

Evolution

- **Process that results in heritable changes in a population** (change in allele frequencies over time) leading to diversity of organisms on earth.
- It is the genetic change in a population or species over generations (Genes mutate, individuals are selected, and populations evolve).
- The slow and gradual changes in flora and fauna that have occurred over millions of years on earth.

Evolutionary biology

- The study of history of life forms on earth

Big Bang theory

- It explains origin of universe and talks of a singular huge explosion unimaginable in physical terms. The universe expanded and hence the temperature came down. Hydrogen and helium formed sometime later. The gases condensed under gravitation and formed the galaxies of the present day universe.

Formation of early atmosphere on earth

- Water vapour, methane, CO₂ and ammonia released from molten mass covered the surface. The UV rays from the sun broke up water into hydrogen and oxygen and the lighter hydrogen escaped. Oxygen combined with ammonia and methane to form water, CO₂ and others. The Ozone layer was formed. As it cooled the water vapor fell as rain to fill all the depressions and formed oceans. Life appeared 500 million years after the formation of earth that is almost four billion years back.

Panspermia theory

- Life came from outside in the form of spores

Theory of spontaneous generation

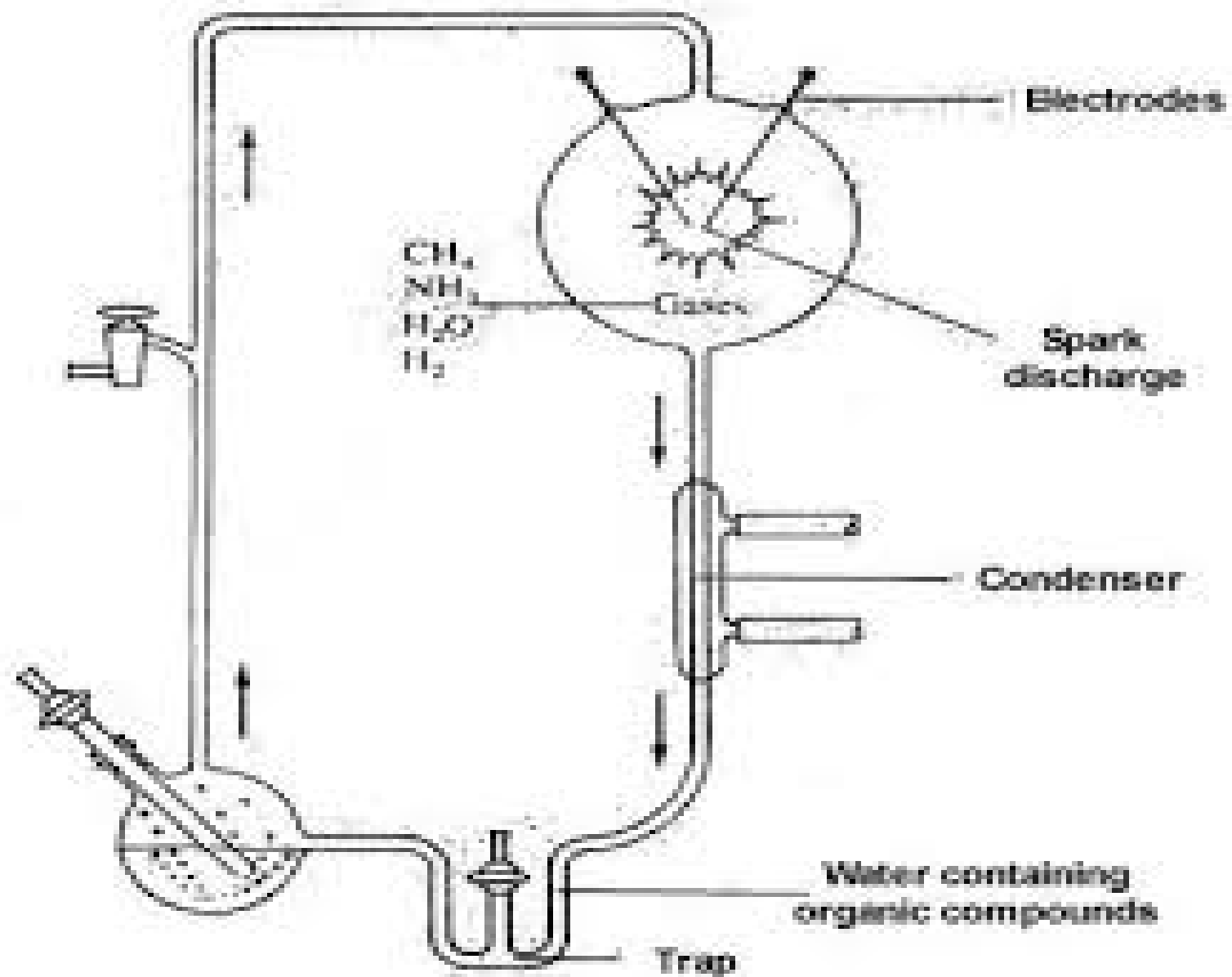
- Life came out of decaying and rotting matter like straw, mud etc.

Louis Pasteur

- He demonstrated that life comes only from preexisting life. He showed that in pre-sterilized flasks life did not come from killed yeast, while in another flask open to air new living organisms arose from killed yeast.

Theory of chemical evolution

It was proposed by Oparin of Russia and Haldane of England. They proposed that the first form of life could have come from preexisting non living organic molecules (RNA, protein etc.). Origin of life was preceded by chemical evolution i.e. formation of diverse organic molecules from inorganic constituents.



Stanley Miller's experiment

- He created electric discharge in a closed flask containing methane, hydrogen and ammonia and water vapour at 800⁰ celcius.
- He observed formation of amino acids, sugars, pigments, fats etc.
- This indicated that similar processes are occurring elsewhere in space.

Three connotations of theory of special creation

- All organisms that we see today were created as such.
- The diversity was always the same since creation and will be the same in future also.
- The earth is about four thousand years old.

Observations of Darwin

- Existing life forms share similarities to varying degrees not only among themselves but also with life forms that existed millions of years ago.
- Many such life forms do not exist any more i.e. there have been extinctions of different life forms in the years gone.
- New life forms arose at different periods of history of earth i.e. there has been gradual evolution of life forms.

Darwin's theory of natural selection

- Any population has built in variations in characteristics, those characteristics which enable some to survive better in natural conditions would outbreed others that are less endowed to survive under such natural conditions.

Reproductive fitness

- Those who are better fit in an environment, leave more progeny than others. These therefore will survive more and hence are selected by nature.

Fossils: remains of hard parts of life forms found in rocks

- A study of fossils in different sedimentary layers indicates the geological period in which they existed.
- The study of fossils show that life forms varied over time and certain life forms are restricted to certain geological time spans.
- New forms of life have arisen at different times in the history of earth.

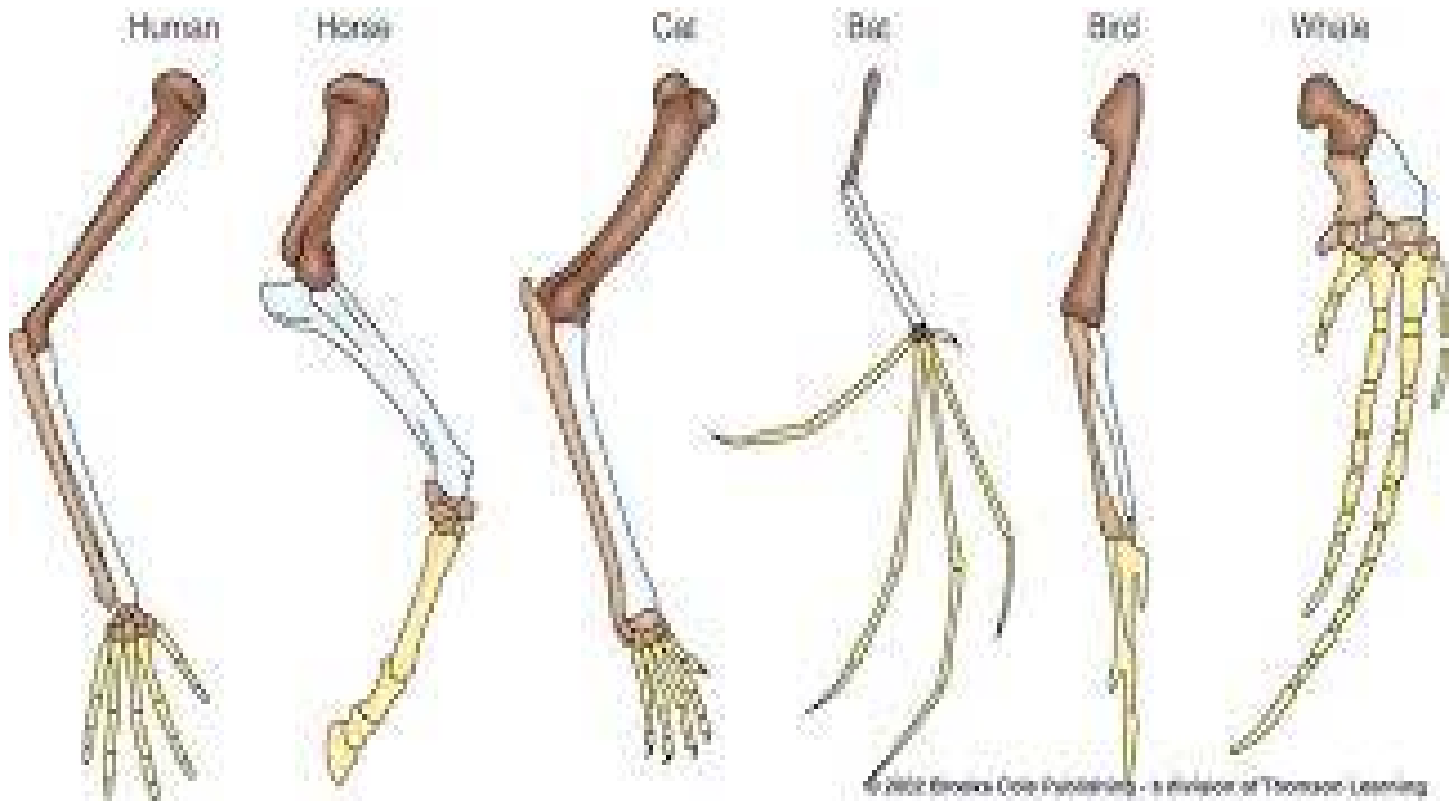


Comparative anatomy and morphology provide evidence of evolution

- It shows similarities and differences among organisms of today and those that existed years ago. These similarities indicate common ancestry.

Homologous organs

- The same structure developed along different directions due to adaptations to different needs. This is divergent evolution and these structures are homologous.
- For example: vertebrate hearts or brains, thorns and tendrils of bougainvillea and cucurbita



Analogous organs

- Structures which are not anatomically similar but perform similar functions are called analogous organs, hence these represent convergent evolution.
- For example: wings of butterfly and birds, the eyes of octopus and mammals, the flippers of penguins and dolphins, potato and sweet potato.

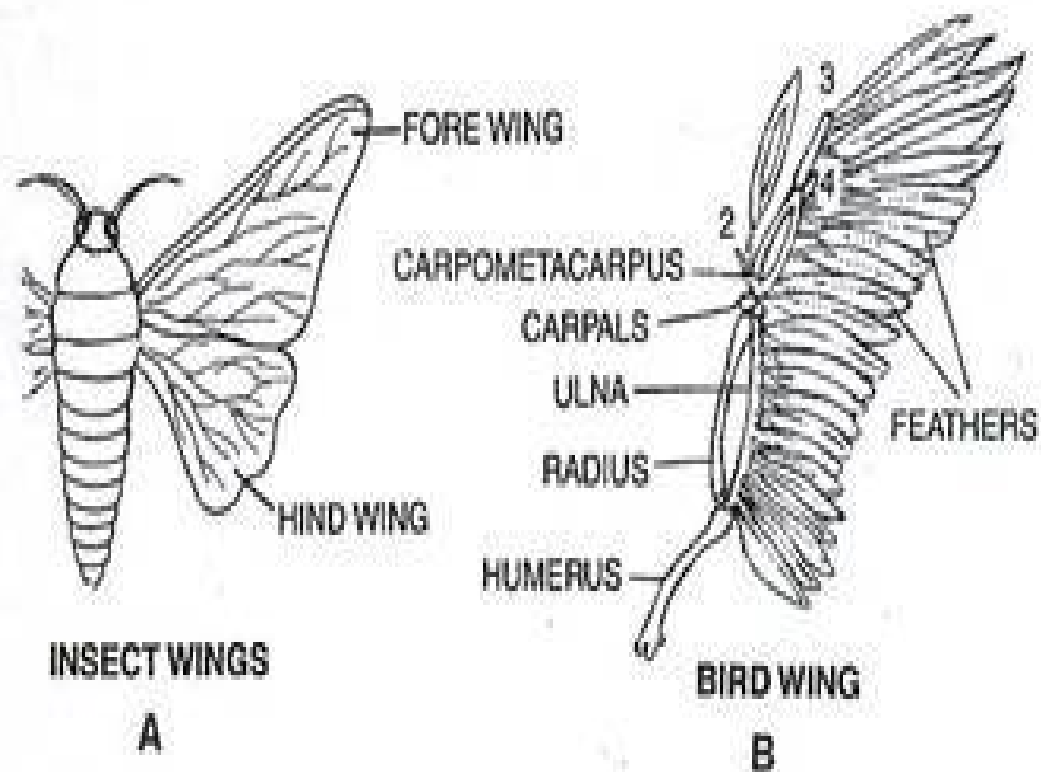


Fig. 7.23. The wings of an insect are analogous to wings of bird.

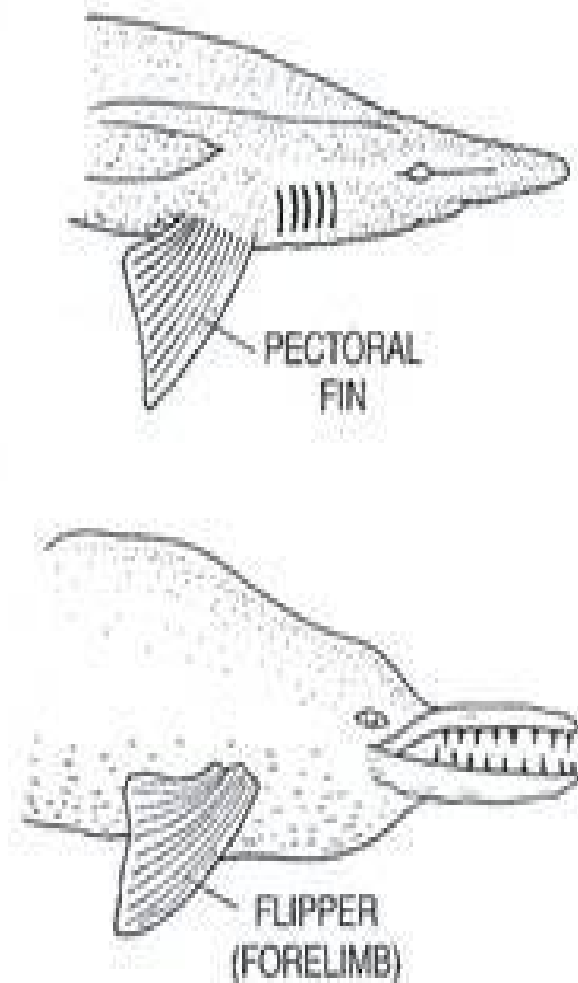


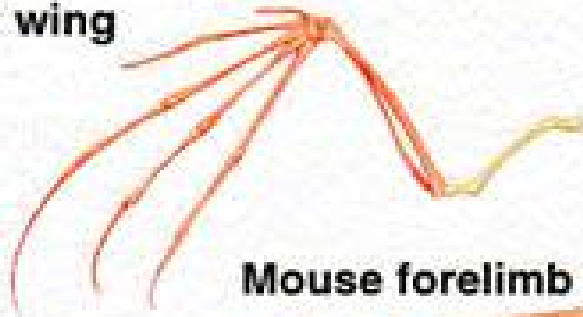
Fig. 7.24. Pectoral fin of shark and flipper of Dolphins.

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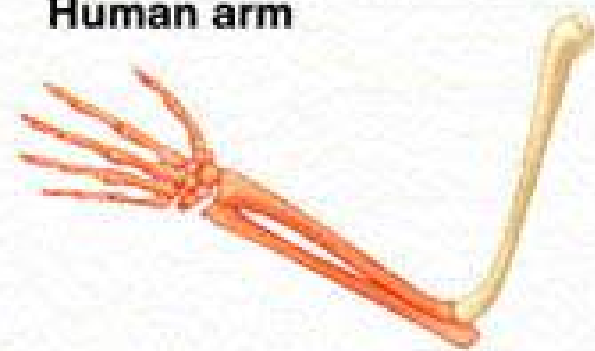
Homology and analogy

Homology

Bat wing



Human arm



Mouse forelimb



Analogy

Bat wing



Butterfly wing



Bird wing



Biochemical similarity provides evidence of evolution

- Similarities in proteins and genes performing a given function among diverse organisms indicates common ancestry.

Species	Sequence of Amino Acids in the Same Part of the Hemoglobin Molecules
Human	Lys—Glu—His—Iso
Horse	Arg—Lys—His—Lys
Gorilla	Lys—Glu—His—Lys
Chimpanzee	Lys—Glu—His—Iso
Zebra	Arg—Lys—His—Arg

Natural selection provides evidence of evolution

- Man has domesticated many wild animals and crops, this intensive breeding programmed has created breeds that differ from other breeds.

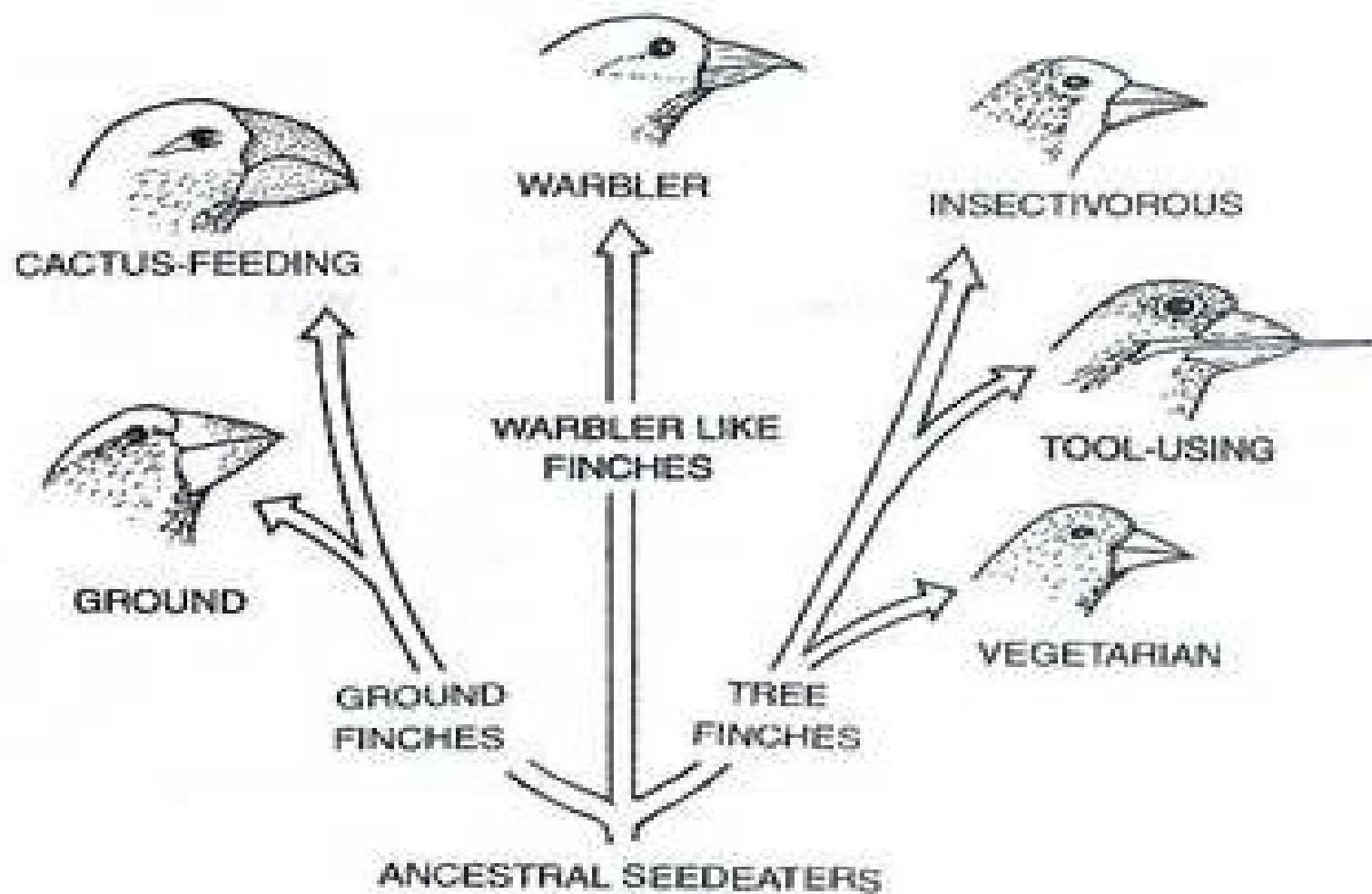


Evolution by anthropogenic action

- Before industrialization, there were more white winged moths on trees than dark winged or melanised moths.
- After industrialization there were more dark winged moths in the same area. After industrialization, the tree trunks became dark due to industrial smoke. Under this condition the white winged moth did not survive due to predators. Dark winged or melanised moths survived.
- Before industrialization set in, thick growth of almost white coloured lichens covered the trees, in that background the white winged moth survived, but the dark coloured moth were picked out by predators.

Adaptive radiation provides example of divergent evolution

- The process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography is called adaptive radiation.
- For example: Darwin's finches and Australian marsupials



Variety of beaks of finches that Darwin found in Galapagos islands.

Adaptive radiation provides example of convergent evolution

- When more than one adaptive radiation appear to have occurred in an isolated geographical area, one can call this convergent evolution.
- For example placental wolf and Tasmanian wolf marsupial.

Rate of appearance of new forms is linked to

- The life span of an individual
- Number of offspring produced

Lamarck Theory of evolution

- Use and disuse of organs
- Inheritance of acquired characters

DeVries theory of evolution

- Mutations cause evolution. Mutations are random and directionless while Darwinian variations are small and directional.
- **Saltation:** Single step large mutation is called saltation

Genetic equilibrium

- Frequency of occurrence remains fixed and even remains same through generations. Hardy Weinberg principle stated that allele frequencies in a population are stable and is constant from generation to generation. The gene pool remains constant. This is called genetic equilibrium. Sum total of all the allelic frequencies is one.

Condition when frequency measured differs from expected values

- This indicates the extent of evolutionary change. Disturbance in genetic equilibrium or Hardy Weinberg equilibrium results in evolution.

Five factors known to affect Hardy Weinberg equilibrium

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

Founder effect

- 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 founder and the effect is called founder's effect

Three types of natural selection

- Directional selection: any one of the extremes is selected.
- Disruptive selection: both the extremes are selected.
- Stabilizing selection: none of the extremes is selected.

Continental drift

- 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.

Evolution

- 2000 mya – first cellular forms of life appeared, some of these released oxygen, multi-cellular life forms were formed.
- 500 mya – invertebrates were formed.
- 350 mya – jawless fish appeared,
- 320 mya – sea weeds and few plants existed, fish evolved into amphibians, amphibians evolved into reptiles.
- In the next 200 mya reptiles of different shapes and sizes dominated on earth.
- 65 mya, dinosaurs suddenly disappeared from the earth and first mammals evolved.

Evolution of man

- 15 mya- Dryopithecus and Ramapithecus
- 3-4 mya – man-like primates
- 2 mya – Australopithecines in East African grasslands, first human-like being and was called Homo habilis
- 1.5 mya – Homo erectus
- 1,00,000 – 40,000 years back – Homo sapiens arose in Africa
- 75,000 to 10,000 years ago – modern homo sapiens arose.