FREE NOTES · NCERT + NEET LEVEL

Evolution

Origin of life, evidences of evolution, adaptive radiation, Darwin's theory, mechanism of evolution, Hardy–Weinberg principle, brief account of evolution and origin of man.

01 Origin of life
02 Evidences of evolution
03 Adaptive radiation
04 Darwin and mechanism of evolution
05 Hardy–Weinberg principle
06 Brief account and origin of man
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08 Important Q&A
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01 Origin of life

- Universe ~20 billion years old; Big Bang theory. Earth formed ~4.5 billion years ago; life appeared ~4 billion years ago.
- **Panspermia**: spores from outer space. **Spontaneous generation** disproved by **Louis Pasteur** (killed yeast in pre-sterilised flask: no life; open flask: life arose).
- **Oparin and Haldane**: first life from pre-existing non-living organic molecules (chemical evolution); early atmosphere CH_4, NH_3, H_2O vapour, H_2 (no free O_2), high temperature, UV, lightning.
- **S.L. Miller** (1953): electric discharge in closed flask with CH_4, H_2, NH_3, water vapour at 800 °C ⇒ amino acids formed. Others observed sugars, nitrogen bases, pigments, fats.
- First non-cellular life ~3 billion years ago (giant molecules: RNA, proteins); first cellular forms ~2000 million years ago, single-celled, in water.

02 Evidences of evolution

Evidence	Example
Palaeontological (fossils)	Rocks of different ages contain different life forms; extinct dinosaurs; horse evolution
Homologous organs (divergent evolution)	Same structure, different function: forelimbs of whale, bat, cheetah, human; heart, brain of vertebrates; thorns of *Bougainvillea* and tendrils of *Cucurbita*
Analogous organs (convergent evolution)	Different structure, same function: wings of butterfly and bird; eyes of octopus and mammals; flippers of penguin and dolphin; sweet potato (root) and potato (stem)
Biochemical/molecular	Similar proteins, genes across diverse organisms
Natural selection in action	**Industrial melanism** in England: before industrialisation more white-winged moths; after, dark moths increased (lichens killed by pollution, dark bark); herbicide, pesticide, antibiotic resistance (anthropogenic action)

03 Adaptive radiation

- Evolution of different species in a geographical area starting from one point and radiating to other areas (habitats).
- **Darwin's finches** (Galapagos Islands): from original seed-eaters, many beak types evolved (insectivorous, etc.).
- **Australian marsupials**: many marsupials from an ancestral stock within Australia (koala, kangaroo, wombat, Tasmanian wolf, sugar glider, marsupial mole, bandicoot).
- When more than one adaptive radiation appears in isolated areas = **convergent evolution**: placental mammals in Australia resemble marsupials (placental wolf vs Tasmanian wolf, mole vs marsupial mole).

04 Darwin and mechanism of evolution



Types of natural selection (grey = original population)

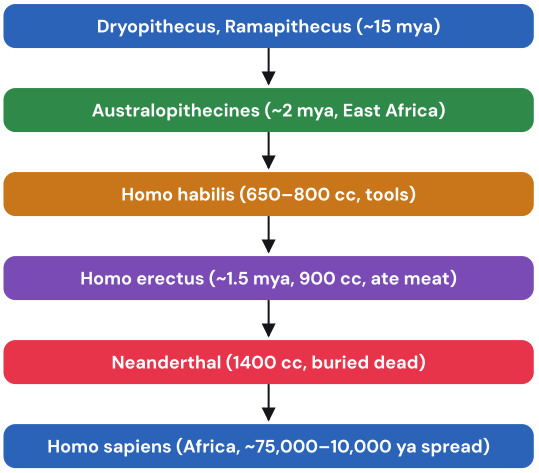
- Darwin (voyage on HMS Beagle) and Alfred Wallace (Malay Archipelago): **natural selection**; **fitness** = reproductive fitness. Key ideas: branching descent and natural selection; variation is heritable; populations tend to overproduce; struggle for existence; survival of the fittest.
- **Lamarck**: use and disuse of organs (giraffe neck); disproved.
- **Hugo de Vries** (*Oenothera*, evening primrose): **mutation** theory; large sudden variations = **saltation**; mutations are random and directionless, Darwinian variations small and directional.
- Sources of variation: mutation, recombination (genetic), gene flow.

05 Hardy–Weinberg principle

- In a population, allele frequencies are stable and constant from generation to generation (genetic equilibrium): $\mathbf{p^2 + 2pq + q^2 = 1}$ ($p + q = 1$).
- Five factors disturb equilibrium: **gene migration/gene flow**, **genetic drift** (by chance; **founder effect** when a small group founds a new population), **mutation**, **genetic recombination**, **natural selection**.
- Natural selection can be **stabilising**, **directional** or **disruptive** (figure above).
- Example: if q^2 (recessive homozygotes) = 0.16, q = 0.4, p = 0.6; heterozygotes $2pq$ = 0.48.

06 Brief account and origin of man

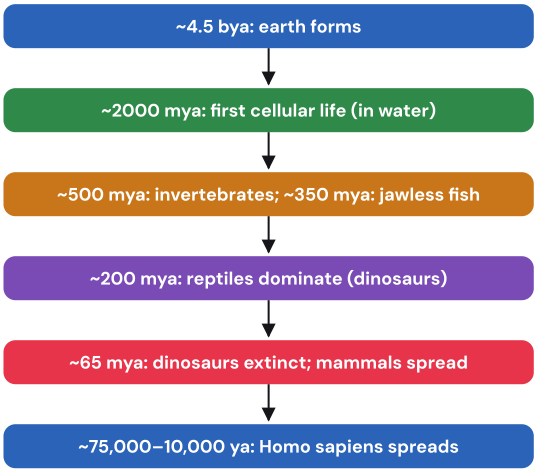
- ~2000 mya first cellular life; ~500 mya invertebrates; ~350 mya jawless fish; lobefins (coelacanth, thought extinct, caught 1938 in South Africa) evolved into first amphibians; ~200 mya reptiles dominated (dinosaurs, *Tyrannosaurus rex* ~20 ft); ~65 mya dinosaurs disappeared.
- Plants: seaweeds → psilophyton → ferns, gymnosperms; first mammals were shrew-like.
- **Homo habilis**: probably did not eat meat. **Neanderthal**: near East and Central Asia, 1,00,000–40,000 years ago. **Homo sapiens** arose in Africa; ice age ~75,000–10,000 years ago. Pre-historic cave art ~18,000 years ago; agriculture ~10,000 years ago.



Human evolution (simplified)

07 Extra + tricks

Theory	Given by / idea
Special creation	God created all life in 6 days; no change
Catastrophism	Cuvier: repeated mass extinctions then new creation
Spontaneous generation	Life from decaying matter (disproved by Pasteur, swan-neck flask)
Panspermia	Arrhenius: spores from space
Chemical evolution	Oparin–Haldane: "primordial soup"; Oparin's **coacervates**; Sidney Fox's **microspheres**



Brief geological timeline

- **Connecting links**: *Euglena* (plant–animal), *Peripatus* (Annelida–Arthropoda), *Neopilina* (Annelida–Mollusca), *Balanoglossus* (non-chordate–chordate), *Archaeopteryx* (reptile–bird).
- **Vestigial organs** in humans: wisdom teeth, appendix, coccyx, ear muscles, nictitating membrane. **Atavism**: reappearance of ancestral trait (tail, thick body hair).
- Embryological evidence: **Haeckel's biogenetic law** (ontogeny repeats phylogeny), disproved in strict form by **von Baer**. Modern synthetic theory = Darwin + genetics (mutation, recombination, selection, isolation).

08 Important Q&A

Q1. Differentiate homologous and analogous organs with examples.

Homologous: same origin, different function (bat wing, human arm), divergent evolution. Analogous: different origin, same function (bird and butterfly wings), convergent evolution.

Q2. In a population, 9% are recessive homozygous (aa). Find frequency of heterozygotes.

$q^2 = 0.09 \Rightarrow q = 0.3$, $p = 0.7 \Rightarrow 2pq = 0.42$ (42%).

Q3. What did Miller's experiment show?

Organic molecules like amino acids can form from inorganic gases under early-earth conditions (chemical evolution).

09 Common mistakes

- Calling potato and sweet potato homologous (they are analogous).
- Saying industrial melanism created dark moths (they existed; selection changed frequency).
- Confusing genetic drift with gene flow.
- Saying Homo habilis ate meat (Homo erectus probably did).

10 Practice (NEET style)

1. Who disproved spontaneous generation?
2. Darwin's finches show?
3. Plant studied by de Vries?
4. Hardy–Weinberg equation?
5. Brain capacity of Homo erectus?

ANSWERS

1) Louis Pasteur · 2) Adaptive radiation · 3) *Oenothera* · 4) $p^2 + 2pq + q^2 = 1$ · 5) ~900 cc

11 Quick revision: 5 minutes before the exam

ORIGIN

- Oparin–Haldane
- Miller: amino acids
- Pasteur: no spontaneous generation

EVIDENCE

- Homologous: divergent
- Analogous: convergent
- Industrial melanism

MECHANISM

- Darwin: natural selection
- de Vries: mutation, saltation
- 5 HW factors

MAN

- Habilis 650–800 cc
- Erectus 900 cc
- Neanderthal 1400 cc

Have a doubt? Ask the AI Doubt Solver at padhaiadda.netlify.app, or take the mock test on this chapter.