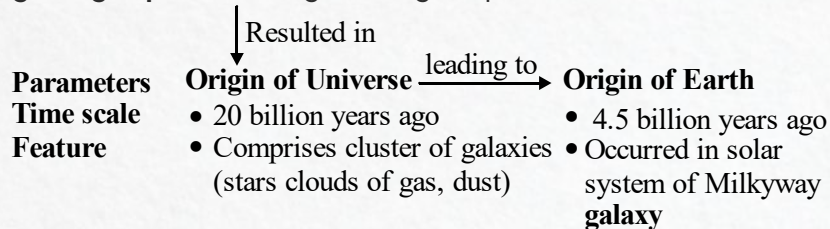




EVOLUTION

1 EVOLUTION

- **Evolutionary biology** is the study of history of life forms on Earth.
- Stellar distances are measured in light years.
- **Big bang explosion** (Singular huge explosion).

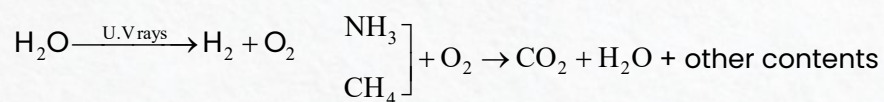


Events after expansion of universe :

- Temperature declined
- $H_2 + He$ formed
- Gases condensed
- Galaxies of present day formed

Hypothesis for Origin of life on early earth :

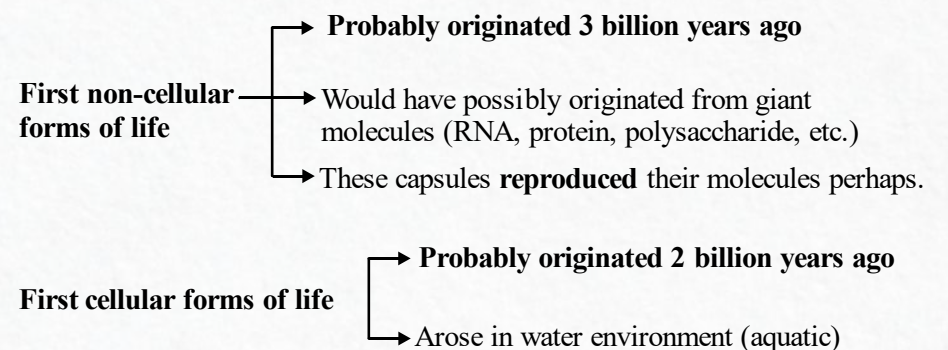
- No atmosphere existed on early earth.
- Water vapours, methane, carbon dioxide and ammonia release from molten mass covered the surface.



- H_2O vapour falls as rain to fill all the depression and form oceans.
- Ozone layer was formed

2 ORIGIN OF LIFE

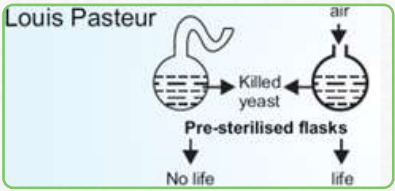
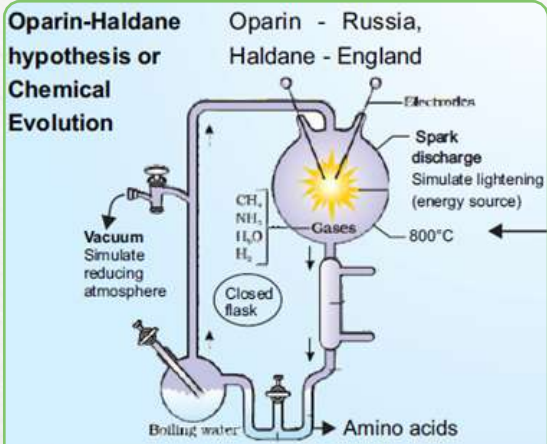
Life appeared 500 million years after the formation of earth, i.e, almost **4 billion years ago**.



This version of Biogenesis i.e., the first form of life arose slowly through evolutionary forces from non-living molecules is accepted by majority.

3 THEORIES FOR ORIGIN OF LIFE

- The origin of life is considered a unique event in the history of universe

Theory	Proponents	Connotations
Special creation	Conventional religious literature	<ul style="list-style-type: none">• All living organisms that we see today were created as such.• Diversity was always the same since creation and will be the same in future also.• Earth is 4000 years old.
Cosmozoic /Panspermia	Early Greek thinkers Astronomers	<ul style="list-style-type: none">• Life came from outerspace.• Units of life called spores were transferred to different planets including Earth.
spontaneous generation		<ul style="list-style-type: none">• Life came out from decaying and rotting matter like straw, mud. etc.• Disapproved by Louis Pasteur
Theory of Biogenesis		<ul style="list-style-type: none">• Life comes only from pre-existing life• He showed that in pre-sterilised flasks, life did not come from "killed yeast".
Oparin-Haldane hypothesis or Chemical Evolution	 <p>Oparin - Russia, Haldane - England</p> <p>Fig.: Diagrammatic representation of Miller's experiment</p>	<ul style="list-style-type: none">• Formation of life was preceded by chemical evolution i.e., formation of diverse organic molecules from inorganic constituents• First form of life could have come from pre-existing non-living organic molecules (e.g. RNA, proteins, etc.)• This hypothesis was proved by Miller's experiment, 1953, S.L. Miller (American scientist)• In similar experiments others observed, formation of sugars, nitrogen bases, pigments and fats.• Analysis of meteorite content also revealed similar compounds indicating that similar processes are occurring elsewhere in space



4 EVIDENCES OF EVOLUTION

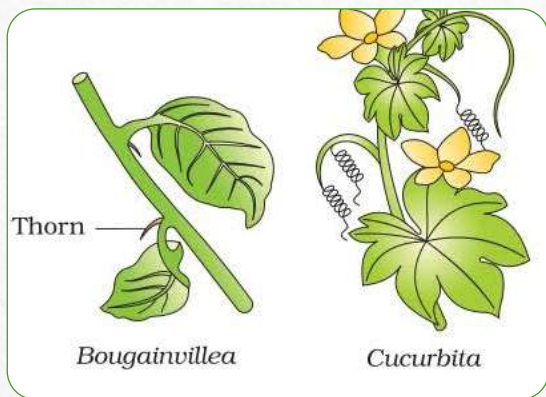
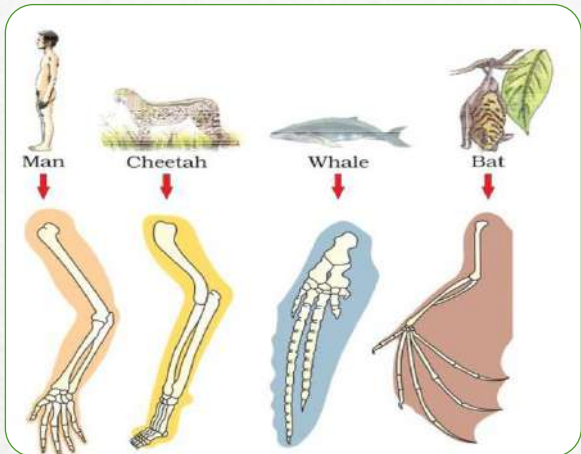
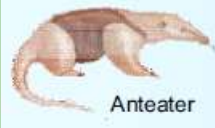





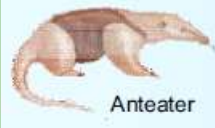





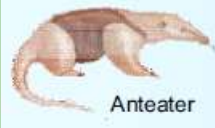





1. Palaeontological evidences (Evidences from fossils)

- **Fossils** are remains of hard parts of life forms found in rocks.
- **Age of fossils** is determined by **radioactive dating method**.
- Fossils of different life forms in different **sedimentary layers** indicates the **geological period** in which they existed (**epochs, periods, eras**)
- Rocks form sediments and a cross-section of Earth's crust indicates the arrangement of sediments one over the other during the long history of earth.
- Different-aged rock sediments contain fossils of different life-forms who probably died during the formation of the particular sediment. Some of them appear similar to modern organisms. They **represent extinct organisms** (e.g., Dinosaurs).

2. Embryological evidences

- Proposed by **Ernst Heckel**
- Based upon the observations of certain features during embryonic stage common to all vertebrates that are absent in adults e.g., embryos of all vertebrates develop a row of vestigial gill slits functional only fish and not found in another adult vertebrates.
- It was **disproved by Karl Ernst von Baer**. He noted that embryos never pass through the adult stages of other animals.
- **Molecular homology**
Similarities in proteins and genes performing a given function among diverse organisms indicates common ancestry. These biochemical similarities point to the same shared ancestry as structural similarities among diverse organisms.

3. Morphological and anatomical evidences

Parameters	Homologous organs	Analogous organs								
Common ancestry	✓	✗								
Anatomical structures	Similar but developed along different directions due to adaptations to different needs.	• Not similar but resulted in selection of similar adaptive features in different groups of organisms, thus, evolving for the same function.								
Function performed	Different	Similar								
Type of evolution	Divergent	Convergent								
Examples	<div><p>Thorn <i>Bougainvillea</i> <i>Cucurbita</i></p><p>fore limbs of vertebrates</p><p>Man Cheetah Whale Bat</p><p>Vertebrate hearts, Vertebrate brains</p></div>	<div><table><tr><th>Placental mammals</th><th>Australian marsupials</th></tr><tr><td> Anteater</td><td> Numbat (anteater)</td></tr><tr><td> Lemur</td><td> Spotted cuscus</td></tr><tr><td> Bobcat</td><td> Tasmanian tiger cat</td></tr></table><ul style="list-style-type: none">• Wings of butterfly and birds• Eyes of octopus and mammals• Flippers of Penguins and Dolphins• Sweet potato (root modification) and potato (stem modification)</div>	Placental mammals	Australian marsupials	 Anteater	 Numbat (anteater)	 Lemur	 Spotted cuscus	 Bobcat	 Tasmanian tiger cat
Placental mammals	Australian marsupials									
 Anteater	 Numbat (anteater)									
 Lemur	 Spotted cuscus									
 Bobcat	 Tasmanian tiger cat									



5 ADAPTIVE RADIATION

- The process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats)

Examples

Darwin's finches

- Small black birds
- Evolved from seed eating birds in Galapagos Island
- Altered beaks arose, enabling them to become insectivorous and vegetarian finches.



Fig.: Variety of beaks of finches that Darwin found in Galapagos Island

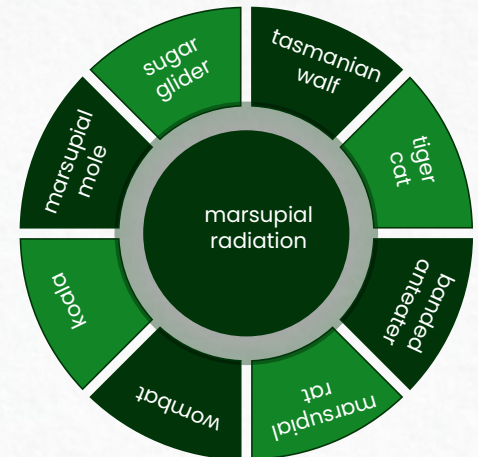


Fig.: Adaptive radiation of marsupials of Australia

When more than one adaptive radiation appeared to have occurred in an isolated geographical area (representing different habitats), one can call this **convergent evolution**.

Examples

Placental mammals	Australian marsupials
Mole	Marsupial mole
Anteater	Numbat (banded anteater)
Mouse	Marsupial mouse
Lemur	Spotted cuscus
Flying squirrel	Flying phalanger (Sugar glider)
Bobcat	Tasmanian tiger cat
Wolf	Tasmanian wolf

6 BIOLOGICAL EVOLUTION

- Metabolic capabilities of different cellular forms of life under the influence of natural selection contributed to biological evolution.

- Rate of appearance of new forms is linked to the life cycle or the life span. e.g., Microbes have the ability to multiply and become millions within hours whereas fish or fowl would take millions of years as life span of these animals are in years.



Theories For The Evolution Of Life Forms

Lamarck's theory of evolution

- Given by French naturalist Lamarch

Main postulates :

Use and disuse of organs

Inheritance of acquired characters

Darwin's theory of natural selection

- Darwin visited Galapagos island, Ship – H.M.S Beagle
- Observations by Charles Darwin:
 - (i) Existing living forms share similarities to varying degrees not only among themselves but also with life forms that existed millions of years ago.
 - (ii) The geological history of earth correlates with the biological history of earth.

Influence of the work of Thomas Malthus on Darwinism:

- (i) Population can grow exponentially
- (ii) Limited resources
- (iii) Nature keeps control/check on population size which are, hence, nearly stable

Darwin's postulates:

- According to Darwin, variations are **small** and **directional** and evolution for Darwin was **gradual** process.
- Darwin asserted that in a population exist variations, which are heritable and which make resource utilisation better for few will enable only those to reproduce and leave more progeny.

- Those characteristics which enable some to survive better in natural conditions (climate, food, physical factors etc.) would outbreed others that are less-endowed to survive under such natural conditions.
- The fitness, according to Darwin, refers **ultimately and only to reproductive fitness**.
- Adaptive ability is inherited and has a genetic basis
- **Fitness is the end result of the ability to adapt and get selected by nature.**
- Branching descent and natural selection are the two key concepts of Darwinian theory of evolution.
- **Habitat fragmentation and genetic drift may accentuate variations leading to speciation.**

Weaknesses of Darwinism :

- (i) Unable to explain the origin of variations
- (ii) Could not explain speciation
- (iii) Ignored work done by Mendel.

Mutation theory

- Given by Hugo de Vries in first decade of 20th century
- Worked on evening primrose
- New species originate as a result of mutations which are single step (saltation) large, random and directionless variations arising suddenly in a population

1

- Alfred Wallace, a naturalist who worked in Malay Archipelago had also come to similar conclusions as Charles Darwin around the same time

2

- Evolution is not a directed process in the sense of determinism. It is a stochastic process based on chance events in nature and chance mutations in the organisms

3

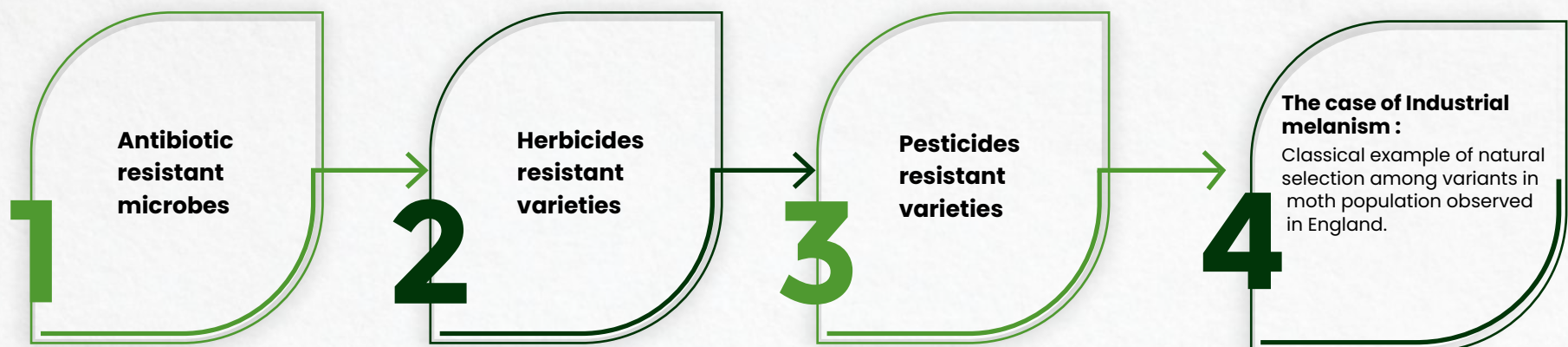
- **When we describe story of this world we describe evolution as a process. When we describe the story of life on earth, we treat evolution as a consequence of a process called natural selection.**



4

- Artificial selection : By intensive breeding programme, man has created breeds that differ from other breeds (e.g., dogs)



7 EXAMPLES OF EVOLUTION BY ANTHROPOGENIC ACTION



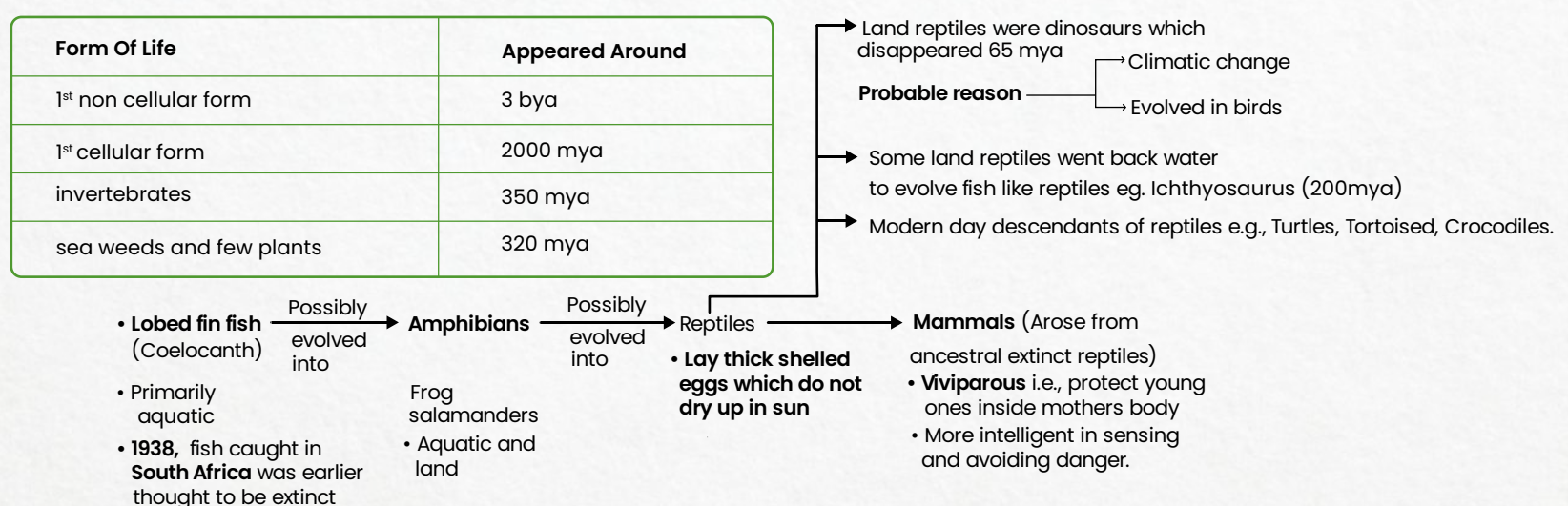
Parameters	Before industrialisation (1850s)	After industrialisation (1920s)
Figure		
Tree trunks	White, covered by lichens	Became dark due to deposition of soot and smoke
White moths	More	Less
Melanised moths	Less	More
Predators feed on	Melanised moths	White winged moths

• Lichens do not grow in polluted area (pollution indicator)

• Agent of natural selection : Predator/ birds

• Moths that were able to camouflage themselves (i.e., hide in the background) survived **but no variant is completely wiped out**

8 A BRIEF ACCOUNT OF EVOLUTION



• A Likely Reason for Restricted Distribution of Pouched Mammals in Australia

- Due to continental drift, when South America joined North America, these animals were overridden by North American fauna. Due to the same continental drift pouched mammals of Australia survived because of lack of competition from any other mammal.
 - The First Mammal were Like Shrews.
- whales, dolphins seals and sea cows are aquatic mammals.



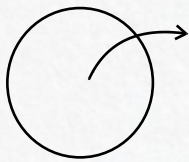
9 HARDY-WEINBERG PRINCIPLE

- Allele frequencies in a population are stable and is constant from generation to generation. This is called **genetic equilibrium**.
- Sum total of all the allelic frequencies is 1 and is represented as :
 $p + q = 1$ [p = Frequency of recessive allele (a); q = Frequency of dominant allele (A)]
 $p^2 + q^2 + 2pq = 1$ [p^2 = Frequency of homozygous dominant (AA); q^2 = Frequency of homozygous recessive (aa); $2pq$ = Frequency of heterozygotes (Aa)]

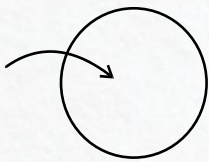
- The **gene pool** (total genes and their alleles in a population) remains a constant.
- When frequency measured, differs from expected values, the difference indicates the **extent of evolutionary change or disturbance in genetic equilibrium**.

Factors affecting Hardy-Weinberg equilibrium:

1. Gene migration : When migration of a section of population to another place or population occurs, gene frequencies change in the original as well as in the new population.



- Emigration (-)
- Some genes/alleles lost



- Immigration (+)
- New genes/alleles added

- When gene migration occurs multiple times, it is called **gene flow**.

2. Genetic recombination: Variations due to recombination during gametogenesis

3. Mutation: Microbial experiments show that pre-existing advantageous mutations when selected will result in observation of new phenotypes. Over few generations, this would result in speciation.

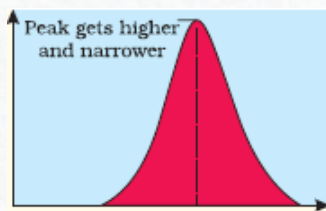
4. Genetic drift: Change in gene frequencies in a small population by chance. Sometimes the change in allele frequency is so different in the new sample of population that they become a different species. The original drifted population becomes founders and effect is called founders effect.

5. Natural selection : A process is which heritable variations enabling better survival are enabled to reproduce and leave greater number of progeny.

Types

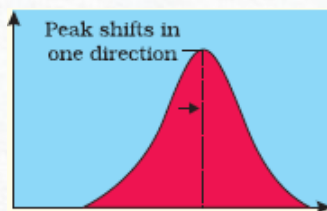
Stabilising selection

- More individuals acquire mean character value



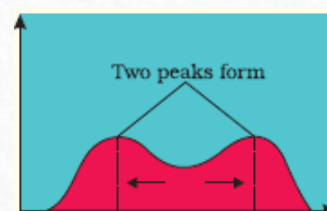
Directional selection

- More individuals acquire value other than the mean character value



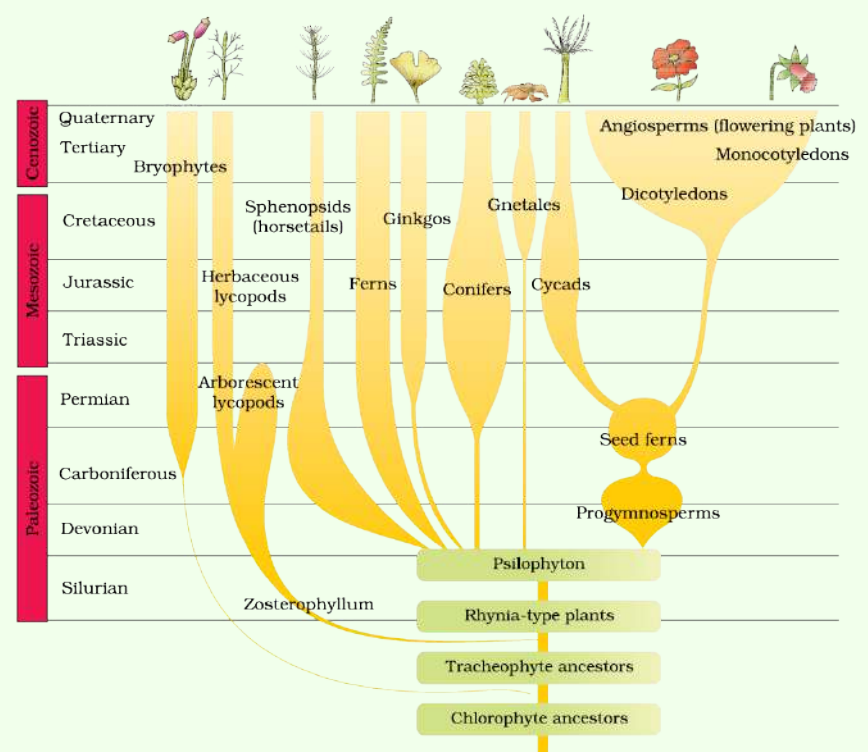
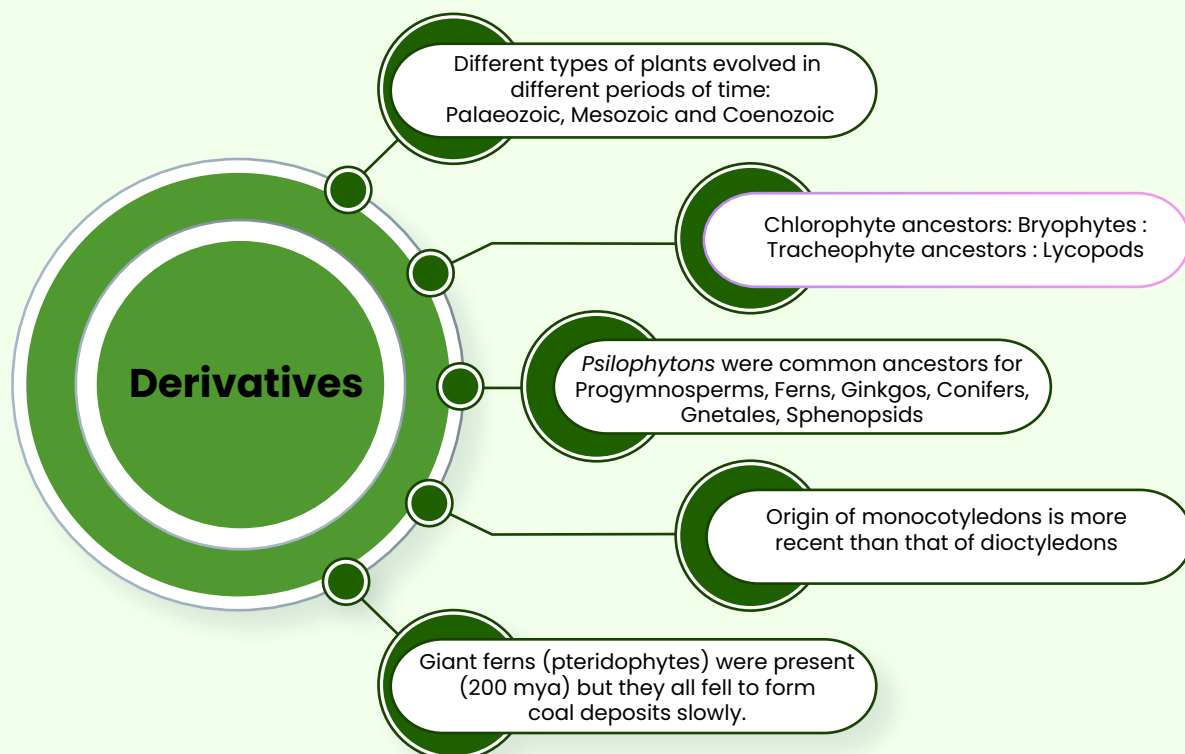
Disruptive selection

- More individuals acquire peripheral character value to both ends at the distribution curve



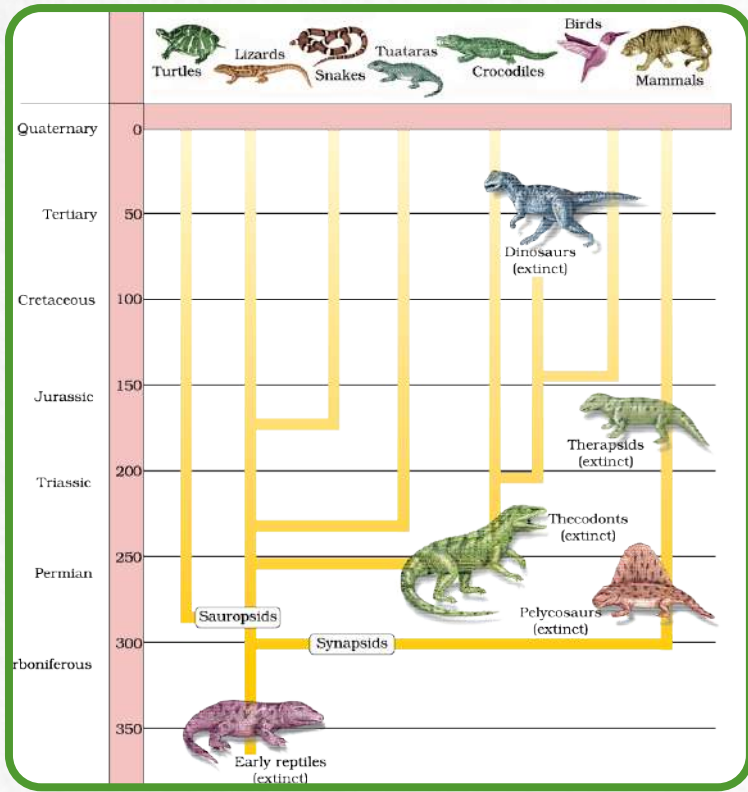
10

A BRIEF ACCOUNT OF EVOLUTION OF PLANTS



**11**

A BRIEF ACCOUNT OF EVOLUTION HISTORY OF VERTEBRATES



Derivatives

- Turtles, Lizards, Snakes and Tuatara arose from common ancestor sauropsids
- Thecodont ancestors gave way to existing crocodiles and birds and extinct dinosaurs.
- Story of origin of mammals:
Extinct reptiles → Synapsids → Pelycosaurs → Therapsids → Mammals

12

A FAMILY TREE OF DINOSAURS

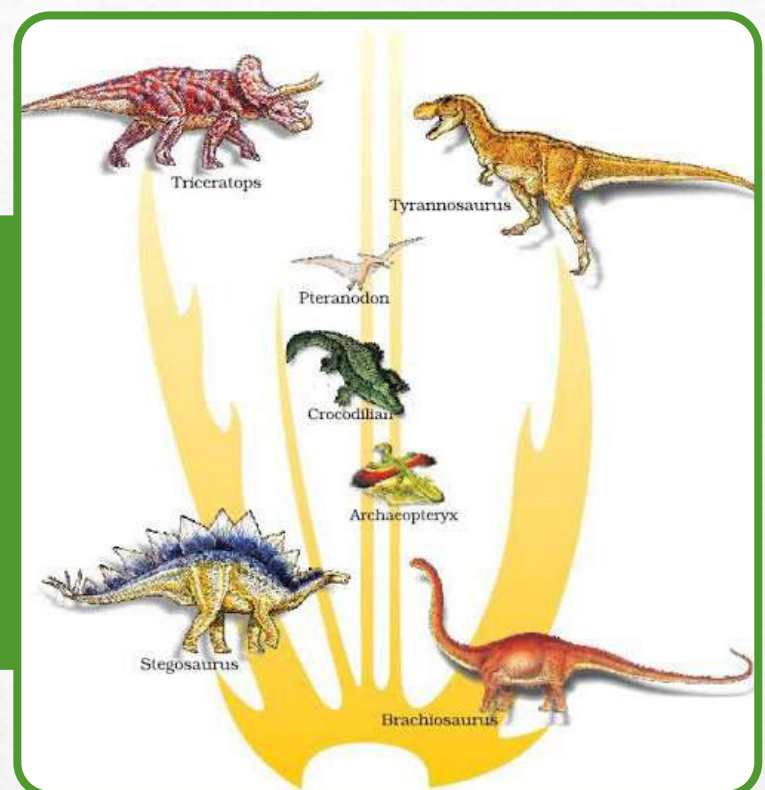
- *Triceratops* – three horned dinosaur with bony frill around back of its head.

Stegosaurus – Large triangular bony plates along the back and spiked tail

Tyrannosaurus rex – 20 feet in height, had huge fearsome dagger-like teeth

Brachiosaurus – Long giraffe like neck, long forelimbs

- *Pteranodon* were possibly flying reptiles
- *Archaeopteryx* is a transitional fossil between non avian dinosaurs and birds
- *Brachiosaurus* and *Tyrannosaurus* arose separately, mostly likely, from a common ancestor.





13

ORIGIN AND EVOLUTION OF MAN

- 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.

Human ancestors	Years back	Cranial capacity	Specific features
<i>Dryopithecus</i> <i>Ramapithecus</i>	15 mya	–	<div>moreape-like</div> <div>more man-like</div> <div>Hairy and walked like Gorillas and Chimpanzees</div>
<i>Australopithecus</i>	2 mya	–	<ul style="list-style-type: none">• Few fossils of man-like bones have been discovered in Ethiopia and Tanzania.• 3–4 mya, man-like primates walked in East African grasslands.• They were probably not taller than 4 feet but walked upright.• Evidence shows they hunted with stone weapons but essentially ate fruit.
<i>Homo habilis</i>	–	650 cc – 800 cc	<ul style="list-style-type: none">• First human-like being, the hominid• Probably did not eat meat
<i>Homo erectus</i>	1.5 mya	900 cc	<ul style="list-style-type: none">• Fossils discovered in Java in 1891• Probably ate meat
<i>Neanderthal man</i>	1,00,000–40,000 years back	1400 cc	<ul style="list-style-type: none">• Lived in near East and Central Asia• Used hides to protect their body and buried their dead
<i>Homo sapiens</i>	75,000–10,000 years ago (ice age)	–	<ul style="list-style-type: none">• Arose in Africa and moved across continents and developed into distinct races

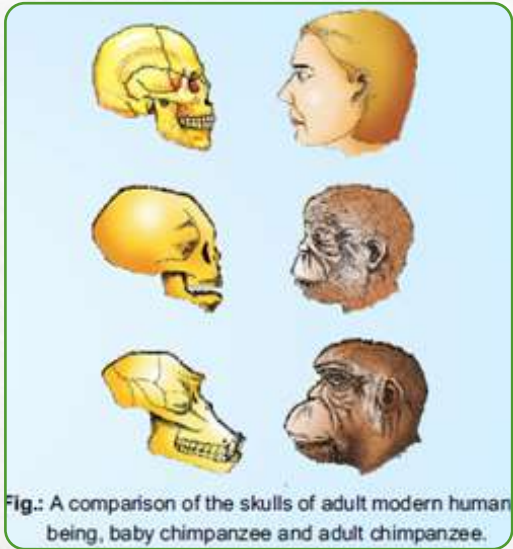


Fig.: A comparison of the skulls of adult modern human being, baby chimpanzee and adult chimpanzee.

- The skull of baby chimpanzee is more like adult human skull than adult chimpanzee skull
- **Pre historic cave art**–18,000 years ago. One such cave paintings by pre-historic humans can be seen at **Bhimbetka rock shelter** in Raisen district of Madhya Pradesh.
- Agriculture came around **10,000 years back** and human settlements started.