiosperms (flowering plants), *i.e.*, dicots and monocots are the dominating land plants in the present era.

(b) Origin and Evolution of Animals

- As we discussed in the beginning that the first cell appeared about 2000 million years ago (mya) on earth. Some of these cells had the ability to release O_2 . The reaction could have been similar to the light reaction in photosynthesis where water is split with the help of solar energy captured and channelised by appropriate light harvesting complexes. These cellular forms which evolved O_2 on early earth, in a way, performed light reaction of photosynthesis.
- Slowly these single-celled organisms became multicellular life forms and gradually evolved from less developed to more developed organisms.
- Life began in water and slowly life forms invaded the earth but the first organisms that invaded earth were plants.
- **Evolution of invertebrates** : Invertebrates (lower animals) evolved around 500 mya and became active during that period. They are still existing on earth but some forms have become extinct.
- **Evolution of fishes** : The jawless fishes (Agnatha) probably evolved around 350 mya. There were some **jaw-bearing fishes** which had strong and stout fins with the help of which they could move on land and go back to water. These were a type of bony fishes and they also evolved around 350 mya. These were called lobefins and were thought to be extinct but in 1938 in South Africa, a fish was caught which was found to be a lobefin (Coelacanth).

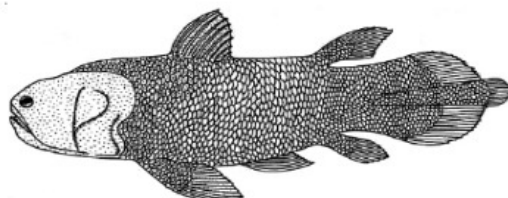


Fig.: *Latimeria* (Coelacanth)

- **Evolution of first amphibians** : These lobefins are thought to be evolved into the first amphibians. The amphibians are the organisms that can live on both land and water. First amphibians have now become extinct and there are no specimens of these left with us. However, they evolved into the modern day amphibians, *i.e.*, modern day frogs and salamanders.

- **Evolution of reptiles** : Reptiles lay thick shelled eggs which do not dry up in sun unlike of amphibians. The amphibians evolved into the reptiles, many of which have become extinct from the earth, e.g., dinosaurs. Modern day descendents of reptiles are turtles, tortoises and crocodiles which are living. As we know that, **reptiles were the first true land inhabiting animals** but probably 200 mya, some of the land reptiles went back into the water and evolved into **fish-like reptiles**. Example of fish-like reptile is *Ichthyosaur*. At that time, dominating land reptiles were dinosaurs and the biggest dinosaur was about 20 feet in height. It was called *Tyrannosaurus rex* which had huge fearsome dagger-like teeth.

About 200 mya, giant ferns (pteridophytes) were present but they fell to form coal deposits slowly.

Extinction of dinosaurs : About 65 mya, dinosaurs suddenly disappeared from earth and various reasons were given for their extinction although true reason is not known. Some say that the climatic conditions of that time killed them and others say that most of them evolved into modern birds. The truth may lie in between. Small sized reptiles of that era still exist today.

- **Evolution of mammals** : The mammals evolved from reptiles and first mammals were small-sized, like shrews. They have become extinct from earth their fossils are small sized. After the extinction of major land reptiles (*i.e.*, dinosaurs), mammals dominated the earth. It is supposed that all the continents that we see today like Asia, Africa, etc., were earlier together as a single landmass but due to certain geological changes like movements of crustal plates below the surface of earth, this single large landmass called '**pangaea**' got broken into pieces. And due to coming of oceans between these pieces, they got separated. This resulted in the **continental drift**. Due to this continental drift, when South America joined North America, the mammals of South America that resembled horse, hippopotamus, bear, rabbit, etc. were overridden by the animals of North America.
- One more effect of continental drift was seen in Australia. As Australia got separated from the other continents, its pouched mammals (marsupials) prevented from facing any threat or competition from the mammals of other continents and hence, they survived and diversified on the Australian land better.
- Some mammals live wholly in water like whales, dolphins, seals and sea cows. Evolution of horse, elephant, dog, etc., are special stories of evolution. You will learn about these in higher classes. The most successful story is the evolution of man which you will learn in this chapter. But before studying this, let us have a look at the rough sketch of evolution of vertebrates.



Knowledge Cloud

- Pelycosaurs and Therapsids are the synapsids which have become extinct from earth. The therapsids were the most advanced synapsids that include the ancestors of mammals.
- The Thecodonts are the sauropsids. The Thecodonts got extinct but they gave rise to many animals. Thecodonts gave rise to crocodiles, dinosaurs and modern birds. Other sauropsids were ancestors of Turtles, Lizards, Snakes and Tuataras (all reptiles).
- We can see that the reptiles **Synapsids** and **Sauropsids** evolved into the modern day reptiles, birds and mammals. Hence, modern day reptiles, birds and mammals all originated from the **early reptiles**.

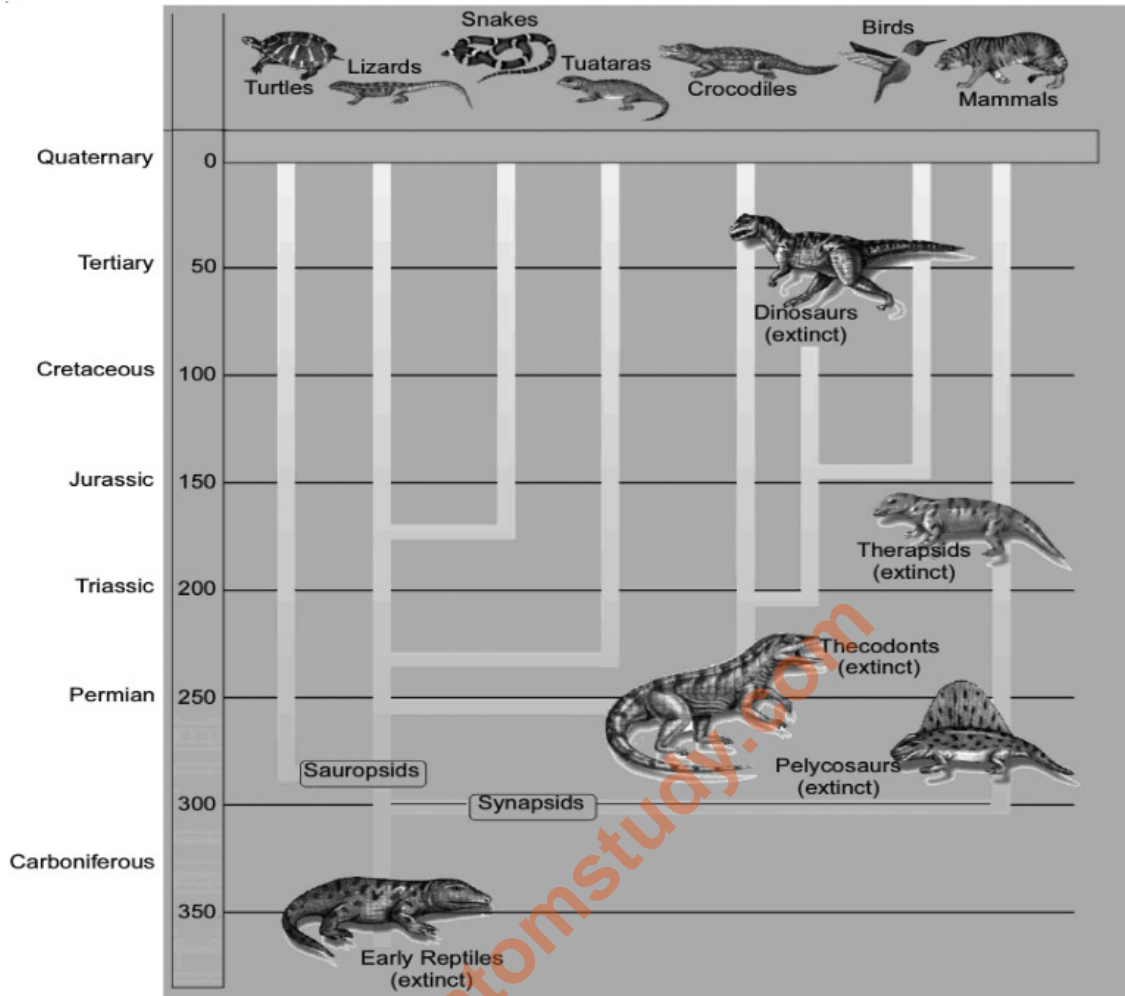


Fig. : A rough sketch representing evolutionary history of vertebrates through geological periods

Example 12 : What do you know about the origin of *Ichthyosaurs*?

Solutions : Probably 200 million years ago (mya), some of the land reptiles went back to the water and evolved into *Ichthyosaurs*. The *Ichthyosaurs* were the fish-like reptiles.

Try Yourself

28. Due to continental drift, the South American mammals were overridden by
- | | |
|---------------------------|--------------------------|
| (1) Australian marsupials | (2) Sauropsids |
| (3) Synapsids | (4) North American fauna |
29. *Ichthyosaurs* evolved around
- | | |
|-------------|-------------|
| (1) 200 mya | (2) 350 mya |
| (3) 500 mya | (4) 600 mya |

EXERCISE

51. Sexually interbreeding or potentially interbreeding group of individuals which is reproductively isolated from other species is
- (1) Biological species (2) Morphospecies
(3) Evolutionary species (4) Sibling species
52. Mule is a product of
- (1) Mutation (2) Inbreeding
(3) Cross-breeding (4) Interspecific hybridisation
53. Speciation in geographically separated region forms
- (1) Sibling species (2) Allopatric species
(3) Sympatric species (4) Paraspecies
54. Reproductive isolation is
- (1) Inability to interbreed in natural populations (2) Ability to interbreed in natural populations
(3) Breeding in isolation (4) Intraspecific breeding
55. Sympatric speciation is caused by
- (1) Genetic isolation (2) Interbreeding
(3) Geographical isolation (4) Reproductive isolation
56. In which of the following barriers to hybridisation, "Breeding seasons or flowering time may be different in the two species"?
- (1) Ecological isolation (2) Temporal isolation
(3) Behavioral isolation (4) Gametic isolation
57. In plants, embryos arising from interspecific crosses abort, due to
- (1) Hybrid inviability (2) Hybrid sterility
(3) Hybrid breakdown (4) Gametic isolation
58. The offsprings of hybrids are inviable or infertile in
- (1) Hybrid inviability (2) Hybrid breakdown
(3) Hybrid sterility (4) Post zygotic barrier
59. Closely related, morphologically similar reproductively isolated, sympatric populations are called as
- (1) Clones (2) Demes
(3) Sibling species (4) Biological species
60. Which is most important for speciation?
- (1) Ecological isolation (2) Reproductive isolation
(3) Temporal isolation (4) Behavioural isolation

(c) Origin and Evolution of Man

Man is the most successful and dominating animal on the planet earth. He developed the skill of language and several developments in the world are the result of his thoughts and experiments.

Man is the only organism on the earth who himself collected evidences of his origin and evolution.

Human evolution is generally studied with the evolution of apes as they are closely related to man than any other animal. In human evolution, we specially study:

The origin and evolution of man can be studied in the following three major headings : **A. Prior to Ape Men, B. Ape Men including Prehistoric men and C. True Men including the Living Modern Man.**

A. Prior to Ape Men**1. *Dryopithecus*.**

Discovery : The fossil of *Dryopithecus africanus* was discovered from Miocene rocks of Africa and Europe. It lived about 15 million years ago. ***Dryopithecus* and *Ramapithecus* were hairy and walked like gorillas and chimpanzees. *Ramapithecus* was more man like while *Dryopithecus* was more ape like.** *Dryopithecus* is the direct ancestor of modern day apes.

Characteristics : It was ape-like, but had arms and legs of the same length. Heels in its feet indicate its semierect posture. It had large brain, a large muzzle and large canines. It was without brow ridges. It was arboreal, knuckle-walker and ate soft fruits and leaves. *Dryopithecus africanus* is regarded a *common ancestor of man and apes* (gibbons, orangutan, chimpanzee and gorilla). It is also called proconsul.

2. *Proconsul*.

Discovery : *Proconsul africanus* or *D. africanus* was discovered by **Louis S.B. Leakey** in 1948 from the rocks around lake Victoria of Kenya, Africa. It lived in early Miocene epoch.

Characteristics : It was morphologically intermediate between apes and man in many features. It had rounded man-like forehead and long, pointed ape like canines. It moved upon land on all the four limbs and hence is not considered amongst the direct ancestors of man. *Proconsul* gave rise to the ancestors of chimpanzee and gorilla in the Pliocene, about 4 million years ago. The chimpanzee and gorilla diverged from each other only about 2.3 million years ago, in the Pleistocene epoch.

3. *Sivapithecus*.

Discovery : This fossil was discovered from middle and late Pliocene rocks of **Shivalik Hills of India**, hence it is named *Shivapithecus*.

Characteristics : It was like *Dryopithecus*. Its fore limbs, skull and brain were like those of monkeys, while the face, jaws and teeth resembled those of apes.

4. *Ramapithecus*.

Discovery : It has been established that in late Miocene epoch, *Dryopithecus* gave rise to *Ramapithecus* ('Rama' = The hero of Indian legend, *Pithecus* = Ape) which was on the direct line of human evolution. *Ramapithecus* survived from late Miocene to Pliocene. Thus, he appeared about 14-15 million years ago. Fossil of *Ramapithecus* was discovered by **Edward Lewis** (1932) from Pliocene rocks of Shivalik Hills of India.

Kenyapithecus wickeri was discovered by **L.S.B. Leakey** (1962) from Pliocene rocks of Kenya (Africa). It was similar to *Ramapithecus*. But *Ramapithecus* was older than *Kenyapithecus*.

B. Ape-men Including Prehistoric Men**1. *Australopithecus* (First Ape-man) :** The early human stock gave rise to *Australopithecus*. It is the connecting link between apes and man.

Discovery. **Raymond Dart** (1924), South African anthropologist, discovered the fossil of *Australopithecus africanus* (**African Ape-man**) from Pliocene rocks near **Tuang** in Africa. They appeared about 5 million years ago. Actually skull discovered by Dart was of 5-6 year old baby so it is also called "**Tuang baby**". Some fossils of *A. africanus* were also discovered from Pleistocene epoch. **Two mya, Australopithecines probably lived in east African grasslands. Evidence shows they hunted with stone weapons** but essentially ate fruits.

Characteristics : *Australopithecus africanus* was about 1.5 metres high and had human as well as ape characters. It was with bipedal locomotion, omnivorous diet and had erect posture. It had human like teeth, but it had more of an ape brain than a human brain. Its brain capacity was about 500 cc., similar to that of an ape. He lived in caves. Brow ridges projected over the eyes. It did not have chin. There was lumbar curve in the vertebral column. The pelvis was broad. *Australopithecus africanus* existed until about 1.5 million years ago and gave rise to *Homo habilis*, about two million years ago.

Australopithecus africanus also gave rise to man-like apes called *Australopithecus robustus* and *Australopithecus boisei* along a separate line that ended blindly (They did not give rise to any other creatures).

In 1981 **Donald Johanson**, found a 3.2 million years old skeleton of a female human ancestor. He nicknamed it **Lucy**. Lucy's scientific name is *Australopithecus afarensis*.

Six species of *Australopithecus* are known. These are *A. africanus* (African Ape man, Southern Ape or Tuang baby), *A. afarensis*, (**Lucy**), *A. ramidus*, *A. aethiopicus*, *A. robustus* and *A. boisei*. **So we can say that Australopithecus had two main types.**

- (i) **Gracile type** : *Australopithecus afarensis* (Johanson) represented by fossil Lucy with small brain, small molar teeth pelvic girdles and short fingers like human.
- (ii) **Robust type** : *A. robustus* had heavier body structure and massive cheek tooth (also called originally *Paranthropus*) cranial capacity 600 cc.

(Other examples - *Zinjanthropus* / *A. boisei* of R. Leakey - Africa, *Meganthropus* from - Java)



Australopithecus

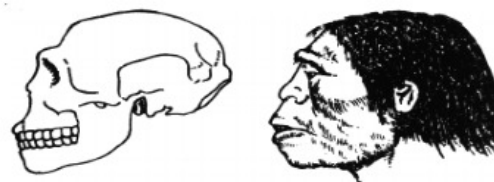
Fig. : Skull and reconstructed head

2. ***Homo habilis* (Able or Skillful man, The tool maker, or 'Handy man')**.

Discovery : **Louis S.B. Leakey** and his wife **Mary Leakey** (1960) discovered the fossils of *Homo habilis* from Pleistocene rocks of **Olduvai Gorge** in **East Africa**. **The first human like being the hominid was *Homo habilis*. They probably did not eat meat.**

Characteristics : He was about 1.2 to 1.5 metres tall. He had bipedal locomotion and moved erect. **It had about 650-800 cc. cranial capacity.** The teeth were like that of modern man. *Homo habilis* (*habilis* = mentally able or skillful) was the first tool maker and used tools of chipped stones extensively. It is also called handy man because heaps of tools found with these fossils included sharpened stones which indicate that *Homo habilis* was capable of 'making tools'. He also led community life in caves and greatly cared for the young ones.

3. ***Homo erectus* (Erect man)** : *Homo erectus* appeared about 1.5 million years ago, in middle Pleistocene. *Homo erectus* **probably ate meat**. He is called middle pleistocene man. *H. erectus* evolved from *Homo habilis*. He was about 1.5-1.8 metres tall. *Homo erectus* males were probably larger than females. He had erect posture. His skull was flatter than that of modern man. He had protruding jaws, projecting brow ridges and small canines and large molar teeth. **The cranial capacity was 900 cc.** Cranium was domed to accommodate the large brain. He was omnivorous. He made more elaborate tools of stones and bones, **hunted big game and perhaps knew the use of fire.**



Homo erectus

Fig. : Skull and reconstructed head

Homo erectus includes three fossils : **Java Ape-man, Peking man and Heidelberg man.**

(a) **Java Ape-man.**

Discovery : In 1891, **Eugene Dubois** discovered a fossil from Pleistocene rocks in central **Java** (Island of Indonesia). Eugene Dubois named it as *Pithecanthropus erectus*. *Pithecanthropus* means 'ape man' **Mayer** in 1950 assigned it as *Homo erectus erectus*.

Characteristics : Body 1.65 to 1.75 metres tall and weight about 70 kg. Legs long and erect, but body slightly bent when moving. Inconspicuous chin and somewhat broader nose. Forehead low and receding, but brow ridges high, like those of apes. Skull cap thick and heavy, flattened

infront. Cranial capacity 800 to 1000 cc. (average 950 cc). Lower jaw large and heavy. Teeth large, but quite like those of modern man, except larger canines of the lower jaw. Lips thick and protruding. He was omnivorous and cannibal. Perhaps, he was the first prehistoric man to make use of fire for hunting, defence and cooking.

(b) **Peking Man.**

Discovery : W.C. Pei (1924) discovered the fossils of Peking man from the lime stone caves of **Choukoutain** near Peking (Beijing – capital of China was formerly known as Peking) and named them *Sinanthropus*. **Davidson Black** (1927) named it *Sinanthropus pekinensis*. **Mayer** (1950) renamed it as *Homo erectus pekinensis* (a subspecies). The Pleistocene rocks from which fossils of Peking man were excavated are about 6 lakh years old.

Characteristics : Placing Java ape man and Peking man as subspecies of *Homo erectus* has a sound basis, because of close similarities between these. The body structure was quite similar in both. Being about 1.55 to 1.60 metres tall, Peking man was slightly shorter and a little lighter and weaker. The only noticeable difference of Peking man from Java ape man was its large cranial capacity, which ranged from 850 to 1100 cc. Like Java ape man, the Peking man was omnivorous and cannibal. There is a clear evidence of use of fire by it. It has been confirmed that both Java and Peking men used to live in caves in small groups or tribes. The tools of Peking man were relatively more sophisticated.

(c) **Heidelberg man.**

Discovery : In 1908 one of the most perfect fossil jaws belonging to middle Pleistocene was found by workmen working near Heidelberg, Germany. It was shown to **Otto Schoetensack**, who gets the credit for its discovery. It was named *Homo erectus heidelbergensis*.

Characteristics : It had lower jaw with all the teeth. The teeth were human like. The massive jaw was ape-like. He used the tools and fire. The cranial capacity is believed to be about 1300 cc; which is intermediate between those of erect man (*H. erectus*) and Neanderthal man (*H. sapiens neanderthalensis*). Thus, it is regarded as intermediate between pithecanthropines and Neanderthals.

C. **True Men Including the Living Modern Man**

1. **Neanderthal Man** (*Homo sapiens neanderthalensis*).

Discovery : Fossils of **Neanderthal man** were first obtained from **Neander Valley** in Germany from the late Pleistocene epoch by **C. Fuhlrott** (1856). Later, many other fossils were excavated in various countries by different palaeontologists.



Neanderthal man

Fig. : Skull and reconstructed head

Characteristics : He had slightly **prognathous** face. Neanderthal man walked upright, as we do, and had low brows, receding jaws, and high domed heads. If there was anything truly different about them, it was that they were much stockier than we are. The cranial capacity was 1,300 to 1,600 cubic centimetres. Neanderthal man existed half a million years ago, but was most numerous from about 100,000 years ago. Became extinct 30,000 years ago. Neanderthal man was the legendary cave dweller, having heavy brow ridge and humped back.

He was adapted to a cold environment, who encountered a succession of glaciers that passed over most of the northern temperate regions of the world. He was not only skilled hunter but true predator, a specialization that did not occur among hominids before or after them. The Neanderthal man was cannibal and fashioned the skin into clothing to protect himself against the harsh climate. Natural caves became campsites that were illuminated and heated by fire. **It is believed that he buried his dead with flowers and tools. He may have had a religion.**

It is usually considered that *Homo sapiens neanderthalensis* did not evolve into *Homo sapiens*.

2. **Cro-magnon man** (*Homo sapiens fossilis*).

Discovery : It has been known as Cro-Magnon man, because its fossils were first discovered in 1868 from **Cro-Magnon rocks** of France by **MacGregor**. Cro-Magnon man emerged about 34,000 years ago in Holocene epoch. Thus, he is regarded as most recent ancestor of today's man.

Characteristics : The Cro-Magnon man had, like us, about 1.8 metres tall, well-built body. His face was perfectly **orthognathous** with an arrow, elevated nose, broad and arched forehead, moderate brow-ridges, strong jaws with man-like dentition, and a well developed chin. His cranial capacity was, however, somewhat more than ours, being about 1650 c.c. It is, therefore, believed that Cro-Magnon man was somewhat more intelligent and cultured than the man of today. It could walk and run faster and lived with families in caves. It made excellent tools and even ornaments, not only of stones and bones, but also of elephant tusks. Its tools included spears, bows and arrows, as he was omnivorous. Use of the skin clothes by this man is also confirmed. **A number of cave paintings done by Cro-Magnon man have been discovered.** The Cro-Magnon man was the direct ancestor of the living modern man. **Prehistoric cave art developed about 18,000 years ago.**

3. **The Living Modern Man** (*Homo sapiens sapiens*).

Discovery : Further evolution of man after Cro-Magnon involves the evolution of culture rather than that of anatomy. *Homo sapiens sapiens* appeared about 25,000 years ago in Holocene epoch and started spreading all over the world about 10,000 years ago. Agriculture came around 10,000 years back and human **settlements started**. Modern man underwent cultural evolution. Paleolithic (age of tools of stones, bones, cave paintings). Mesolithic (age of animal husbandry, development of language reading and writings). Neolithic (development of agriculture, manufacture of pottery and clothes). Bronze age followed by iron age.

Modern Humans (*Homo sapiens*)

The evolutionary journey to modern humans ends with the appearance, about five hundred thousand years ago, of *Homo sapiens* ("wise man"), our own species. We are newcomers to the human family – *H. sapiens* has not been around nearly as long as *H. erectus* was. Still, humans have changed quite a bit, since those first days.

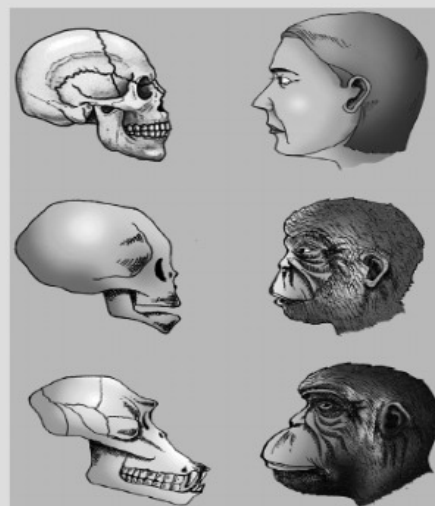


Knowledge Cloud

Out of Africa – Again

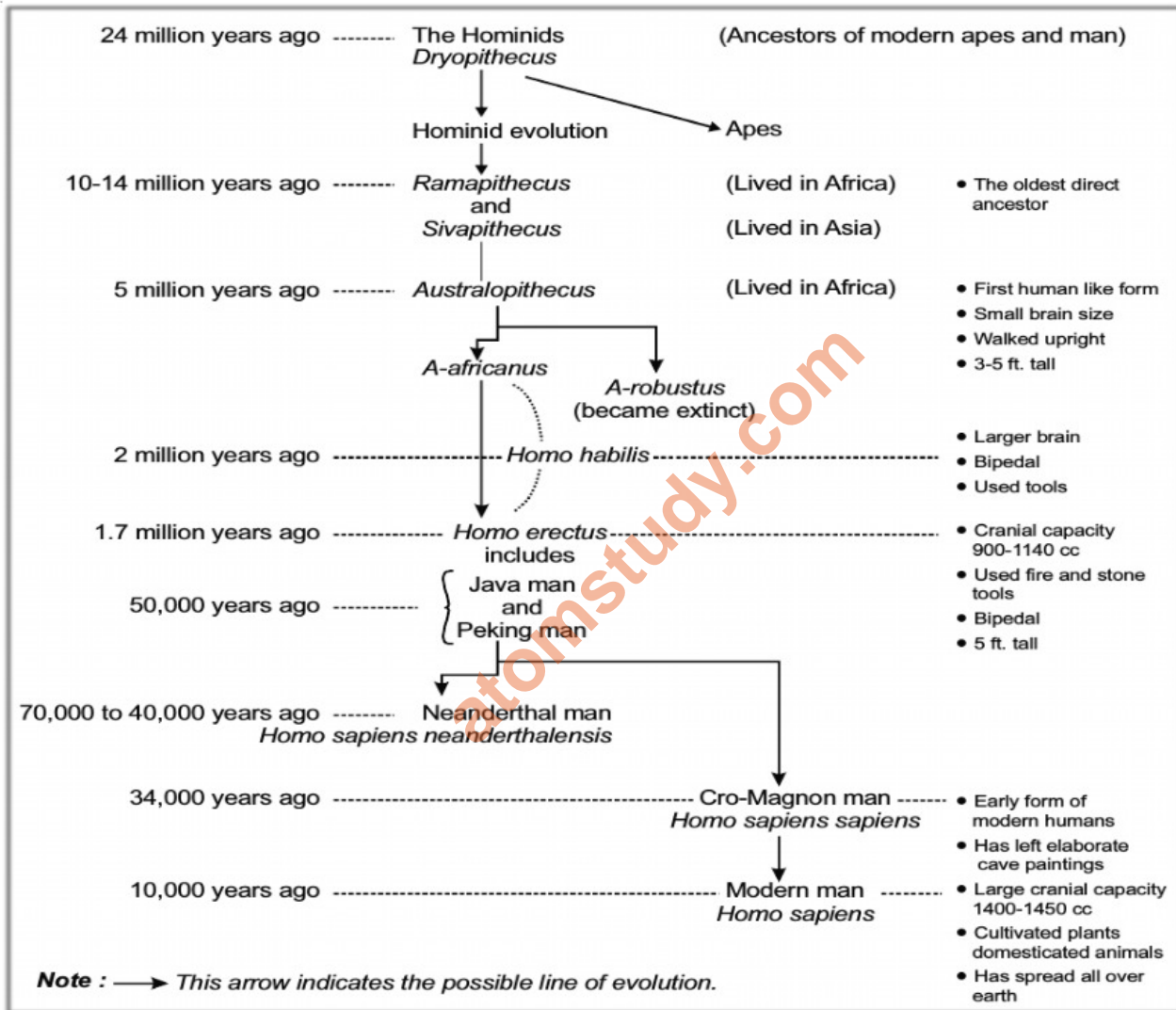
The origin of human races is a much-debated point among scientists studying human evolution. Many argue that the different races evolved from *H. erectus* independently, and that each adapted to a different place – Orientals in Asia, Caucasians in Europe, Aborigines in Australia, and so on. Others believe that the same species would be unlikely to evolve more than once and argue that human races appeared after *H. sapiens* evolved from *H. erectus*. Recently, scientists studying **mitochondrial DNA** from living humans all over the world have argued that their research shows that all human races originated from one *H. sapiens* ancestor in Africa.

Scientists looked at mitochondrial DNA to study evolution, because the DNA within mitochondria is transmitted only by females. Female's eggs carry many mitochondria within them that become part of a new baby, while sperms contribute no mitochondria to the new baby. Sperms carry their mitochondria wrapped around their tails and so do not inject them into the egg during fertilization. For that reason, particular versions of a mitochondrial gene can be traced back through a family tree, from mother to grandmother to great-grandmother.



A comparison of the skulls of adult modern human being, baby chimpanzee and adult chimpanzee. The skull of baby chimpanzee is more like adult human skull than adult chimpanzee skull

Human races evolved only recently in the evolutionary scale of things, and there has not been enough time for many mitochondrial DNA differences to accumulate, so the exact human tree cannot be reliably traced using this approach. So far, however, the greatest number of different mitochondrial DNA sequences occur among modern Africans. Since DNA accumulates mutations over time, the oldest DNA should show the largest number of mutations. This result thus argues, that humans have been living in Africa longer than on any other continent. While researchers are not in complete consensus, this line of investigation appears to suggest that *H. sapiens* evolved in Africa and that the human races evolved after that, and not independently from separate species of *H. erectus*. If this is correct, then *H. sapiens* was born in Africa and from there spread to all parts of the world, retracing the path taken by *H. erectus* half a million years before.



Homology in Chromosomes of Man and Great Apes

The somatic cells of humans contain 46 chromosomes (44 autosomes and 2 sex-chromosomes). Human chromosomes are usually obtained by culturing certain types of white blood cells from the peripheral blood. They can then be treated with specific stains to produce characteristic bands along the length of each chromosome. The pattern of banding so obtained is unique for each pair of chromosomes. Banding techniques enable the identification of individual chromosomes and their parts. The diploid number of chromosomes in gorilla, chimpanzee and orangutan is 48.

Comparisons have been made between banded chromosomes of man and those of the great apes. The **total amount of DNA in human diploid cells and that of the great apes are not dissimilar**. But what is most interesting from an evolutionary viewpoint, is that the banding pattern of individual human chromosomes is very similar and in some instances, identical to the banding pattern of apparently homologous chromosomes in the great apes. **Diagrammatic representations of the banding pattern of human chromosome numbers 3 and 6 are compared with those of particular autosomes in the chimpanzee. This remarkable similarity in the fine structural organisation of the chromosomes is understandable only in terms of a common origin for man and chimpanzee.**

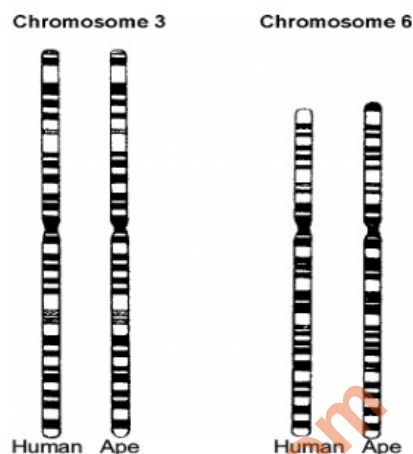


Fig. : Diagrammatic representation of banding pattern in chromosomes number 3 and 6 of man and chimpanzee

EXERCISE

61. Which of the following is **not** true?
- (1) About 15 mya, primates called *Dryopithecus* and *Ramapithecus* were existing
 - (2) *Ramapithecus* was more ape like
 - (3) *Homo erectus* had a large brain around 900 cm³
 - (4) The brain capacities were between 650 to 800 cm³ of *Homo habilis*
62. Who were the first to use hides to protect their body and buried their dead?
- (1) Neanderthal man
 - (2) *Homo erectus*
 - (3) Cromagnon man
 - (4) *Homo habilis*
63. Modern *Homo sapiens* arose
- (1) Near east and central Asia between 1,00,000 to 40,000 years back
 - (2) During ice age between 75,000 to 10, 000 years ago
 - (3) About 10,000 years back
 - (4) About 18,000 years ago

64. The most apparent change during the evolutionary history of *Homo sapiens* is traced in
- (1) Loss of body hair
 - (2) Walking upright
 - (3) Shortening of the jaws
 - (4) Remarkable increase in the brain size
65. The first human like being the hominid was called
- (1) *Australopithecus*
 - (2) *Homo erectus*
 - (3) *Homo habilis*
 - (4) *Homo sapiens*
66. What evidence suggests that chimpanzee is more closely related to humans than other hominoid apes?
- (1) DNA from sex chromosomes only
 - (2) Chromosome morphology only
 - (3) Fossil remains
 - (4) Banding pattern of autosomes
67. Centre of human evolution was
- (1) Ethiopian realm
 - (2) Oriental realm
 - (3) Palaeartic realm
 - (4) Neotropical realm
68. A well preserved and most complete homonid fossil named Lucy belongs to the genus
- (1) *Dryopithecus*
 - (2) *Australopithecus*
 - (3) *Homo*
 - (4) *Pithecanthropus*
69. Which of the following is direct ancestor of *Homo sapiens*?
- (1) *Homo erectus*
 - (2) *Homo sapiens neanderthalensis*
 - (3) *Ramapithecus*
 - (4) *Australopithecus*
70. Modern man differs from apes in
- (1) Protruding eyes
 - (2) Sparse body hair
 - (3) Arms shorter than legs
 - (4) Wearing of clothes



Knowledge Cloud

- **Cope's Law** : It states that there is a tendency for animals to increase in size during the long course of evolution.
- **Bergman's Law** : It states that warm blooded animals become larger in the northern and colder parts of their range.
- **Allen's Law** : It states, that in animals which live in very cold climates, their extremities such as ears, tails etc. become progressively smaller.
- **Gause's Law** : (Gause, 1934) or the **Competitive Exclusion Principle** (Hardin, 1960). It states that two species having the same ecological requirements cannot continue to occupy indefinitely the same habitat.
- **Gloger's rule** : It states that among warm blooded animals, those living in warm and moist climate develop more melanin pigment (are darker than animals in cold, dry climates) whereas forms in dry, hot climates have more yellow and red pigment.
- **Jordan's rule** : Temperature also influences the morphology of certain fishes and is found to have some relation with the number of vertebrae. Fishes inhabiting water of low temperature tend to have more vertebrae than those of warmer water.
- *Anthropology* is the study of evolutionary history of man.
- *Ethology* is the study of animals' habits and behaviours.
- *Homo erectus* is also known as the Java man.
- *Australopithecus* is considered as the connecting link between man and apes.
- Basic unit of evolution is population.
- Basic unit of natural selection is individual.
- **Mimicry** : It is a kind of adaptation. The term mimicry was introduced in Biology by Bates (1862). It is defined as "the resemblance of one organism to another or to any natural object for the purpose of concealment, protection or for some other advantages. The organism which exhibits mimicry is called a **mimic**. The organism or object which is mimicked or imitated is called a **model**.
- **Batesian Mimicry** : It is a form of mimicry in which an edible species resembles an inedible one. *e.g.*, Viceroy butterfly (edible) resembles monarch butterfly (inedible)
- **Mullerian Mimicry** : When two or more inedible or unpalatable species resemble each other the mimicry is termed Mullerian mimicry. *e.g.*, Honeybee, Wasp and Hornet etc..
- Both Batesian and Mullerian mimics are two forms of **protective mimics**.



Some Important Definitions

- **Evolutionary biology** is the study of history of life forms on earth.
- **Evolution** means an orderly 'change' from one form to another.
- **Chemical evolution** means formation of diverse organic molecules from inorganic constituents.
- **Abiogenesis** is the origin of life from non-living matter.

- **Biogenesis** is the origin of life from pre-existing life.
- **Characteristics** are defined as the details of appearance and behaviour of organisms.
- **Fossils** are defined as the preserved remains of hard parts of life-forms found in rocks.
- **Homologous structures** are the structures which have different functions but anatomically they are similar.
- **Analogous structures** are the structures which are not anatomically similar but perform similar functions.
- **Divergent evolution** is said to occur when one structure or species develops along different directions due to adaptations to different needs.
- **Convergent evolution** is said to occur when different structures or species develop similar adaptive features due to similar habitats.
- **Anthropogenic actions** mean the man-influenced actions or the actions caused/produced by humans.
- **Adaptive radiation** is the process of evolution of different species from single species in an isolated geographical area and then its radiation to other areas of geography.
- **Mutations** are defined as the large differences arising suddenly in a population.
- **Speciation** means origin of new species.
- **Saltation** is the single step large mutation, which brings evolution.
- **Natural selection** is the process of selection of advantageous variations by nature.
- **Gene migration** is the migration of alleles or genes from one population to another.
- **Gene flow** is said to occur when gene migration occurs multiple times between two populations.
- **Genetic drift** is the change in the frequency of alleles in a small isolated population by chance.
- **Hominid features** are the human or human-like features.



Quick Recap

1. The origin of life on earth can be understood only against the background of origin of universe and especially of earth.
2. Several theories were proposed for the origin of life like theory of panspermia, spontaneous generation, special creation, chemical evolution etc.
3. The sea voyage of Charles Darwin in H.M.S. Beagle round the world explored the ideas of common ancestor, natural selection, reproductive fitness, variations, adaptive radiation etc.
4. Fossils (Paleontological evidences), homologous and analogous structures, biochemical similarities, artificial selection, natural selection, drug resistance in microbes etc. are the evidences of evolution.
5. Darwin's finches, Australian marsupials are the examples of adaptive radiation in their respective habitats.
6. The appearance of new life-forms is related to their life spans.
7. Branching descent and natural selection are the two key concepts of Darwinian theory of evolution.

8. Use and disuse of organs and inheritance of acquired characters are the main points of Lamarckian theory of evolution.
9. Hugo deVries studied mutations in evening primrose.
10. Mutations are sudden and directionless while Darwinian variations are small and directional.
11. Hardy-Weinberg principle talks about the stability of allelic frequencies in populations. Five factors (gene migration, gene flow, genetic drift, natural selection and genetic recombination) are said to affect the genetic equilibrium.
12. Natural selection can be stabilising, directional or disruptive.
13. First cellular form of life appeared about 2000 million years ago (mya), invertebrates 500 mya and jawless fish 350 mya.
14. Biggest land reptiles were dinosaurs which suddenly disappeared 65 mya from earth.
15. First mammals on earth were like shrews.
16. *Dryopithecus* was more ape-like and *Ramapithecus* was more man-like primate. They existed about 15 mya on earth.
17. *Australopithecines*, *Homo habilis*, *Homo erectus*, Neanderthal man, *Homo sapiens* were the ancestors of man, present at different time periods.
18. Modern *Homo sapiens* (today's man) arose around 75,000–10,000 years ago in Africa and moved across different continents and evolved into different races.
19. Among the stories of evolution of individual species, the story of evolution of modern man is most interesting and appears to parallel evolution of human brain and language.

