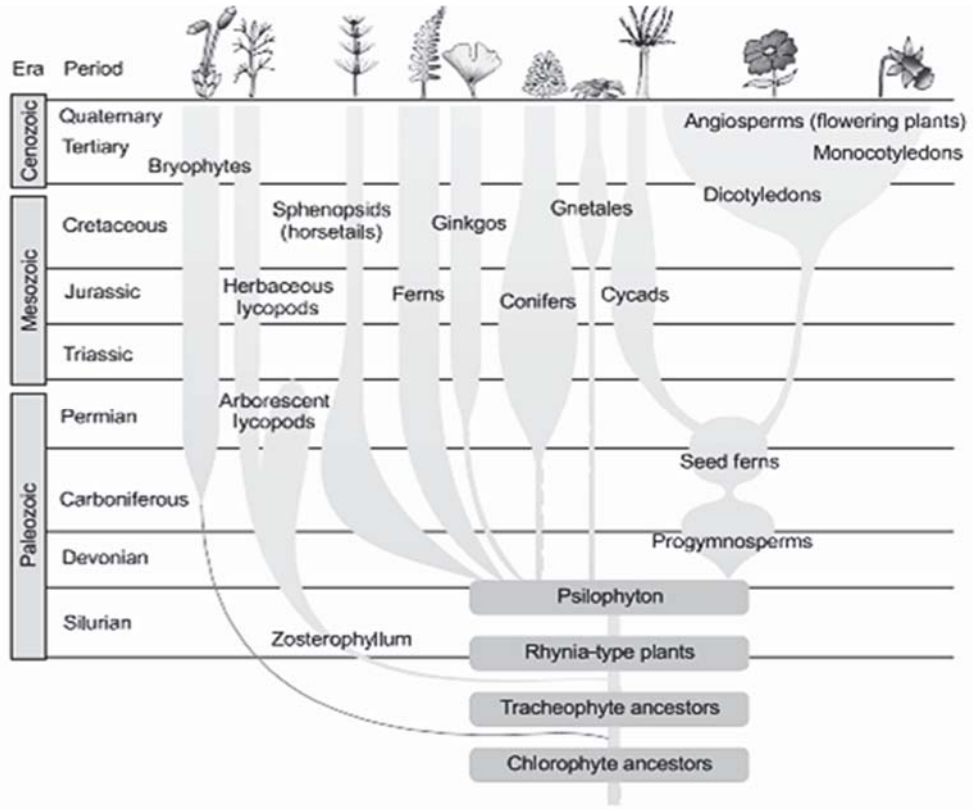
A BRIEF ACCOUNT OF EVOLUTION

- Around 2000 million years ago (mya), life first emerged on Earth in the form of single-celled organisms. These early life forms possessed certain cellular structures that enabled them to undergo photosynthesis, releasing oxygen into the atmosphere. Over time, this gradual increase in oxygen levels fostered the development of more complex and efficient organisms.
- The transition from single-celled to multi-cellular life forms occurred gradually. Approximately 500 mya, invertebrates emerged, marking a significant milestone in the evolutionary timeline. From these invertebrates, the first fish emerged around 350 mya, likely in the form of jawless fish.
- Around 320 mya, seaweeds and early plants began to appear. The coelacanth, a lobe-finned fish discovered in South Africa, is believed to have evolved into the first amphibians, which could inhabit both land and water, paving the way for modern-day frogs and salamanders.
- As amphibians evolved, they gradually transitioned into reptiles, characterized by eggs that could withstand drying out in the sun, unlike those of amphibians. Giant ferns, such as Pteridophytes, dominated the terrestrial landscape and contributed to the formation of fossil fuels as they fell and became buried in soil.
- Some reptiles returned to aquatic environments and evolved into fish-like reptiles approximately 200 million years ago. Among these reptiles, dinosaurs emerged as the dominant land species, with the Tyrannosaurus rex being one of the largest and most formidable examples, standing about 20 feet tall and equipped with dagger-like teeth.
- Around 65 mya, a mass extinction event wiped out the dinosaurs, leading to the rise of birds from some dinosaur lineages. The earliest mammals were small and shrew-like, with fossils indicating their diminutive size.
- Mammals eventually evolved to become viviparous, allowing them to nurture developing embryos within their mothers' bodies. In Australia, pouch-bearing mammals persisted due to limited competition from other mammals, a result of Continental Drift.



Origin and Evolution of Animals

- As previously discussed, the earliest known cells emerged around 2000 million years ago (mya) on Earth. Some of these cells possessed the remarkable ability to release oxygen (O_2), possibly through a process resembling the light reaction of photosynthesis. This process likely involved the splitting of water molecules with the aid of solar energy, captured and channeled by specialized light-harvesting complexes within the cells.
- Over time, these primitive single-celled organisms transitioned into multicellular life forms, gradually evolving from simpler to more complex organisms. Life initially emerged in aquatic environments, but eventually, some life forms began to colonize terrestrial habitats. Notably, among the first organisms to inhabit land were plants.
- The evolution of invertebrates occurred around 500 million years ago (mya), marking a significant period of activity and diversification for these lower animals. While many invertebrate species still exist today, others have become extinct over time.
- Around 350 million years ago (mya), the first fishes emerged. Among them were the jawless fishes known as Agnetha. Additionally, there were jaw-bearing fishes with robust fins that enabled them to navigate both land and water environments. These bony fishes, known as lobefins, also appeared around the same time. Thought to be extinct, lobefins were rediscovered in 1938 when a specimen was caught off the coast of South Africa, confirming their continued existence.

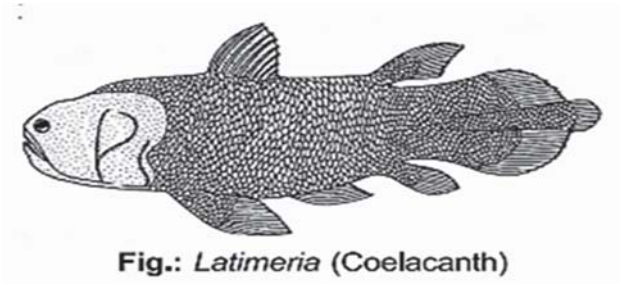
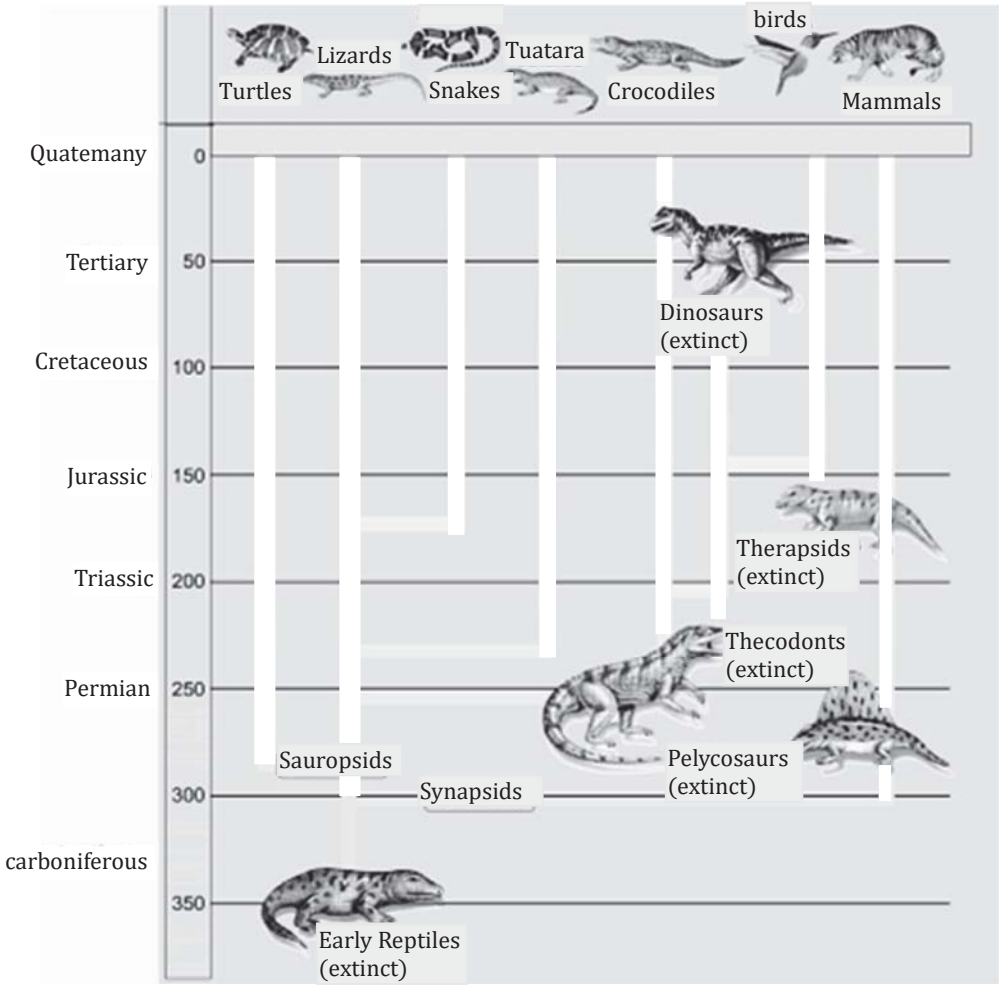


Fig.: *Latimeria* (Coelacanth)

- The evolution of the first amphibians likely originated from lobefins, a group of fishes with robust fins, which eventually transitioned into organisms capable of living both on land and in water. While the earliest amphibians have since become extinct, they are believed to have evolved into modern-day amphibians, such as frogs and salamanders.
- Reptiles, characterized by their ability to lay thick-shelled eggs that resist desiccation, evolved from amphibians. Many reptile species, including dinosaurs, have gone extinct over time, while others, like turtles, tortoises, and crocodiles, still exist today. Approximately 200 million years ago, certain land reptiles returned to aquatic environments, evolving into fish-like reptiles like the Ichthyosaur. Meanwhile, dinosaurs, such as the fearsome Tyrannosaurus rex, dominated the terrestrial landscape, reaching heights of up to 20 feet.
- Around 200 million years ago, giant ferns known as pteridophytes were abundant, contributing to the formation of coal deposits over time. The sudden extinction of dinosaurs approximately 65 million years ago remains a topic of debate, with theories ranging from climatic changes to evolutionary transitions into modern birds. Following the demise of dinosaurs, mammals emerged from reptilian ancestors, initially appearing as small-sized creatures like shrews. These early mammals, though small, left behind fossils that provide clues to their existence.
- The rise of mammals coincided with significant geological changes, including the breakup of the supercontinent Pangaea into separate landmasses due to continental drift. This separation led to the isolation of various mammalian populations, resulting in unique evolutionary trajectories. For instance, the marsupials of Australia thrived due to their isolation from competition elsewhere. Meanwhile, some mammals adapted to aquatic life, such as whales, dolphins, seals, and sea cows.

- The evolution of specific mammals, such as horses, elephants, and dogs, represents fascinating tales of adaptation and diversification, which are explored further in advanced studies. However, one of the most remarkable evolutionary stories is that of humans, which will be examined in detail in subsequent chapters. Before delving into human evolution, let us first explore a brief overview of vertebrate evolution.



- Pelycosaurs and Therapsids, both belonging to the synapsid group, have vanished from the Earth's ecosystems. Among these, Therapsids represented the most sophisticated branch, encompassing the forebears of mammals.
- On the other hand, Thecodonts are categorized as Sauropsids. Although Thecodonts have disappeared, their legacy endures through the diverse array of species they gave rise to. Notably, they served as ancestors to crocodiles, dinosaurs, and the contemporary avian species.
- Additionally, other Sauropsids contributed to the ancestry of various reptiles such as turtles, lizards, snakes, and tuataras.
- This evolutionary journey highlights the transformation of reptiles, synapsids, and Sauropsids into the present-day forms of reptiles, birds, and mammals. Consequently, modern reptiles, birds, and mammals can trace their lineage back to the early reptilian ancestors.

Example: Can you elaborate on the origins of Ichthyosaurs?

Solutions: It is believed that around 200 million years ago (mya), certain terrestrial reptiles underwent a significant evolutionary shift, transitioning from land to aquatic habitats, ultimately giving rise

to the Ichthyosaurs. These creatures, which bore a striking resemblance to fish, were a group of reptiles adapted to life in the water.

The Origin and Evolution of man

man, beings stand out as the most successful and dominant species on planet Earth. Their remarkable development of language and numerous advancements in various fields stem from their ingenuity and experimentation.

Interestingly, humans are unique among all organisms on Earth in their capacity to gather evidence regarding their own origins and evolutionary journey.

The study of human evolution often focuses on the evolutionary trajectory of apes, given their close genetic relationship to humans compared to other animals. Within the scope of human evolution, we typically delve into the following three significant categories:

A. Preceding Ape-Men
B. Ape-Men, which encompasses prehistoric human ancestors
C. True Men, encompassing the present-day modern human population

A. Preceding Ape-Men

Preceding Ape-Men refers to the evolutionary predecessors of modern humans who exhibit characteristics and features similar to both apes and humans. These ancestors represent a crucial phase in the evolutionary lineage leading up to Homo sapiens. They are distinguished by their bipedal locomotion, increased brain size, tool usage, and other anatomical and behavioral adaptations that differentiate them from earlier hominins and non-human primates. Studying these preceding ape-men sheds light on the transitional stages and adaptive changes that occurred during the evolution of early human ancestors.

(1) Proconsul/ Dryopithecus:
- Regarded as a common ancestor of both humans and apes.
- Dryopithecus is perceived as the direct precursor to modern-day apes.
- They exhibited a semi-erect posture, possessed thick hair, U-shaped jaws, larger and sharper teeth, and predominantly followed a vegetarian diet.
- Their mode of locomotion involved walking on all fours, with forelimbs longer than hind limbs.
- Primarily forest-dwelling creatures, they spent the majority of their time in trees.

(2) Ramapithecus: Fossils unearthed from the Shivalik hills in India.

(3) Sivapithecus: Fossils discovered in the Shivalik hills of India.

(4) Kenyapithecus:
- Fossils discovered in Kenya.
- Considered ancestral to humans, sharing characteristics akin to Dryopithecus but primarily terrestrial in habitat.
- Ramapithecus displayed more human-like traits, while Dryopithecus leaned towards ape-like features.

B. Ape-Men, which encompasses prehistoric human ancestors

Ape-Men, within the context of human evolution, encapsulates the category of prehistoric human ancestors who demonstrate characteristics intermediate between modern humans and non-human primates. These transitional figures played a pivotal role in the evolutionary journey leading to Homo sapiens. They exhibit a blend of ape-like and human-like traits, such as bipedal locomotion, increased brain size, tool usage, and cultural advancements. Studying the ape-men provides valuable insights into the gradual emergence of human characteristics and behaviors over time, offering a deeper understanding of our evolutionary history.

1. Australopithecus

- Professor Raymond Dart made a significant discovery when he unearthed the fossilized skull of a 5-6-year-old infant from the Pliocene strata in the Tuang region of South Africa. Initially dubbed the "Tuang baby," it was later renamed as A. africanus, denoting its African origin as an early hominid.
- Approximately 2 million years ago, Australopithecines likely inhabited the grasslands of East Africa, as indicated by available evidence.
- While evidence suggests Australopithecines may have engaged in hunting activities using stone tools, their primary diet consisted of fruit.

Australopithecus is widely recognized as a transitional link between apes and humans, displaying a combination of ape-like and human-like characteristics:

(i) Ape-like features:
- Relatively small cranial capacity (approximately 600 cc).
- Dense hair covering the body.
- U-shaped jaw structure (prognathous face).
- Large and robust teeth.

(ii) Human-like traits:
- Fully erect posture and bipedal locomotion, marking the earliest instance of upright walking in hominids.
- Shorter forelimbs compared to hind limbs.
- Distinctive lumbar curve in the vertebral column.

A handful of fossils displaying human-like characteristics have been unearthed in Ethiopia and Tanzania. These discoveries suggest that around 3-4 million years ago, hominids with human-like traits inhabited eastern Africa. It is believed that these early hominids were likely not taller than 4 feet but walked upright, signifying a crucial stage in the evolutionary transition towards modern humans.

2. Homo habilis

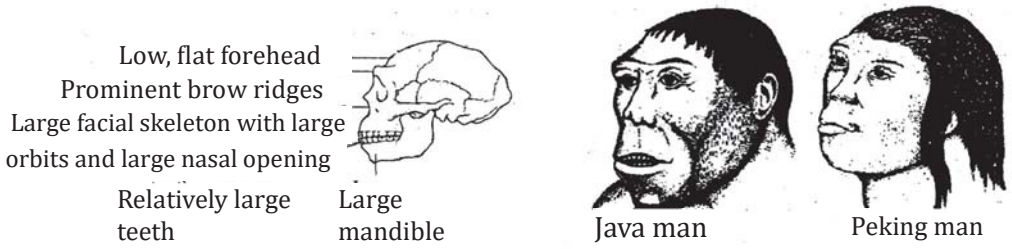
- Homo habilis is recognized as the earliest human-like species.
- It is credited as the first species to craft stone tools for hunting animals, earning the epithet "first toolmaker" or "Handy man."
- Dietary habits of Homo habilis likely consisted predominantly of plant-based foods.
- Brain capacities of Homo habilis ranged from approximately 650 to 800cc.
- Fossils of Homo habilis were excavated by Dr. Leakey from rocks dating back 2 million years in Africa.
- They are believed to have inhabited caves for shelter.

3. Homo erectus

- Homo erectus thrived approximately 1.5 million years ago.
- This species exhibited a relatively large brain, boasting a cranial capacity of around 900cc.
- Homo erectus populations were primarily cave-dwellers and likely consumed meat as part of their diet.
- Numerous subspecies of Homo erectus have been identified, including:

(a) Java man (Homo erectus erectus/ Pithecanthropus erectus):
- Fossils of Java man was discovered in Java in 1891.
- They were the first hominins known to utilize fire for hunting, protection, and cooking.
- Tools made of both bones and stones were employed by Java man.
- The cranial capacity of Java man ranged from 800 to 1000cc, with an average of 900cc.

- Their diet was varied, consisting of both plant and animal matter, and evidence of cannibalism has been found in some populations.



(b) Peking Man (Homo erectus pokiness/Synanthropes erectus):

- Fossils of Peking Man were uncovered in China, with the discovery credited to W.C. Pei.
- Peking Man, like other Homo erectus populations, exhibited evidence of fire usage for cooking meat and providing protection.
- They employed sharp chisel-shaped tools crafted from stones and bones for cutting and hunting animals.
- With a cranial capacity ranging from 850 to 1300cc, averaging around 1050cc, Peking Man displayed a notable brain size within the Homo erectus lineage.
- Their diet was versatile, consisting of both plant-based foods and meat, and instances of cannibalism have been documented among Peking Man populations.

C. True Men, Encompassing the Present-Day Modern Human Population

True Men refers to the contemporary human population, encompassing Homo sapiens in their current form. This category represents the culmination of human evolutionary development, characterized by distinct anatomical, cognitive, and behavioral features that differentiate modern humans from their predecessors. True Men exhibit advanced cognitive abilities, complex social structures, symbolic communication through language, and sophisticated cultural practices. By studying the traits and behaviors of the present-day human population, researchers gain insights into the unique characteristics and adaptive strategies that have enabled Homo sapiens to thrive and dominate diverse environments across the globe.

(a) Neanderthal Man (Homo sapiens neanderthalensis):

- Neanderthal man inhabited regions near East and Central Asia approximately between 100,000 to 40,000 years ago, with fossils first discovered by Folcroft in the Neanderthal valley of Germany.
- Their cranial capacity, at 1400cc, was comparable to that of modern humans.
- Neanderthals utilized animal hides as a form of protection for their bodies.
- Evidence suggests that Neanderthals practiced burial rituals, indicating a possible belief in the immortality of the soul or some form of afterlife.
- They likely lived in huts or shelters and had an omnivorous diet.
- The development of the speech center and the origins of language are believed to have begun during the Neanderthal period.

(b) Modern Man (Homo sapiens sapiens):

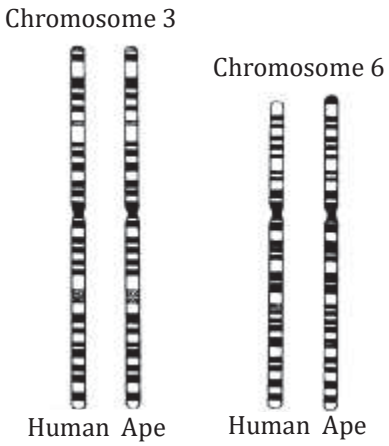
- The emergence of modern Homo sapiens occurred during the ice age, spanning from approximately 75,000 to 10,000 years ago.
- Originating in Africa, modern Homo sapiens migrated across continents, leading to the development of distinct racial groups, including Caucasoid, Negroid, Mongoloid, and Australoid.

- Modern humans, characterized by a brain capacity ranging from 1300 to 1600 cc, with an average of 1450 cc, represent the contemporary human population.
- They possess distinct features such as a well-developed chin, a prominent speech center, a smaller forehead, and reduced body hair.
- Their facial structure typically includes a semi-circular jaw and an orthognathous face.
- Modern humans exhibit an omnivorous diet, consuming both plant and animal-based foods.
- The advent of agriculture, marking a significant shift in human lifestyle, began approximately 10,000 years ago, coinciding with the establishment of human settlements.

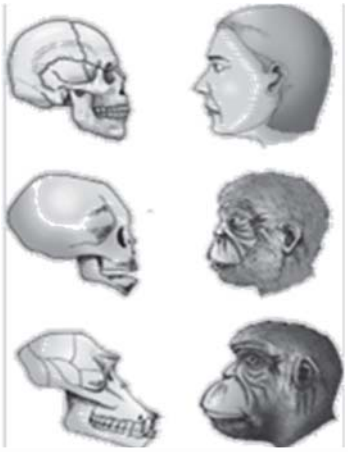
Homology in Chromosomes of Humans and Great Apes

The somatic cells of humans are characterized by 46 chromosomes, comprising 44 autosomes and 2 sex chromosomes. To examine human chromosomes, a common approach involves culturing specific types of white blood cells sourced from peripheral blood. These cells can then be subjected to staining techniques that reveal distinctive bands along the length of each chromosome. These bands serve as unique identifiers for each chromosome pair, aiding in their individual recognition and analysis. It's worth noting that gorillas, chimpanzees, and orangutans possess a diploid chromosome count of 48.

Comparisons have been drawn between the banded chromosomes of humans and those of great apes. While the total amount of DNA in human diploid cells and that of great apes shows similarities, what stands out from an evolutionary perspective is the striking resemblance in the banding pattern of individual human chromosomes to those of apparently homologous chromosomes in great apes. For instance, diagrams illustrating the banding pattern of human chromosome numbers 3 and 6 are juxtaposed with corresponding autosomes in chimpanzees. This notable similarity in the fine structural organization of chromosomes strongly suggests a shared ancestry between humans and chimpanzees.



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



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.