

EVOLUTION

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- Evolutionary Biology - Study of history of life forms on Earth.
- Evolution - To understand the changes in flora and fauna that have occurred over millions of years on earth.
- Acc to Darwin - Descents with modification (Variation)
- Unit of evolution - Population
- Raw material of evolution - Variation.

→ Origin of universe -

- When we look at stars on a clear night sky we are, in a way looking back in time.
- Stellar distances are measured in light years. What we see today is an object whose emitted light started its journey millions of years back and from trillions of kilometres away and reaching our eyes now.
- However, when we see objects in our immediate surroundings we see them instantly and hence in the present time. Therefore, when we see stars we apparently are peeping into the past.

Origin of universe - 20 bya

Origin of Earth - 4.5 bya

Origin of life - 4.0 bya [500 million after formⁿ of Earth]

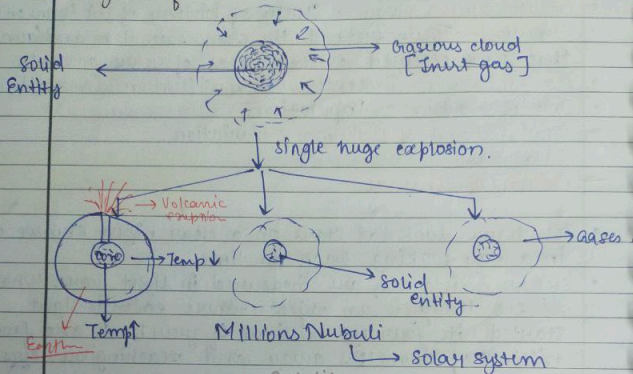
(Noncellular life) (3 bya)

↓
Giant molecules
(RNA, Protein, Polysac)

(Cellular life) (2 bya)

↓
unicellular → multicellular

⇒ Origin of universe (BIG BANG THEORY)



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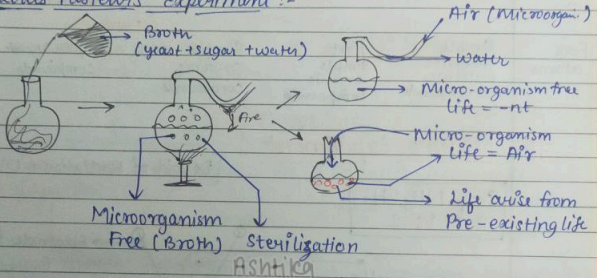
Theories to Explain Origin of Life

- 1) Theory of special creation.
- 2) Theory of Catastrophism.
- 3) Theory of Panspermia / Cosmozoic Theory -
Some scientists believe that it came from outside. Early Greek thinkers thought units of life called spores, were transferred to different planets including Earth. 'Panspermia' is still a far idea for some astronomers.
- 4) Theory of Spontaneous Generation (Theory of abiogenesis) (Aristotle and Von Helmont)
- Acc to this life arise spontaneously out of non living matter.
- Von Helmont - within 21 days, rats are produced from wheat grains kept with a shirt drenched in sweat.
- 5) Theory of Biogenesis. (Aurkay)
- The theory of spontaneous generation was disproved by many scientists.

- They proved that new organisms can be formed from pre-existing ones, i.e. omnis vivum ex vivo. Noted scientists who experimentally challenged the theory were Francesco Redi, Spallanzani and Louis Pasteur.

6) Opalin - Haldane Theory / Pre-abiogenesis / Chemical Evolution

Louis Pasteur's Experiment:-



6) OPARIN AND HALDANE'S THEORY OF ORIGIN OF LIFE or theory of pre-abiogenesis or chemical evolution.

- The above mentioned simple molecules combined to form complex biomolecules in water in the presence of following energy sources.

- Heat from volcanic eruptions
- Lightning from clouds
- UV rays and X-rays.

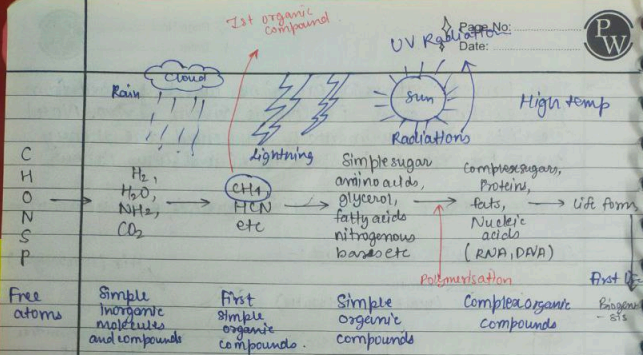
→ Life originated in water

→ Alexander I. Oparin was a Russian biochemist.

→ He wrote the book 'Origin of Life'

→ J.B.S. Haldane was an English physiologist who later on settled in India in Bhubaneswar.

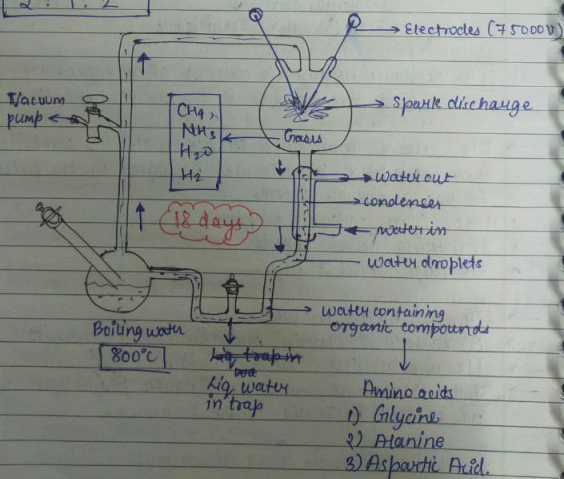
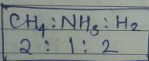
Term → Hot dilute soup.



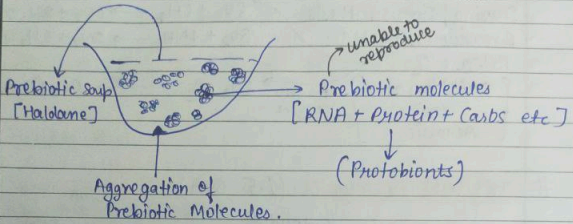
Miller's Experiment

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[Devoid of Radiation = UV rays]



→ Biological Evolution: (Biogenesis) — Isolation of Organic Molecules



Types of Protobionts

Coacervates (Large Protein + Polysaccharides)
(Oparin)

(Protobionts + Lipid)

Microspheres (Sydney Fox)

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- Show simple metabolism
- Lipid membrane = - nt

→ Lipid by layer ant

Eobionts

⇒

able to divide

~~Prebiotic~~

1st Non-cellular life = 3by a (Anaerobic)

[RNA + Protein + Polysac]

Origin of Prokaryotes
[2. Bya]
1st cellular

1) Chemoheterotroph (Anaerobic)

Fermentation of organic mole

→ Energy

2) Chemogautroph (Anaerobic)
eg- Ironsacteria

Chemical Rzn

→ Energy

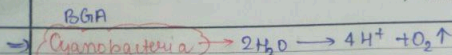
3) Simple photo autotroph (Anaerobic)
eg- Sulphur bacteria

Formⁿ of Pigments

→ used light energy

→ H₂S = Source of H⁺

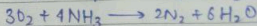
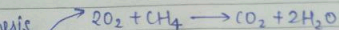
4) Photoautotroph
→ H₂O



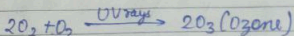
During photosynthesis
Breakdown of H_2O

Release O_2

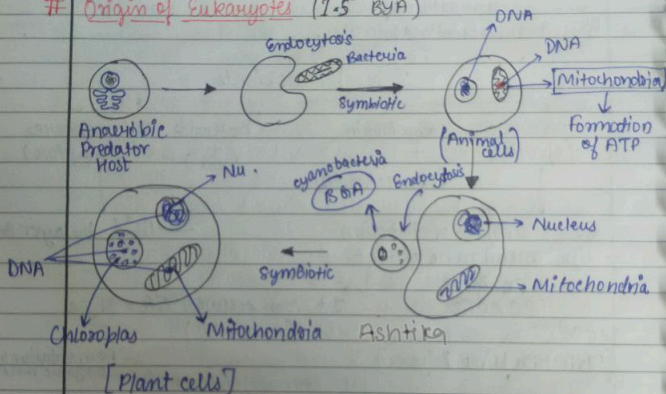
[Oxidising atm
or
Aerobic]



Formation
of ozone



Origin of Eukaryotes (1.5 BYA)



Evidences in favour of Evolution

- 1) Palaeontological Evidences (Evidences from fossil record)
- 2) Evidences from Comparative Anatomy and morphology.
- 3) Embryological Evidences (Evidences from Embryology)
- 4) Evidences from Physiology and Biochemistry.

1) Palaeontological Evidences (Evidences from Fossil Record)

Palaeontology $\rightarrow$ Study of Fossils

Fossil $\rightarrow$ It is a preserved remains of Hard part of the organism.

$\Rightarrow$ Types of Rocks

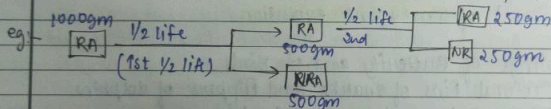
$\rightarrow$ Sedimentary Rocks (Lime stone & sandstone) (Best for study of fossil)

$\rightarrow$ Metamorphic (Marble)

$\rightarrow$ Igneous (Granite stone)

$\rightarrow$ Age of Rocks / Fossils - Ashtika

A) Radio active dating Technique - used to determine the age of material - Rocks & fossils.



Ratio of Radioactive Sub $\rightarrow$ 1st $\frac{1}{2}$ life (1:1)
 $\rightarrow$ 2nd $\frac{1}{2}$ life (1:3)

a) Carbon Dating $\rightarrow$ C^{14} $\xrightarrow[5760 \text{ years}]{\frac{1}{2} \text{ life}}$ N^{14}
 (stable) (RA) (unstable) (NRA)

b) Uranium Dating $\rightarrow$ U^{238} $\xrightarrow[\text{Millions Year}]{\frac{1}{2} \text{ life}}$ Pb^{206}

B) Electron Spin Resonance (ESR)

$\rightarrow$ Modern and most accurate Technique

2) Evidences from Comparative Anatomy and Morphology

Homologous Organs:-

- Similar Anatomical structure but different in functions
- Show common ancestry and development
- Divergent evolution.

eg:- 1) Forelimbs of man, cheetah, whale and bat.

2) The mouth parts of cockroach, honey bee, mosquito and butterfly.

3) Thorn and tendrils of Bougainvillea and Cucurbita represent homology. (stem modification)

4) Potato and Ginger (S) 5) Radish and Carrot (R)

Analogous Organs

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- Different their anatomical structural but similar in functions due to same needs.

- Result of convergent evolution.

eg:- 1) Wings of Butterfly and of Birds.

2) Pectoral Fins of sharks and flippers of dolphins

3) Stings of honey bee and scorpion.

4) Eye of octopus and eye mammals.

5) Sweet potato (root modification) and potato (stem modification)

Vestigial Organs

- The organs which are present in reduced form and do not perform any function in the body but correspond to the fully developed functional organs of related animals are called vestigial organs.

eg- Vestigial Organs in Human Body

- Nictitating membrane (plica semilunaris)
- Auricular muscles of ear
- Segmental muscles of abdomen.

- Vermiform appendix
- Coccyx or tail bone
- Third molars (wisdom teeth)
- Nipples in males.

3) Embryological Evidences (Evidences from Embryology)

→ Embryological support for evolution was also proposed by Haeckel based upon the observation of certain features during embryonic stage common to all vertebrates that are absent in adult.

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→ For example, the embryos of all vertebrates including human develop a row a vestigial gill slit just behind the head but it is a functional organ only in fish and not found in any other adult vertebrates. However, this proposal was disapproved on careful study performed by Karl Ernst von Baer. He noted that embryos never pass through the adult stages of other animals.

→ Biogenic law - Acc to Haeckel - Ontogeny (development of embryo) recapitulates phylogeny.

4) Evidences from Physiology and Biochemistry

→ Similarities in protein and genes performing a given function among diverse organism give clues to common ancestry.

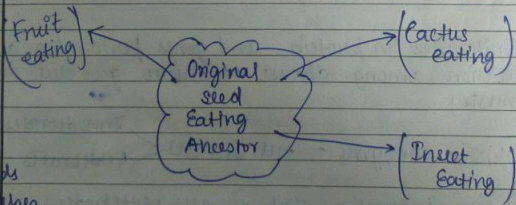
Eg - Trypsin Enzyme - +nt in all Invertebrates
Vertebrates

Pepsin Enzyme - +nt in all vertebrates.

ADAPTIVE RADIATION :-

- During his journey (1831) Darwin went to Galapagos islands - 22
- Ship - H.M.S Beagle
- Duration of journey 5 years.
- There he observed an amazing diversity of creatures. Of particular interest, small black birds later called Darwin's Finches amazed him. He realised that there were many varieties of finches in the same island.
- All the varieties are evolved on the island itself. From the original seed-eating features, many other forms with altered beaks arose, enabling them to become insectivorous and vegetarian finches.
- This process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats) is called adaptive radiation.
- Darwin's finches represent one of the best examples of this phenomenon. Another example is Australian marsupials and Placental mammals.

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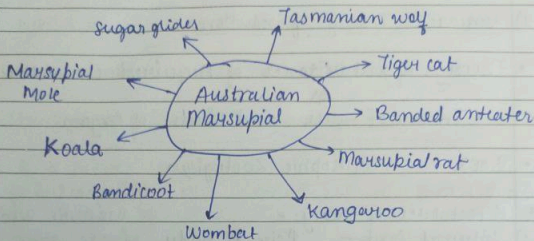


- 22 islands

- 13 finches.

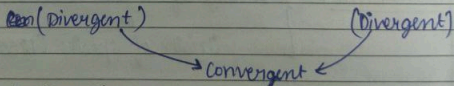
[Divergent]

⇒ Australian Marsupials



→ When more than 1 adaptive radiation appeared to have occurred in an isolated geographical area (representing different habitats), one can call this convergent evolution. Ashika

→ Placental mammals in Australia also exhibit adaptive radiation in evolving into varieties of such placental mammals each of which appears to be 'similar' to a corresponding marsupials (eg placental wolf and Tasmanian wolf marsupials)



Convergent Evolution b/w Placental and Australian Marsupials.

PM	AM
• Mole	- Marsupial mole
• Anteater	- Numbat (anteater)
• Mouse	- Marsupial mouse
• Lemur	- Spotted cuscus
• Flying squirrel	- Flying phalanger
• Bobcat	- Tasmanian tiger cat
• Wolf	- Tasmanian wolf

BIOLOGICAL EVOLUTION :-

1) Lamarck's Theory of Evolution :-

- Theory of inheritance of Acquired characters
or
Theory of use and Disuse of organ
- Book = Philosophie Zoologique

4 Postulates of theory :-

- 1) Internal force - ↑ size of body.
- 2) Formation of new organisms in the result of the need
by organism Ashtika
- 3) Development of organ & its use.
- 4) All changes acquired by organism during its life
are transferred to its offsprings (wrong)

Note:- Lamarck theory was discarded by :-

(Weismann theory of Germplasm)

- Somatoplasm - Somatic cell ✗
- Germplasm - Germ cells ✓

2) Darwinism :- { Theory of Natural Selection or Origin of species (1859) }

* Darwin influenced by a article

"An essay on Principles of Population"
(By - T.R. Malthus)

* Main points of theory of Natural selection:-

- 1) High rate of Reproduction.
- 2) Total number almost constant (^{Natural}Resources are limited).
- 3) Struggle of existence (competition)

Intraspecific
- b/w number of same species

Interspecific
- b/w memb. of Diff. species
- Responsible for evolution.

4) Variation and Heredity (continuous variation)

Adaptive
or
Useful

Ashitika

Non adaptive
(Harmful)

- 5) Natural Selection - Individual with max^m useful variation selected by Nature.
- 6) Survival of fittest :- Fitness is end result of the ability to adapt and get selected by Nature.

2 Key Concepts of Darwin theory

Branching Descent

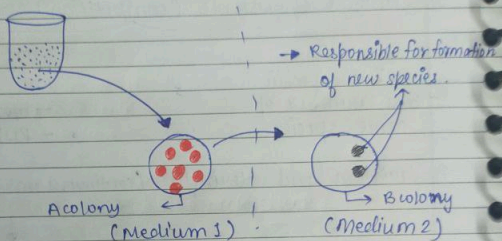
Pattern of Evolution

Natural Selection

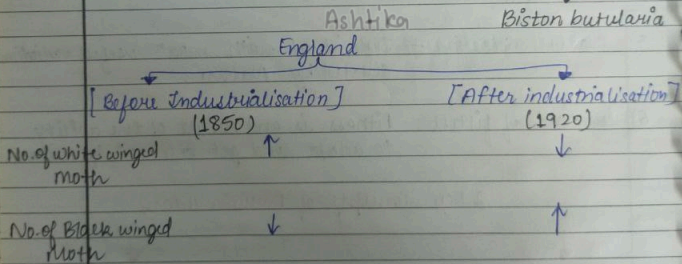
Mechanism of Evolution
(Driving force.)

* Darwin said that the appearance of new life forms is due to $\Rightarrow$ accumulation of variations from one generation to another.

eg:- Microbial Colony -



Industrial Melanism (Peppered moth)



Other Theories of Darwin:-

- 1) Theory of Artificial Selection.
- 2) Theory of Sexual Selection
- 3) Theory of Pangenesis - Rejected by Weismann's Theory of Germplasm.



MUTATION THEORY

→ Hugo de Vries, work on - Evening primrose
[*Oenothera lamarckiana*]

→ According to this theory-

- Mutations are responsible for evolution.
- Mutation provide raw material for evolution.

↓
Discontinuous source of variation.

Darwin

- 1) Variations are →
Small, continuous,
Directional, Adaptive

- 2) Evolution is slow
and gradual.

Ashtilca

Hugo de Vries

- 1) Variations are →
Large, Discontinuous,
Non-directional, Random

- 2) Evolution is - sudden
and jerky process

Called - saltation - single
step, mutation
large

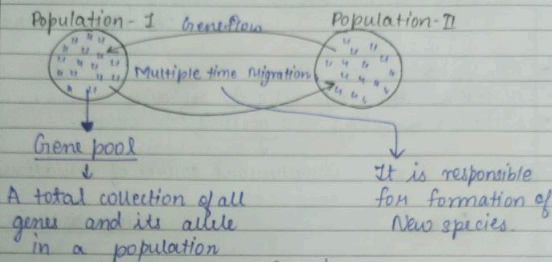
Modern / Synthetic Theory -

→ Many factors are collectively responsible for formation of new species. :-

- 1) Gene migration or gene flow
- 2) Genetic Drift
- 3) Mutation
- 4) Genetic Recombination
→ Regular source of variation
- 5) Natural Selection

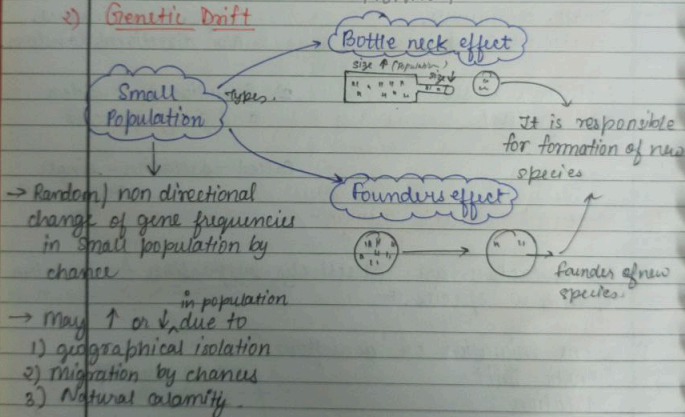
→ All are responsible
for formation of
new species.

1) Gene flow



2) Genetic Drift

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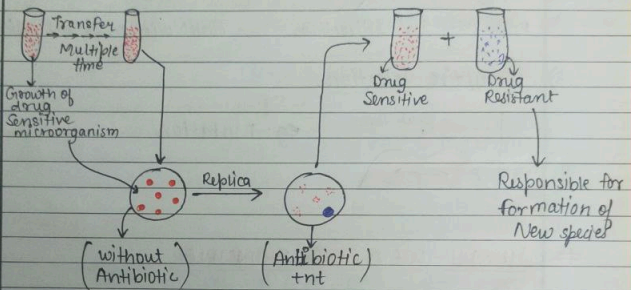
3) Mutation / Genetic Basis of Adaptation

* Lederberg's experiments →

- 1) Microbial experiments show that pre-existing advantageous mutations when selected will

result in observation of new phenotypes.

2) Over few generations, this would result in speciation.



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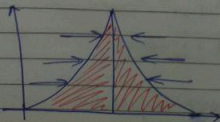
Note: The new environment does not induce the mutation, it only selects the preadaptive mutations that occurred earlier.

4) Natural Selection

- eg: → Industrial Melanism
→ Evolution of Pesticide Resistant Mosquito.
→ Antibiotic Resistant microbes.
→ Sickle Cell Anaemia
→ Darwin finches etc.

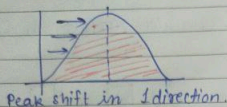
* Types of Natural Selection -

a) Stabilising Selection



eg - Sickle Cell Anaemia

2) Directional Selection :-

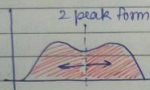


eg- Industrial Melanism

+
Pesticide Resistant Mosquito

+
Antibiotic resistant Microbes

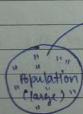
3) Disruptive Selection :-



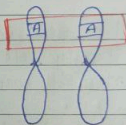
eg:- Mutation

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HARDY - WEINBERG PRINCIPLE



Frequency of occurrence of allele of gene or locus or individual



AA
aa
Aa

♂ — A } = A+A
♀ — A } = a+a
A+a

$$p^2 + q^2 + 2pq = 1$$

or

$$(p+q)^2 = 1$$

or

$$p+q = 1$$

→ Gene or allelic frequency in large population remain constant over generations.

if — } Mating occur at random
 } absence of above 5 factors

- 1) Mutation
- 2) Genetic Drift
- 3) Recombination

- 4) Gene migration
- 5) Natural Selection

Ques Frequency of an autosomal lethal gene (P) is 0.4, the frequency of carrier in a population of 200 individual is:-

$$P = 0.4$$

$$2pq = ?$$

$$p + q = 1$$

$$q = 1 - 0.4 = 0.6$$

$$2pq = 2 \times 0.4 \times 0.6 = 0.48 \text{ (100)}$$

$$= 2 \times 0.48 \text{ (200)}$$

$$= 0.96 \text{ (200)}$$

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BRIEF ACCOUNT OF EVOLUTION:

1st Acellular life (3 Bya)



1st cellular life (Prokaryotes) (2 Bya)



Invertebrate become active (500 mya)



1st vertebrate (Jawless fish) (350 mya)



1st Jawed Vertebrate (350 mya)

eg - Latimeria / Coelacanth / Lobefin fish

→ Caught in South Africa (1938)

→ Living fossil

→ Thought to be extinct



1st Amphibia (Extinct)



[Frogs & Salamander]



Early Reptiles (Extinct)



Birds

Mammals

Some back to water (200 mya) - Ichthyosaurs

→ Dinosaurs (Extinct)

→ Turtles } S

→ Lizards } D

→ Snakes } R

→ Tuatara } V

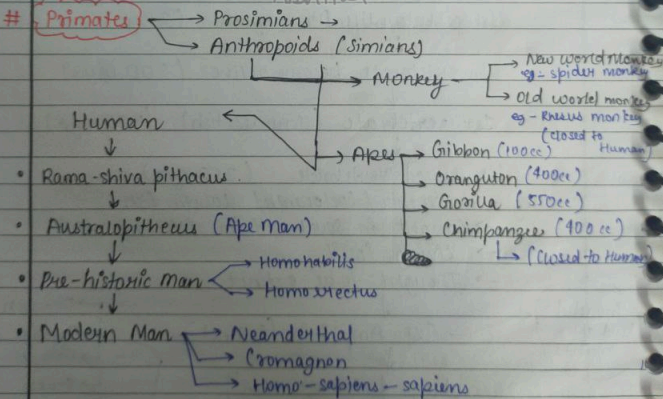
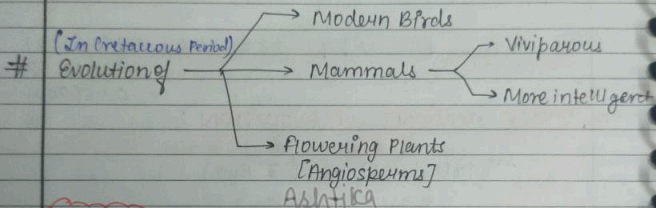
→ Crocodiles } G

Involved land after plants

Dinosaurs = Dominating land reptiles in jurassit period (150 mya)

Biggest Dinosaur - Tyrannosaurus rex (20 feet)

→ About 65 mya dinosaurs suddenly ~~dies~~ disappeared from earth (in Cretaceous Period)



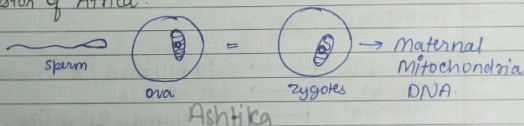
Chromosomal Similarities b/w - Human and Chimpanzee

→ No. of chromosome

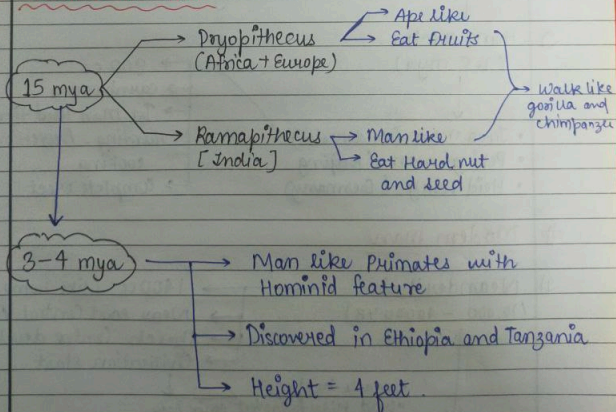
↓ Chimpanzee = 48 } DNA const = 100% similar
 ↓ Human = 46 } No. of chromosome ↓

* Banding patterns of chromosome 3 and 6 are similar in Human and chimpanzee.

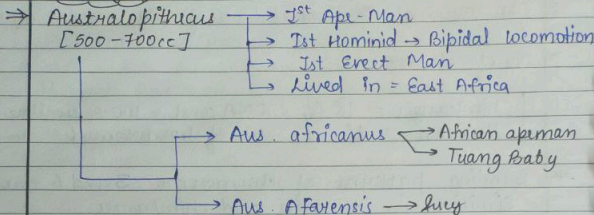
Note - Acc to Mitochondrial DNA research show
 ↳ All human races originate from 1 H sapiens ancestor of Africa.



ORIGIN OF MAN

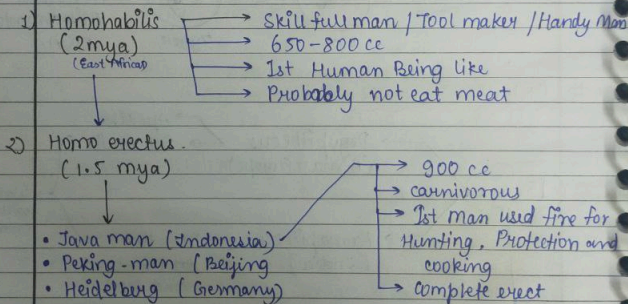


2-5 mya

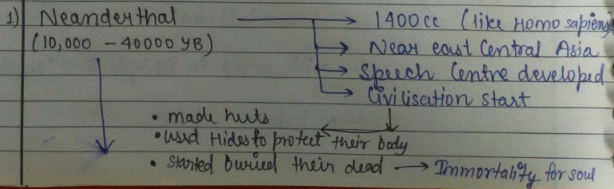


- Hunted with stone weapons (for protection)
- Eat = fruits

Pre-Historic Man Ashika



Modern man





- ↓
- 2) Cromagnon → 1650 cc
(50,000 - 10,000 YB) → Painted Painting on cave wall (18,000 YB)
- ↓
- 3) Homo-sapiens-sapiens → 1400 cc
(10,000 YB) → Agriculture started

⇒ The skull of baby chimpanzee is more likely to be same as adult human skull than adult chimpanzee skull.

Ashtika

→ Thank You ♡
with love.