NEET CRASH COURSE

EVOLUTION

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EVOLUTION

MODERN THEORY OF EVOLUTION or NEO-DARWINISM:

Hardy-Weinberg principle:

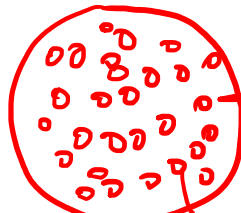
• It states that allele frequencies in a population are stable and constant from generation to generation, if a population has no selection, no mutation, no migration, no genetic drift, and are random mating.

• $(p + q)2 = p2 + 2pq + q2 = 1$.

$p+q = 1$

Gene pool: All the genes in a population at a particular time.

Population (Balanced / equilibrium)



Random mating

-Factors are known to affect Hardy-Weinberg equilibrium:

- **Gene migration or gene flow**
- **Genetic drift**
- **Mutation**
- **Genetic recombination**
- **Natural selection**

Selective mating →

TT

Tt

tt

p q

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

$p+q = 1$

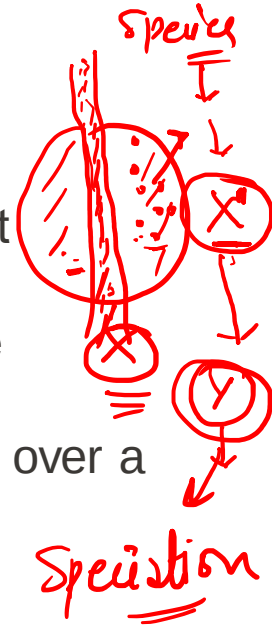
EVOLUTION

1. Gene Migration:

- When some individuals of a population migrate to other populations, or when certain individuals come into a population, the gene frequencies of the given population change, i.e., some genes are lost in the first case & added to the second.
- If this migration occurs a number of times, gene flow occurs.

2. Genetic Drift:

- Random changes in the allele frequencies of a population occurring by chance, constitute genetic drift
- The change in allele frequency may become so drastically different that they form new species.
- The original drifted population becomes the founder & the change in the phenotype & genotype of the progeny, constitute the founder effect
- This is clear with microbial experiments, where he pre- existing advantageous mutants get selected & over a few generations speciation occurs



Speciation

3. Mutations:

- Mutations are random & occurs at very slow rate.
- They create considerable genetic variation for speciation to occur.

4. Recombination:

- New combination of genes occur due to crossing over in meiosis during gametogenesis.

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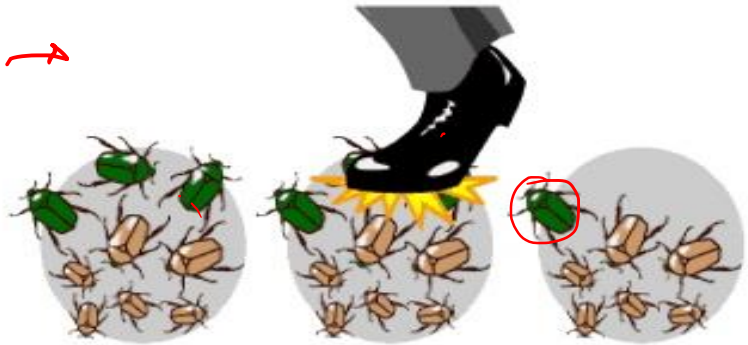
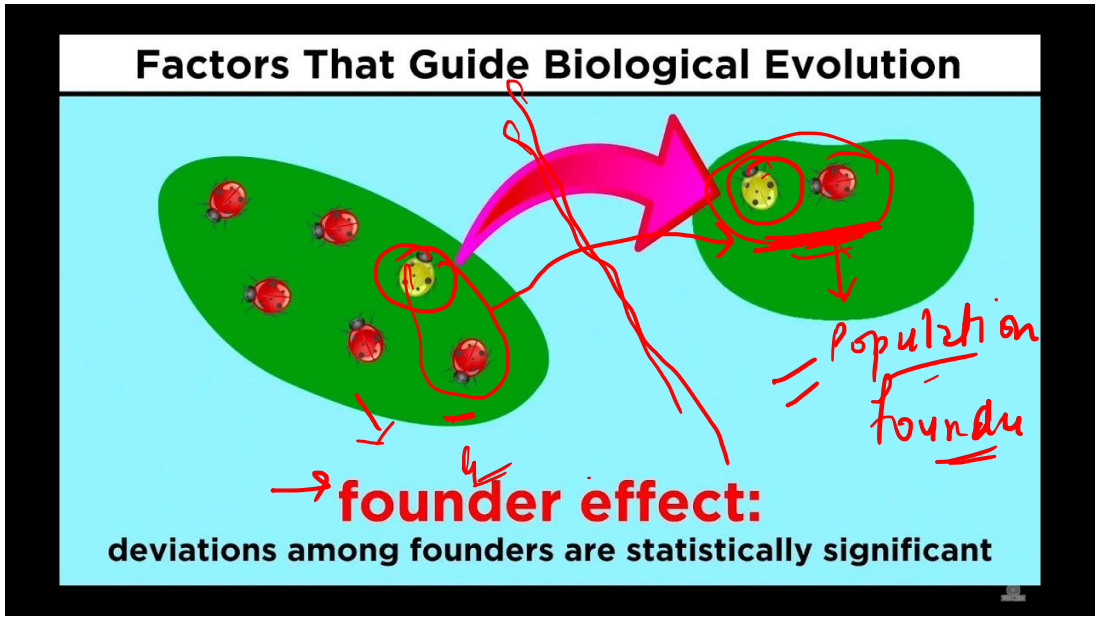
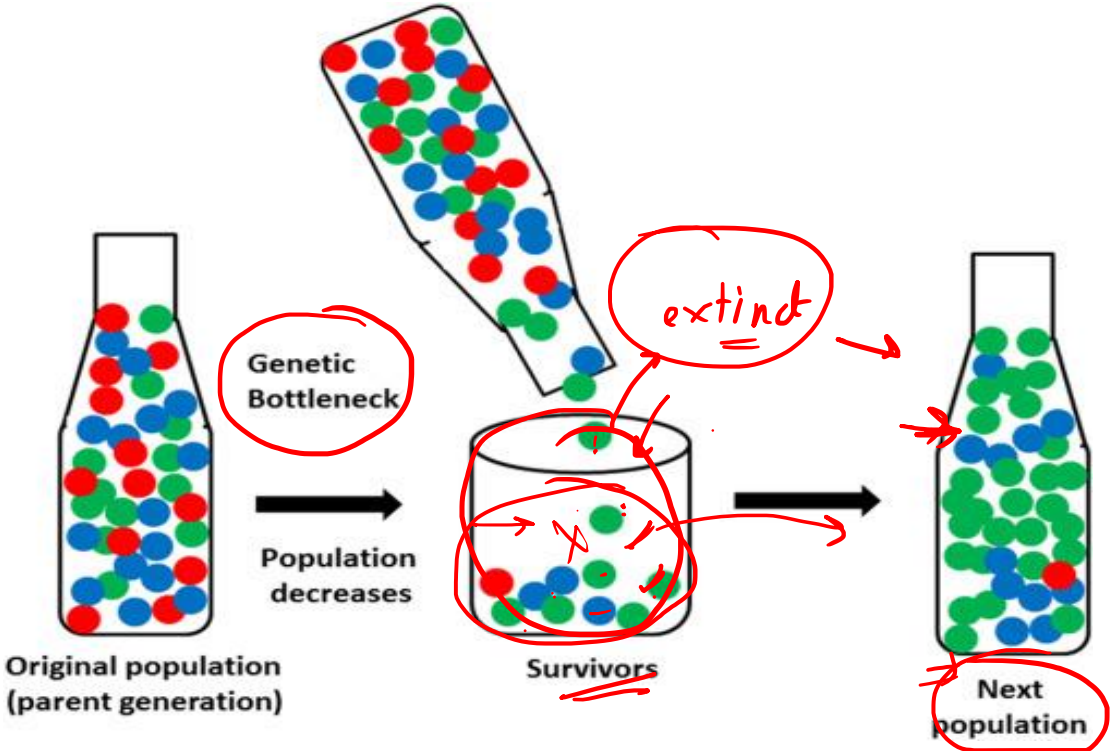
GENETIC DRIFT



Sudden decrease



Population
founder



extinct

EVOLUTION

5. Natural Selection:

- Natural selection is the most critical evolutionary process that leads to changes in allele frequencies & favours or promotes adaptation as a product of evolution.
- Coupled to increased reproductive success, natural selection makes the population look entirely different from the original population, i.e., speciation
- Natural selection process depends on the traits favoured & produce one of the three following effects:

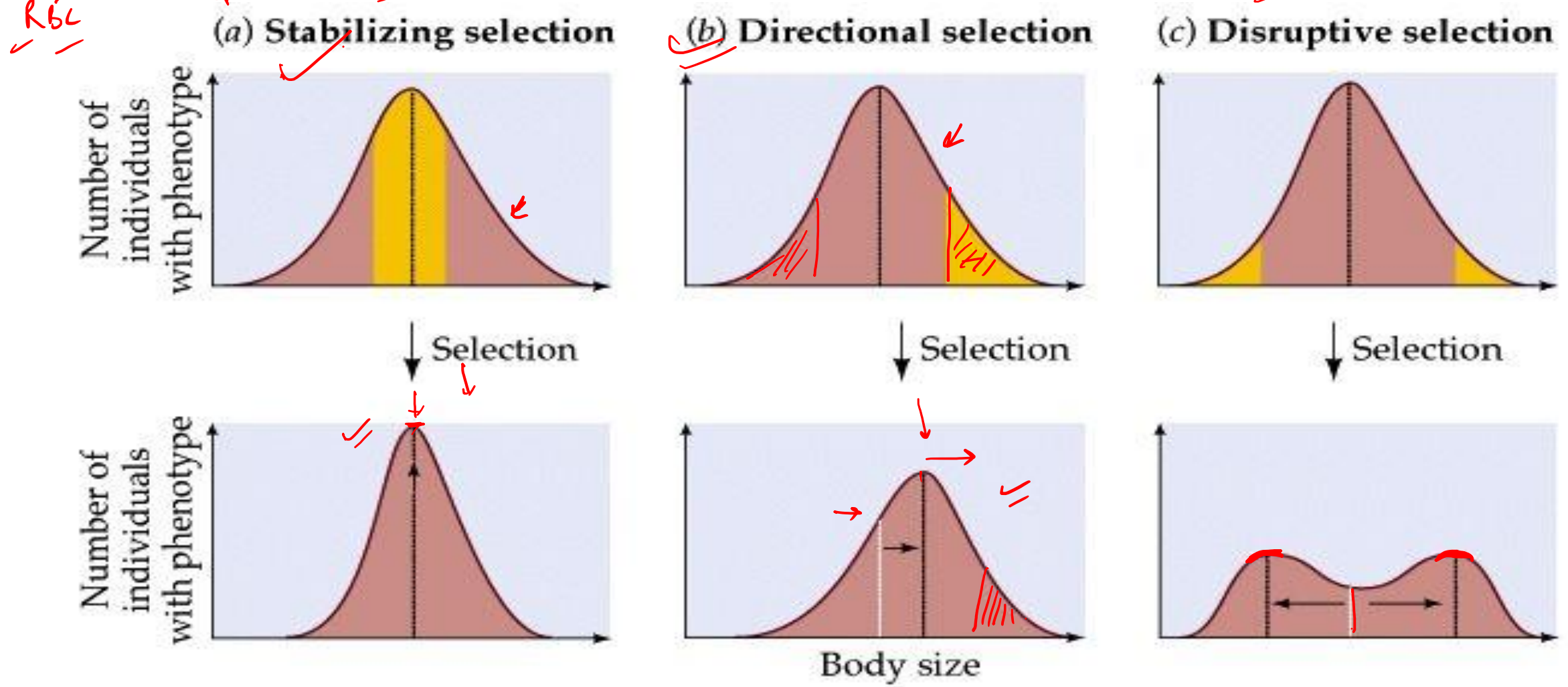
1.Stabilization- in which more individuals acquire mean character value, i.e., variation is much reduced

2. Directional change, in which more individuals acquire value other than the mean character value.

3. Disruption, in which more individuals acquire peripheral character value at both ends of the distribution curve.

EVOLUTION

TYPES OF NATURAL SELECTION



EVOLUTION

Evidences for Evolution

• Evidences for evolution come from, Palaeontology, Embryology, Comparative anatomy and morphology, Molecular homology & Biogeography.

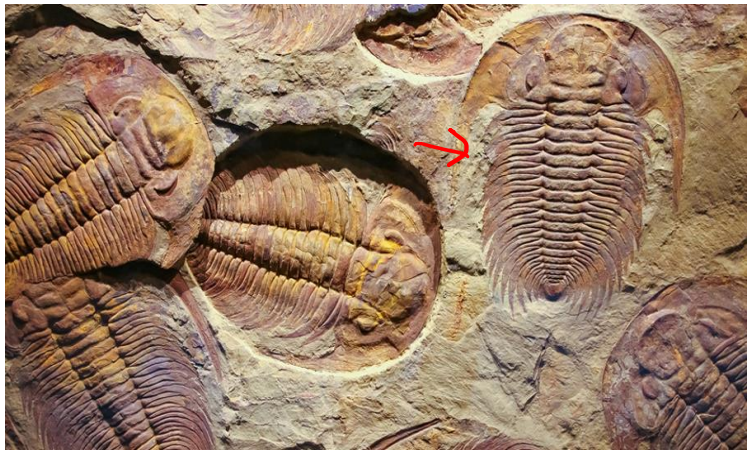
Palaeontology: • Is a study of fossils found in the rocks to support organic evolution

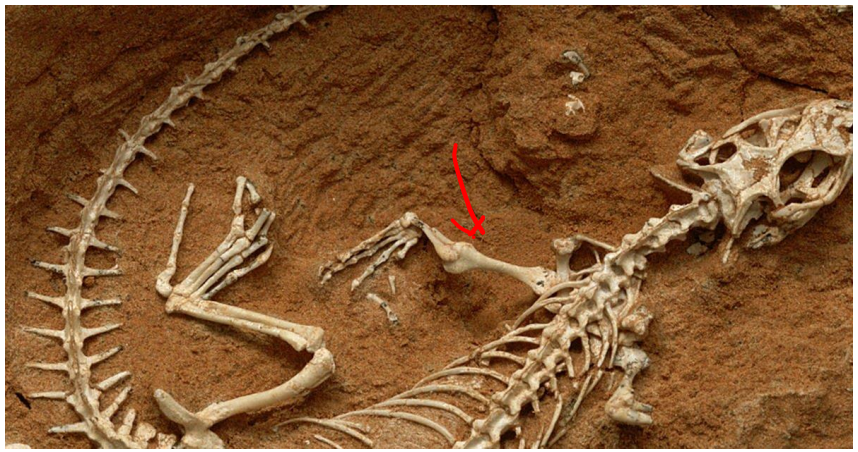
• Study of fossils from different sedimentary layers indicates:

i. The geological time period in which the organisms existed

ii. The life forms varied over time & certain life forms are restricted to certain geological life- span

iii. The new forms of life that have appeared at different times in the history of earth





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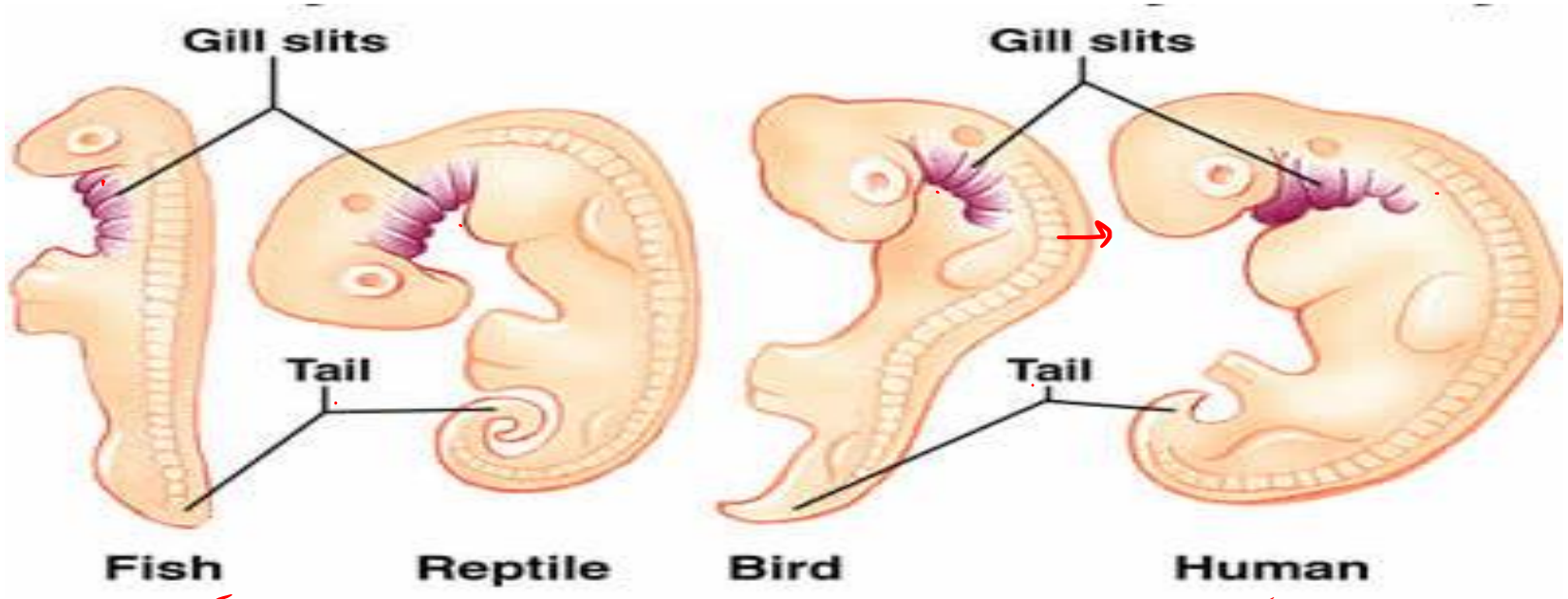
Embryology:

- It is a study based upon the observation of certain common features during embryonic stages of all vertebrates
- Ernst Haeckel proposed biogenetic law which states that 'ontogeny recapitulates phylogeny' i.e., developmental/ embryological stages of organisms (ontogeny) recapitulate their evolutionary history (phylogeny)
- Vertebrate embryos shows similarities which are:

1. All vertebrate embryos develop a row of gill slits, but they are functional only in fish & not found in any other vertebrates
2. Notochord is present in all vertebrate embryos

- But this proposal was disapproved by Ernst Von Baer; he noted that embryos never pass through the adult stage of other animals

egg → Tadpole → Adult Frog
Fish



ontogeny = (life history) repeats
Phylogeny = evolutionary history

EVOLUTION

Comparative Anatomy & Morphology:

• Comparative anatomy and morphology shows both similarities & differences among the present day organisms & those existed long before.

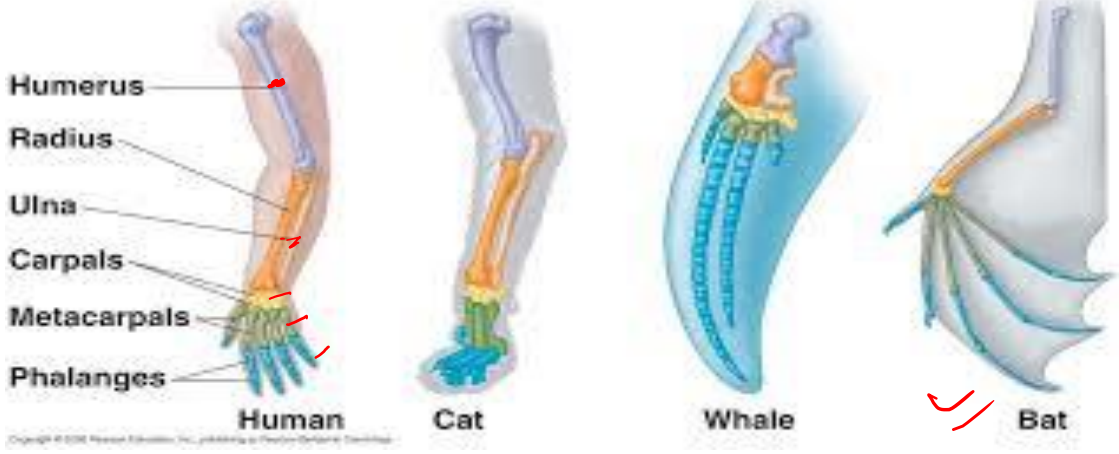
i. Homology

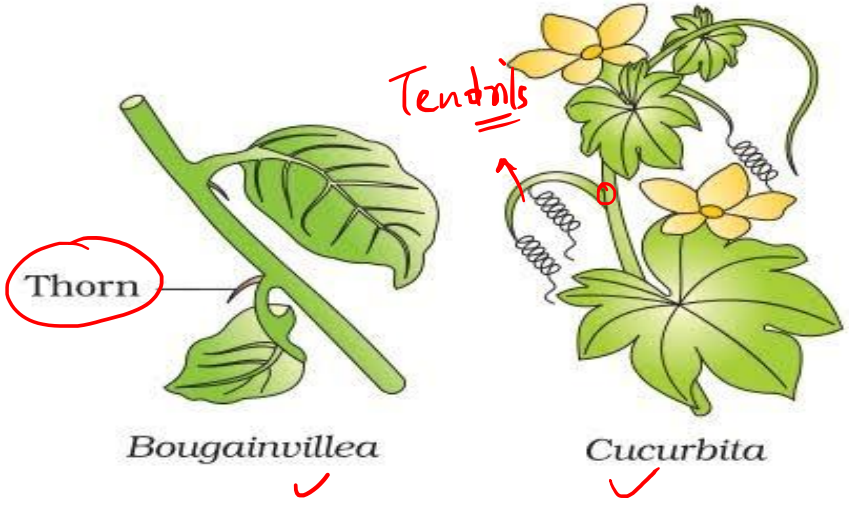
• Homology is the relationship among organs of different groups of organism, that show similarity in the basic structure and embryonic development, but perform different functions.

• Homology of organs of different organisms indicates their common ancestry

• Homology is found in the bones of forelimbs of whales, cheetah, birds, amphibians and human; they have similar basic anatomical structure with the bones humerus, radius, ulna, carpals, matacarpals & phalanges • The thorns of Bougainvillea & tendrils of Cucurbita represents homology

• Homology/ homologous organs are the result of divergent evolution, i.e., the evolutionary process where the same structure develops along different directions due to adaptations for different needs.





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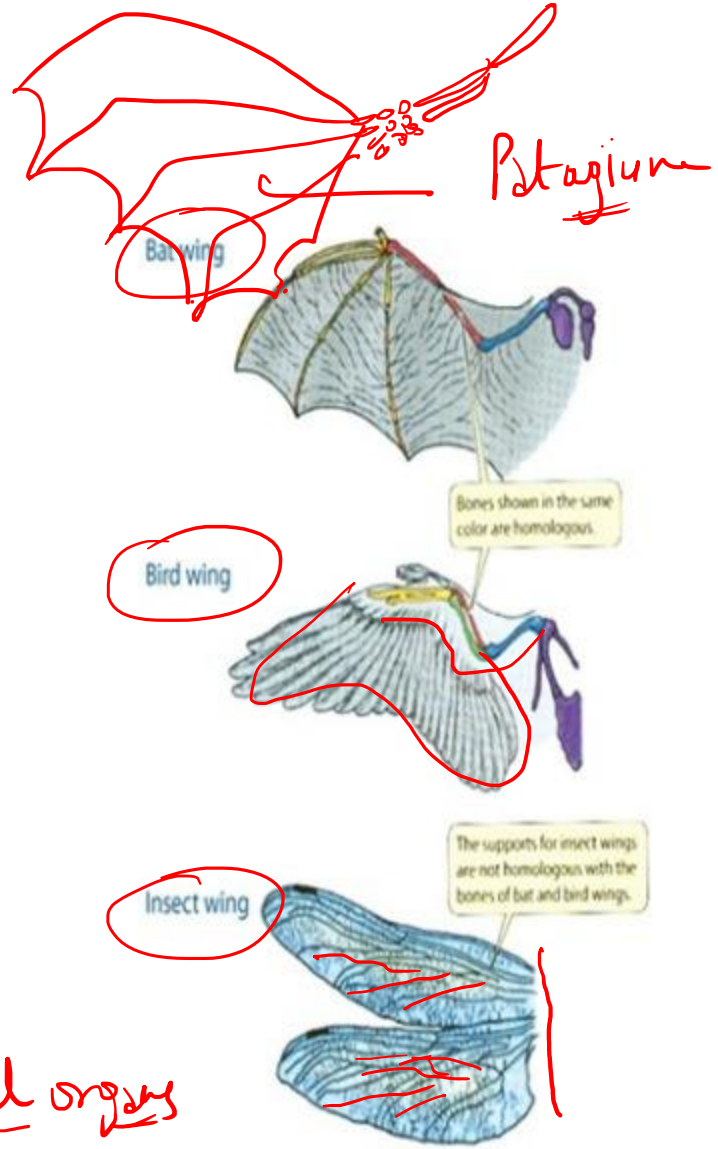
Different origin
Same function

ii. Analogy

- Analogy is the relationship among organs of different groups of organisms performing the same function, irrespective of structural or anatomical differences.
- Eg.- Eyes of octopus & those of mammals; wings of butterfly & those of birds; flippers of whales or dolphins & those of penguins; tubers of sweet potato (root modified) & those of potato (stem modified)
- Analogy is the result of convergent evolution, i.e., the evolutionary process, where anatomically different structures in different groups of organisms evolve towards the same function.
- It is the similar habitat conditions that have selected similar adaptive features in different groups of organisms towards the same function.



Vestigeal organs
↳ Hair
↳ Nictitating membrane

EVOLUTION

Adaptive Radiation

• Adaptive ration is an evolutionary process in which an ancestral stock gives rise to new species in a given geographical area, starting from a point & literally radiating to other geographical areas or habitats.

1 Darwin's finches

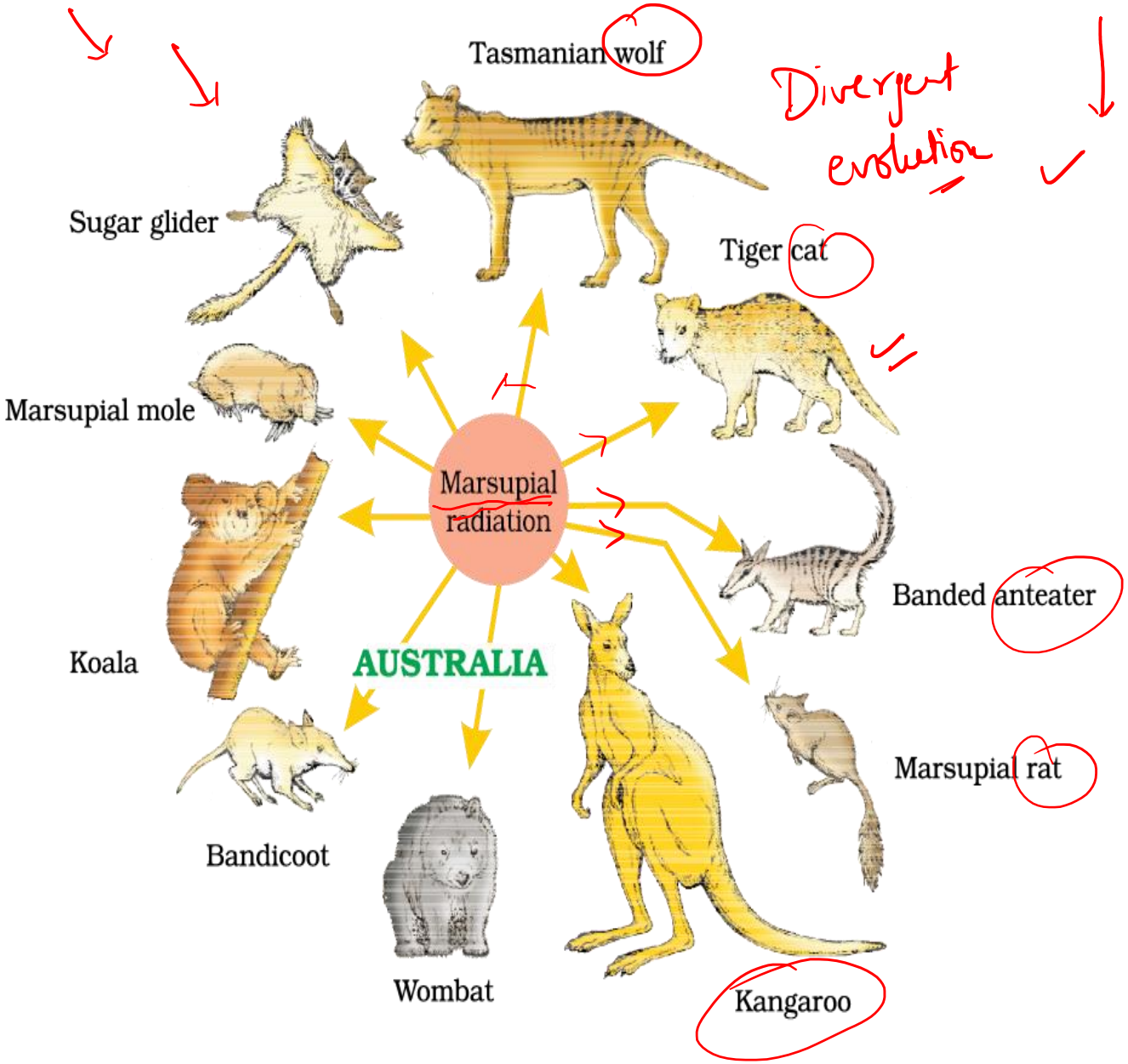
2 Australian marsupials.

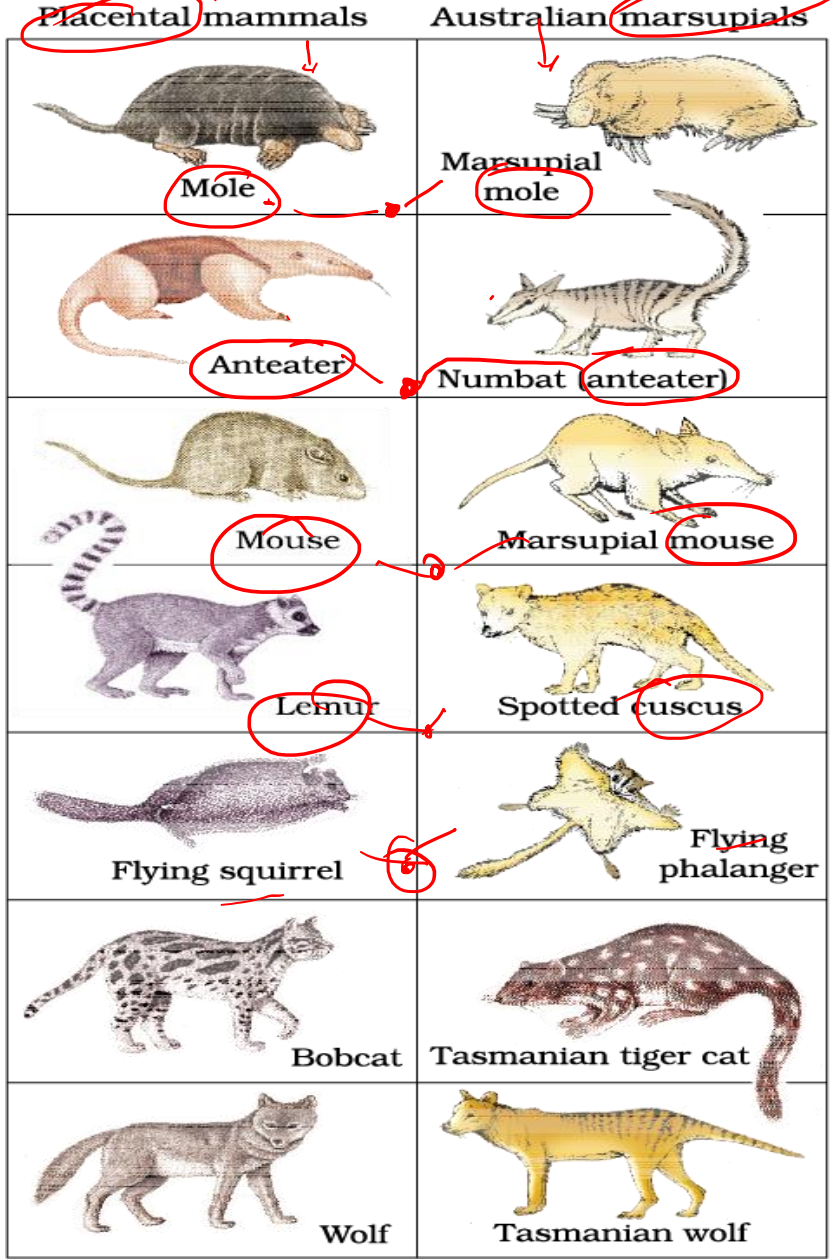
• A number of marsupials (pouched mammals) each different from the other, evolved from an ancestral stock within Australia,it can be called divergent evolution.

• When more than one adaptive radiation appeared to have occurred in an isolated geographical area with different habitats, it can be called as convergent evolution.

• Placental mammals of Australia show parallel evolution as they have evolved from other marsupial mammals, each of which closely resembles & looks similar to a corresponding marsupial.

EVOLUTION


Tasmanian wolf
Sugar glider
Tiger cat
Marsupial mole
Marsupial radiation
Banded anteater
Koala
AUSTRALIA
Marsupial rat
Bandicoot
Wombat
Kangaroo


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

EVOLUTION

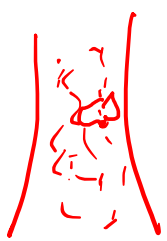
Molecular Homology:

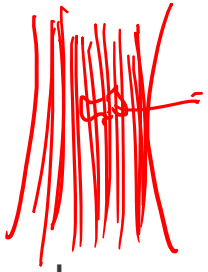
- Molecular homology refers to the similarities in the biomolecules of different groups of organisms.
- The sequences of nucleotides in nucleic acid & many proteins are similar in apes & humans
- The biochemical similarities point to the same/ common ancestry of diverse organisms

Biogeography:

- The differential geographical distribution of different organisms also indicates common/ shared ancestry in that restricted region.
- Habitat isolation has probably restricted these organisms to particular geographical regions on the earth.

EVOLUTION





Evidence to prove Natural Selection

a) Industrial Melanism:

• In a collection of moths made in 1850s (before industrialization) it was observed that there were more white-winged/ dull grey winged moths on trees than dark-winged or melanised moths.

• White-colored lichen covered the trees - in that background the white winged moth survived but the dark-coloured moth were picked out by predators- camouflage

• However, in the collection carried out from the same area, but after industrialization, i.e., in 1920, there were more dark-winged moths in the same area, i.e., the proportion was reversed.

• This was explained that 'predators will spot a moth against a contrasting background'.

• During post industrialization period, the tree trunks became dark due to industrial smoke and soots. Under this condition the white-winged moth did not survive due to predators, dark-winged or melanised moth survived- camouflage

• The obtained study was compared with areas where industrialization did not occur e.g., in rural areas, the count of melanic moths was low.

• Conclusion: In a mixed population, individuals that are better adapted, can survive & reproduce in large numbers & increase their population size & no variants was completely wiped out.

EVOLUTION

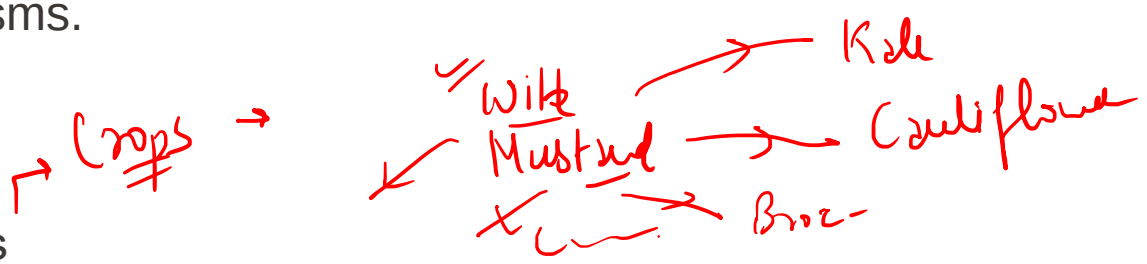
b) Resistance to chemicals:

• Use of pesticides/ insecticides has resulted in resistant varieties of organisms in a less time, e.g., DDT resistance in mosquitoes

• It is also true for microbes (bacteria); many antibiotic resistant varieties of disease causing bacteria are appearing in a very short period

• These are examples of evolution due to anthropogenic actions (produced by human).

• This shows that evolution is not a direct process but is a stochastic process (chance/probability), that is based on chance events in nature & mutation in the organisms.



Artificial Selection

• Man has domesticated many wild animals & plants

• He has also selected many plants & animals and carried out intensive breeding programs to raise new varieties of plants and animals for agriculture, horticulture, sport or security.

• He has raised a number of high- yielding breeds of animals (like cows, buffalo, poultry birds etc.) & crops (like varieties of wheat, rice, maize, pulses, etc.)

EVOLUTION

A BRIEF ACCOUNT OF EVOLUTION

ERA	PERIOD	EPOCH	AGE (MILLION OF YEARS)	SOME IMPORTANT EVENTS IN THE HISTORY OF LIFE
Cenozoic (Age of mammals)	Quaternary	Recent holocene	0.01	Historic time
		Pleistocene	1.8	Ice ages; humans appear
	Tertiary	Pliocene	5	Apelike ancestors of humans appear
		Miocene (Golden age of mammals)	23	Continued radiation of mammals and angiosperms
		Oligocene	34	Origin of most modern mammalian orders, including apes
		Eocene	57	Angiosperm dominance increases; further increase in mammalian diversity
		Palaeocene	65	Major radiation of mammals, birds, and pollinating insects
Mesozoic (Age of reptiles)	Cretaceous		144	Flowering plants (angiosperms) appear; dinosaurs and many groups of organisms become extinct. First modern birds appeared.
	Jurassic		208	Gymnosperms continue as dominant plants; dinosaurs dominant; first birds
	Triassic		245	Gymnosperms dominate landscape; first dinosaurs and mammals
Paleozoic	Permian		285	Radiation of reptiles, origin of mammal-like reptiles and most modern orders of insects; extinction of many marine invertebrates
	Carboniferous		360	Extensive forests of vascular plants; first seed plants; origin of reptiles; amphibians dominant. Age of amphibians
	Devonian		408	Diversification of bony fishes; first amphibians dominant. Age of fishes.
	Silurian		438	Diversity of jawless vertebrates; colonization of land by plants and arthropods; origin of vascular plants
	Ordovician		505	First vertebrates (jawless fishes); marine algae abundant. Age of invertebrates
	Cambrian		544	Origin of most invertebrate phyla; diverse algae
Precambrian or Proterozoic			700	Origin of first animals
			1500	Oldest eukaryotic fossils
			2500	Oxygen begins accumulating in atmosphere
			3500	Oldest definite fossils known (prokaryotes)
			4600	Approximate origin of Earth

EVOLUTION

A BRIEF ACCOUNT OF EVOLUTION

- About 2000 million years before, the first cellular form of life appeared on the earth.
- Slowly these single- celled organisms evolved into multicellular organisms.
- Invertebrates were formed around 500 million years before.
- Jawless fish must have evolved around 340 million years ago.
- At around the same time, fish with stout & strong fins, that could move on land & go back to water, must have appeared.
- The coelacanth or lobefins were the ancestors of modern day frogs & salamanders.
- These amphibians evolved into reptiles that lay thick- shelled eggs which do not dry up in the sun; this made the reptiles more successful than amphibians
- In the next 200 million year or so, reptiles of different shapes and sizes dominated the earth
- Some of these land reptiles moved back to water to evolve into fish like reptiles (Ichthyosaurs) at around the same time (200 million years ago)
- The land reptiles i.e., dinosaurs suddenly disappeared from the earth (mass extinction) about 65 million years ago, while some small sized reptiles continue to exist today like birds, crocodiles etc.

EVOLUTION

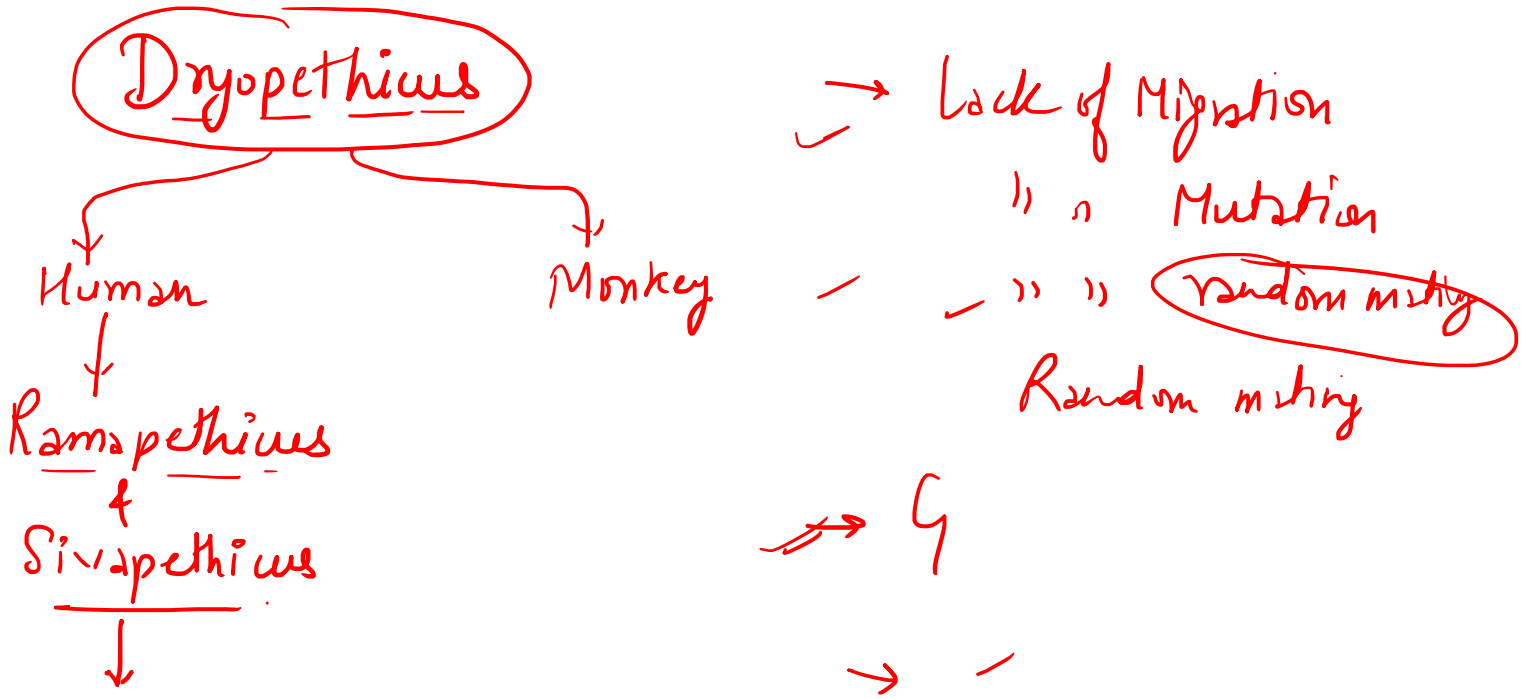
HUMAN EVOLUTION

Genus	Age of appearance/ million years ago	Brain capacity/cm³	Diet	Significance
1. *Dryopithecus* (earliest fossil ape)	15 (Miocene)	?	Soft fruit, leaves	Was more ape-like. Arms and legs of equal size
2. *Ramapithecus* (Earliest hominid fossil)	14-15 (Miocene)	?	Seeds nuts	Was more man-like, ground dwellers
3. *Australopithecus africanus* (Tuang child)	5 (Pliocene)	500 c.c	Omnivorous	Brow ridges projected over the eyes. It did not have chin.
4. *Homo habilis* (The tool maker, handy man)	2.0 (Pleistocene)	650-800 c.c	Probably did not eat meat	Earliest stone tools, major increase in brain size foreshadowing social attributes
5. *Homo erectus* (The erect man)	1.5 (Pleistocene)	900	Probably ate meat	Beginning of cultural evolution, used stone and bone tools, cooperative hunting used fire.
6. *Homo sapiens neanderthalensis* (Neanderthal man)	100,000 to 40,000 yrs. (Pleistocene)	1400	Omnivous and Cannibal	Cave dweller used hides as clothes, buried the dead
7. *Homo sapiens fossilis* (Cro-Magnon man)	34000 yrs. (Holocene)	1650	Omnivorous	Strong jaws with teeth close together, wisdom teeth, cave-dweller, paintings and carvings in caves, had art and culture
8. *Homo sapiens sapiens* (Living modern man)	25000 yrs. (Holocene)	1300-1600 (Average 1450)	Omnivorous	Backbone with 4 curves: most intelligent; has art, culture, language, speech; cultivates plants; domesticates animals.

Human evolution
Homologous & Analogous
Modern theory
Lucy
Cave
Skin & fire
family
Peripatus (Annelids & Arthro)
Neopilina (Annelids & Mollusca)

EVOLUTION

HUMAN EVOLUTION



Thank You