

5. EVOLUTION

Single Page Simple Synopsis

Evolution is the process by which populations of organisms change over successive generations through the alteration of their heritable traits. Driven by mechanisms like natural selection, genetic drift, and mutation, it explains the origin of all species and Earth's staggering biodiversity.

1. Origin of Life

- **The Universe & Earth:** Evolution is studied in the grand context of the universe's origin
Ex: the Big Bang theory and the formation of Earth about 4.5 billion years ago.
- **Chemical Evolution:** Life is believed to have originated from non-living organic molecules (like RNA, proteins, and sugars) through chemical evolution.

2. Evidences of Evolution

- **Paleontological:** Fossils found in different rock strata reveal the history of life forms.
- **Morphological & Anatomical:**
- **Homologous organs:** Same structure but different functions
Ex: Forelimbs of whales, bats, and humans, indicating common ancestry (divergent evolution).
- **Analogous organs:** Different structures but same function
Ex: Wings of a butterfly and a bird, indicating adaptation to similar needs (convergent evolution).
- **Biochemical:** Similarities in DNA and proteins across different species point to a shared evolutionary origin.

3. Key Theories of Evolution

- **Lamarckism:** The theory of the inheritance of acquired characters
Ex: Giraffes developed long necks by stretching them to reach food.
- **Darwinism:** The theory of Natural Selection, which states that organisms with traits better suited to their environment are more likely to survive and reproduce ("survival of the fittest").
- **Mutation Theory:** Proposed by Hugo de Vries, stating that evolution is caused by sudden, large genetic mutations rather than minor variations.

4. Mechanism and Types of Evolution

- **Hardy-Weinberg Principle:** A mathematical principle stating that allele (gene) frequencies in a population remain constant from generation to generation if no evolutionary forces (like mutation, selection, or genetic drift) are acting upon it. The formula used is $p^2 + 2pq + q^2 = 1$.
- **Adaptive Radiation:** The process of evolution of different species in a given geographical area starting from a point and radiating to other areas.**Ex:** Darwin's finches in the Galapagos Islands

5. Human Evolution:

The course traces human ancestry from early ape-like ancestors (*Dryopithecus* and *Ramapithecus*) through species like *Australopithecus*, *Homo habilis*, and *Homo erectus*, leading to modern humans (*Homo sapiens*)

FRUIT POINTS

1. **Evolution** explains the changes in flora and fauna that have occurred over millions of years.
2. **Evolutionary Biology** is the study of the history of life forms on Earth.
3. The universe is approximately **13.8 billion years old** and contains clusters of galaxies.
4. The **Big Bang theory** describes a singular, massive explosion that caused the universe to expand and cool.
5. **Panspermia** is the idea that units of life called spores were transferred to Earth from outer space.
6. The theory of **spontaneous generation** suggested life arose from decaying matter like straw or mud.
7. **Chemical evolution** refers to the formation of diverse organic molecules from inorganic constituents.
8. In 1953, **S.L. Miller** created early Earth conditions in a lab, using an electric discharge and specific gases.
9. **Charles Darwin**, during his voyage on the *H.M.S. Beagle*, challenged the idea of fixed species.
10. **Natural selection** is the mechanism where nature selects individuals better adapted to survive and breed.
11. **Alfred Wallace** independently reached similar conclusions about evolution while working in the Malay Archipelago.
12. **Homologous structures** (e.g., forelimbs of mammals) have similar anatomy but perform different functions.
13. **Homology** indicates common ancestry and is the result of **divergent evolution**.
14. **Analogous structures** (e.g., wings of birds and butterflies) perform similar functions but are anatomically different.
15. **Adaptive radiation** is the evolution of different species in a geographical area starting from a single point.
16. De Vries called single-step large mutations **saltation**.

17. The **Hardy-Weinberg principle** states that allele frequencies in a population are stable and constant.
18. **Genetic drift** occurs when allele frequencies change purely by chance.
19. The **founder effect** occurs when a drifted population becomes the founders of a new species.
20. **Invertebrates** were formed and active by 500 mya; jawless fish evolved around 350 mya.
21. The **first mammals** were small, shrew-like creatures whose fossils are small-sized.
22. **Homo habilis**, the first human-like being (hominid), had a brain capacity of 650-800cc.
23. **Homo erectus** appeared 1.5 mya with a 900cc brain and likely ate meat.
24. Modern **Homo sapiens** arose in Africa during the ice age between 75,000-10,000 years ago.
25. Variations caused by mutations, as proposed by Hugo de Vries, are **random and directionless**. [NEET-2019]
26. **500 Million years** of formation of Earth, life appeared on this planet. [NEET-2020]
27. Embryological support for evolution was proposed by **Ernst Haeckel**. [NEET-2020]
28. Flippers of Penguins and dolphins are examples of **convergent evolution**. [NEET-2020]
29. The factor that leads to founder effect in a population is **Genetic drift**. [NEET-2021]
30. **Panspermia** an idea that is still a favourite form some astronomers means transfer of spores are unit of life from other planet to Earth. [NEET-2022]
31. **Constant gene pool** will not affect the Hardy-Weinberg equilibrium. [NEET-2024]