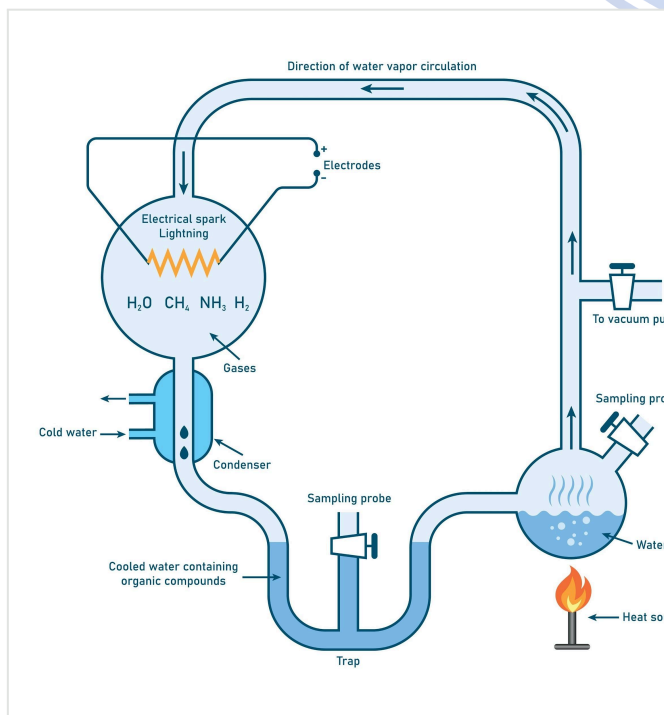


CUET (UG) Biology Notes: Evolution
1. Origin of Life

The universe is about 20 billion years old. The Big Bang theory attempts to explain the origin of the universe. Earth was formed about 4.5 billion years ago.

- **Early Earth Conditions:** There was no atmosphere. Water vapor, methane (CH₄), carbon dioxide (CO₂), and ammonia (NH₃) released from molten mass covered the surface. UV rays from the sun broke up water into Hydrogen and Oxygen.
- **Theory of Chemical Evolution (Oparin and Haldane):** Proposed that the first form of life came from pre-existing non-living organic molecules (e.g., RNA, protein) and that formation of life was preceded by chemical evolution.
- **Miller's Experiment (1953):** S.L. Miller created primitive Earth conditions in the laboratory.
 - Setup: Electric discharge in a closed flask containing CH₄, H₂, NH₃, and water vapor at 800°C.
 - Observation: Formation of amino acids.



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2. Concepts of Evolution

- **Charles Darwin:** Based on his observations during a sea voyage in a sail ship called H.M.S. Beagle, he concluded that existing

living forms share similarities to varying degrees not only among themselves but also with life forms that existed millions of years ago.

- **Darwinian Fitness:** Fitness, according to Darwin, refers ultimately and only to reproductive fitness. Those who are better fit in an environment leave more progeny.

3. Evidences for Evolution

Type of Evidence	NCERT Description & Examples
Paleontology	Study of fossils found in sedimentary rocks. Fossils in different sedimentary layers indicate the geological time period in which they existed.
Embryology	Proposed by Ernst Haeckel (embryos pass through ancestral adult stages). Strictly disproved by Karl Ernst von Baer, who noted that embryos never pass through the adult stages of other animals.
Homologous Organs	Indicate Divergent Evolution (same structure, different functions). <ul style="list-style-type: none"> • Animals: Forelimbs of whales, bats, cheetahs, and humans (all have humerus, radius, ulna, carpals, metacarpals, phalanges). Vertebrate hearts or brains. • Plants: Thorns of Bougainvillea and tendrils of Cucurbita.
Analogous Organs	Indicate Convergent Evolution (different structures, similar functions). <ul style="list-style-type: none"> • Animals: Wings of butterfly and of birds; eye of the octopus and of mammals; flippers of penguins and dolphins. • Plants: Sweet potato (root modification) and potato (stem modification).

Evolution by Anthropogenic Action

- **Industrial Melanism:** In England (1850s, pre-industrialization), white-winged moths

(*Biston betularia*) survived better on lichen-covered trees. Post-industrialization (1920s), tree trunks became dark with soot; dark-winged (melanized) moths survived better as predators couldn't spot them.

- Chemical Resistance: Excess use of herbicides, pesticides, and antibiotics has resulted in selection of resistant varieties in a much lesser time scale.



4. 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 (Galapagos Islands) and Australian marsupials.
- Convergent Evolution: When more than one adaptive radiation occurs in an isolated geographical area. Example: Placental mammals in Australia exhibit similarities to corresponding Australian marsupials (e.g., Placental wolf and Tasmanian wolf).

5. Biological Evolution & Mechanisms

- Lamarck: French naturalist who proposed evolution was driven by use and disuse of organs (e.g., giraffes elongating their necks). This theory is discarded.
- Charles Darwin: The two key concepts of Darwinian Theory of Evolution are branching

descent and natural selection. Darwinian variations are small and directional.

- Hugo de Vries: Based on his work on evening primrose, he brought forth the idea of mutations (large differences arising suddenly in a population). He believed mutation causes evolution and termed it saltation (single step large mutation). Mutations are random and directionless.

6. Hardy-Weinberg Principle

States that allele frequencies in a population are stable and constant from generation to generation (genetic equilibrium). The gene pool remains constant.

- Equation: For a diploid organism with alleles A (frequency p) and a (frequency q):

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

(Where p^2 = frequency of AA, q^2 = frequency of aa, and $2pq$ = frequency of Aa)

Factors Affecting Hardy-Weinberg Equilibrium:

1. Gene Migration / Gene Flow: If gene migration happens multiple times, it is called gene flow.
2. Genetic Drift: Change in gene frequency by chance. Can lead to the founder effect (the original drifted population becomes founders of a new species).
3. Mutation: Pre-existing advantageous mutations result in new phenotypes.
4. Genetic Recombination: Occurs during crossing over in meiosis.
5. Natural Selection: Can lead to three outcomes:
 - Stabilisation: More individuals acquire mean character value.
 - Directional Change: More individuals acquire value other than the mean character value.
 - Disruption: More individuals acquire peripheral character value at both ends of the distribution curve.

7. A Brief Account of Evolution

- Flora (Plants): First organisms that invaded land were plants. Evolutionary pathway: Chlorophyte ancestors \rightarrow Tracheophyte ancestors \rightarrow Rhynia type plants \rightarrow Psilophyton \rightarrow Ferns, Conifers, and Angiosperms.
- Fauna (Animals):
 - 350 mya: Jawless fish evolved.

- 1938: A fish caught in South Africa happened to be a Coelacanth (lobefins). These evolved into the first amphibians that lived on both land and water.
- Amphibians evolved into reptiles (which lay thick-shelled eggs which do not dry up in sun).
- 65 mya: Dinosaurs suddenly disappeared from the earth (e.g., Tyrannosaurus rex was about 20 feet in height and had huge fearsome dagger-like teeth).
- The first mammals were like shrews.

2 mya	Australopithecines	Lived in East African grasslands. Evidence shows they hunted with stone weapons but essentially ate fruit.
~2 mya	Homo habilis	650 - 800 cc. The first human-like being (the hominid). They probably did not eat meat.
1.5 mya	Homo erectus	900 cc. Fossils discovered in Java in 1891. They probably ate meat.
1,00,000 - 40,000 years ago	Neanderthal man	1400 cc. Lived in near east and central Asia. Used hides to protect their body and buried their dead.
75,000 - 10,000 years ago	Homo sapiens	Arose in Africa and moved across continents. Pre-historic cave art developed about 18,000 years ago. Agriculture came around 10,000 years ago.



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8. Origin and Evolution of Man

NCERT specifies strict timelines and cranial capacities (brain sizes) for human ancestors.

Timeline	Hominin Stage	Cranial Capacity & NCERT Characteristics
15 mya	Dryopithecus & Ramapithecus	Hairy and walked like gorillas and chimpanzees. Ramapithecus was more man-like while Dryopithecus was more ape-like.