

Evolution

- Evolutionary biology is the study of history of life forms on earth. the evolution of life on earth, different changes in flora and fauna around earth that co-exist along with human beings also forms parts of evolution.

origin of life

<u>Year</u>	<u>Scientist</u>	<u>Theory/Experiment</u>	<u>conclusion</u>
1927	<u>Lemaitre</u>	<u>Big bang theory</u>	The universe expanded from explosion of a primordial hot substance
1924 1929	<u>Oparin and Haldane</u>	<u>chemical evolution preceded organic evolution</u>	Simple organic molecules originated from inorganic precursors.
1952	<u>Stanley Miller and Urey</u>	Synthesis of biomolecules by creation of similar conditions as primitive atmosphere on laboratory scale	Amino acids were synthesised from ammonia, oxygen, and CO ₂ , inside specialised apparatus

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the origin of life is considered unique events in the history of universe. Huge cluster of galaxies comprises the universe. Galaxies contain stars and clouds of dust and smoke.

• Big Bang theory - attempts to explain the origin of universe. According to this theory, a huge explosion occurs that forms the different galaxies.

In solar system of milky way galaxies, earth has been supposed to be formed about 4.5 billion years ago.

There are no atmosphere in early earth. Water, Vapour, methane, CO₂ and ammonia released from molten mass covered the earth surface.

UV rays from sun splits the water into hydrogen and oxygen. Life appeared 500 million years after the formation of earth.

There are different theories regarding the origin of life on earth -

• Some scientist believes that life comes from other planets. Early Greek thinker thoughts that unit of life is called Spores transferred

from other planets

• According to other theory, life comes out of dead and decaying matters like straw and mud. This theory is called theory of spontaneous origin.

• Louis Pasteur experimentally proved that life arises only from pre-existing life. Spontaneous theory of origin of life is dismissed after that

• Oparin and Haldane proposed that the first form of life could have come from pre-existing non-living organic molecules like RNA and protein. The formation of life preceded by chemical evolution. At that time condition on earth were - high temperature, volcanic eruption, reducing atmosphere containing CH_4 and NH_3

• Miller experiment of origin of life

S.L. Miller in 1953, conducted an experiment to show the origin of life on earth in the physical environment similar to condition prevails at that time.

Miller created similar condition of tem. and pressure in laboratory scale. he created electric discharge in a flask containing CH₄, H₂ and NH₃ and water vapour at 8000°C. he observed formation of amino acids in flask after 15 days of electric discharge. Similar experiment by other scientist found formation of sugars, nitrogen bases, pigments and fats.

Analysis of meteorite content also reveals similar compounds that reveal that similar process are occurring elsewhere in the space. This experimental evidence about the origin of life is called chemical evolution of life.

Experimental representation of Miller's Experiment-

The first non-cellular forms of life could have originated 3 billion years back. They could have been giant molecules like RNA, protein polysaccharide.

The cellular form of life was probably single cell and

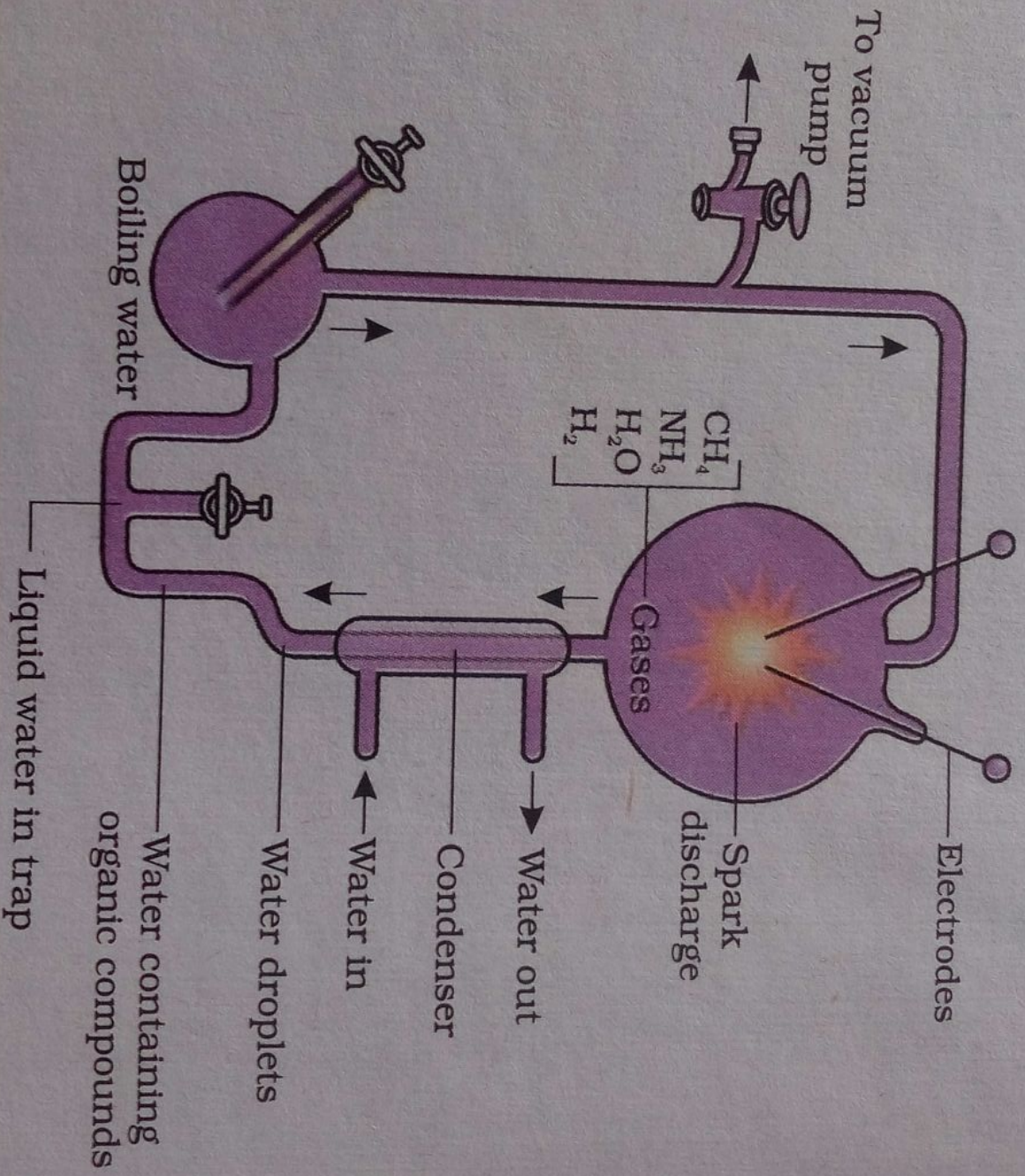


Figure 7.1 Diagrammatic representation of Miller's experiment

originates in water medium. the theory that first form of life arose slowly through evolutionary forces from non-living molecules is called biogenesis.

Evidence of Evolution - evidence that evolution of life forms has taken place on earth have many proofs as mentioned below-

1. Paleontological Evidence - Different aged rock sediments contain fossils of different life forms that probably died during the formation of particular sediment.

fossils are remains of hard parts of life forms found in rocks. the study showed that different form varied over time and certain life form are restricted geological time span. hence, new forms of life have arisen at different times in history of earth.

2. Homologous Organs - those organs that perform different function but have similar origin and structure are called homologous organs. Ex. human, bat, and whales share similarities in pattern of bones of forelimbs although

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these forelimbs perform different functions in these animals. In these animal similar structure developed along different directions due to adaptation of different needs. this is called "divergent evolution".

3. Analogous Structures - they are not anatomically similar organs but perform similar function. for ex. eyes of mammals and octopus or flippers of penguin and dolphins. this is due to similar habitat that resulted in similar adaptive features in different groups of organisms. this that of evolution is called Convergent evolution.

4. Biochemical evidences - similarities in proteins and genes performing a given function among diverse organisms give hints to common ancestry. these biochemical similarities point to the same shared ancestry as structural similarities among diverse organisms.

- Evolution by natural selection
Industrial melanism a case of natural selection was seen in

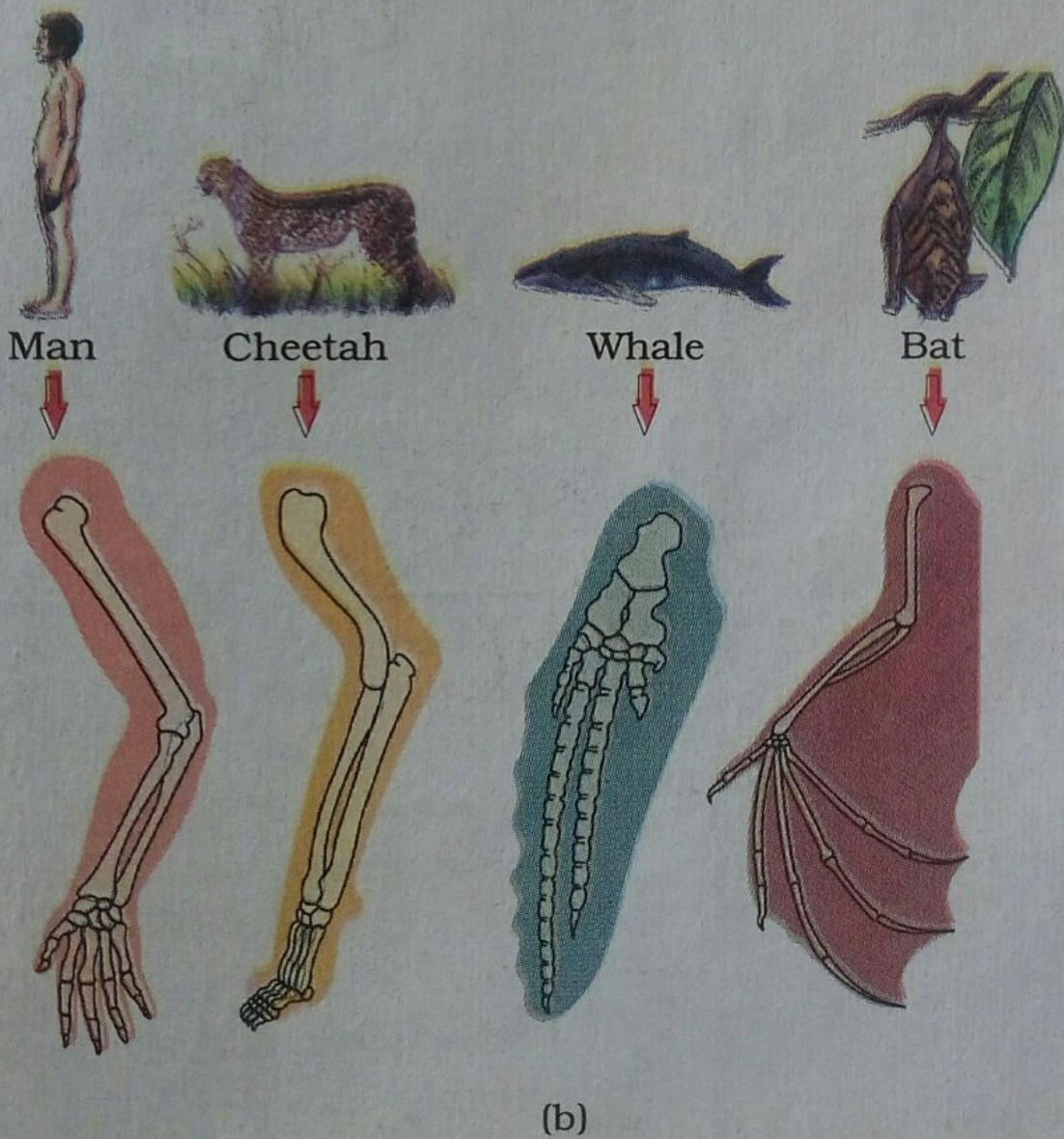
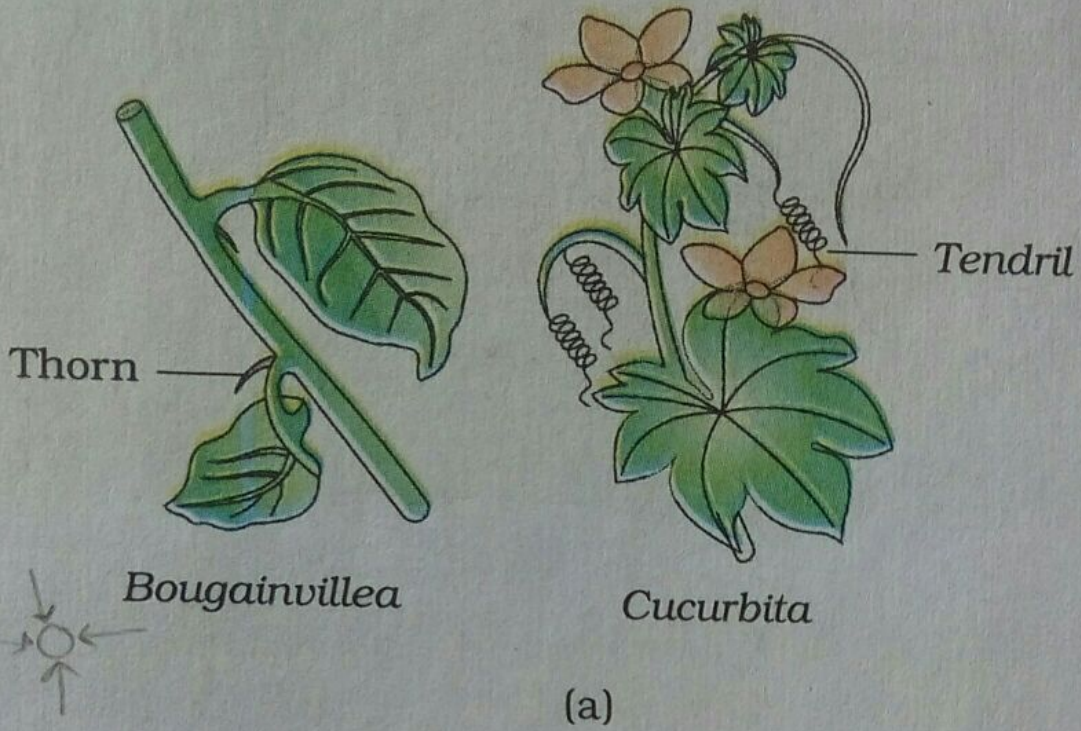


Figure 7.3 Example of homologous organs in (a) Plants and (b) Animals



(a)



(b)

Figure 7.4 Figure showing white - winged moth and dark - winged moth (melanised) on a tree trunk (a) In unpolluted area (b) In polluted area



England in 1850, *s.p.* i.e. before industrialisation in a peppered moth (*Biston betularia*). This moth had two forms: grey colour and black colour (*carbonaria*). In the early part of 19th century, before industrialization only the grey coloured forms of moths were present, the dark forms were rare. The grey coloured moths were seen on the tree trunks covered with lichens and so they were able to escape from their enemies. Later on in 1920, due to the development of industries, post industrialization, the lichens were killed and the tree trunks looked dark due to the deposition of industrial soot. Birds, now were able to spot these grey coloured moths and feed upon them. So the grey coloured moths were eaten by the birds and the dark coloured moths escaped from birds. Then now the coal is replaced by the industries and oil and electricity is used. This has reduced the soot production, and ultimately less deposition of soot on the tree trunks. These tree trunk have now, again become grey in colour. Consequently

grey coloured moths have again increased in number. This ex. clearly bring out the action of natural Selection.

- Evolution by anthropogenic action-
Resistance of mosquitoes to pesticides. When DDT was introduced to control mosquitoes it was tremendously successful. Most of the mosquitoes were sensitive to DDT and were therefore killed. In that population of mosquitoes few mosquitoes became resistant to DDT and survived. They multiplied and now almost total population of mosquitoes became resistant to DDT.

Some pattern has been observed in bacteria which are multidrug resistant due to excess use of drugs and medicines

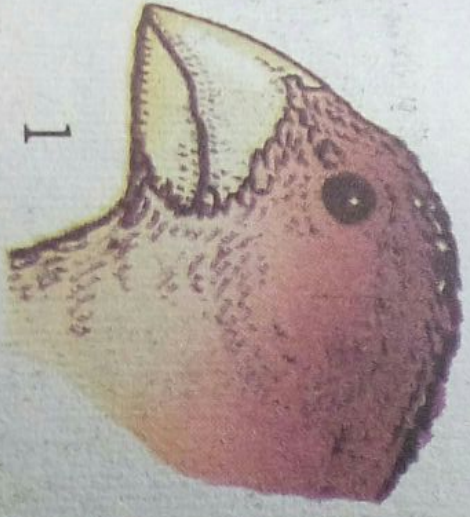
- Adaptive Radiation- the process of evolution of different species in given geographical area starting from a point and radiating to other areas of geography (habitat) is called "adaptive radiation".

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Figure 7.5 Variety of beaks of finches that Darwin found in Galapagos Island

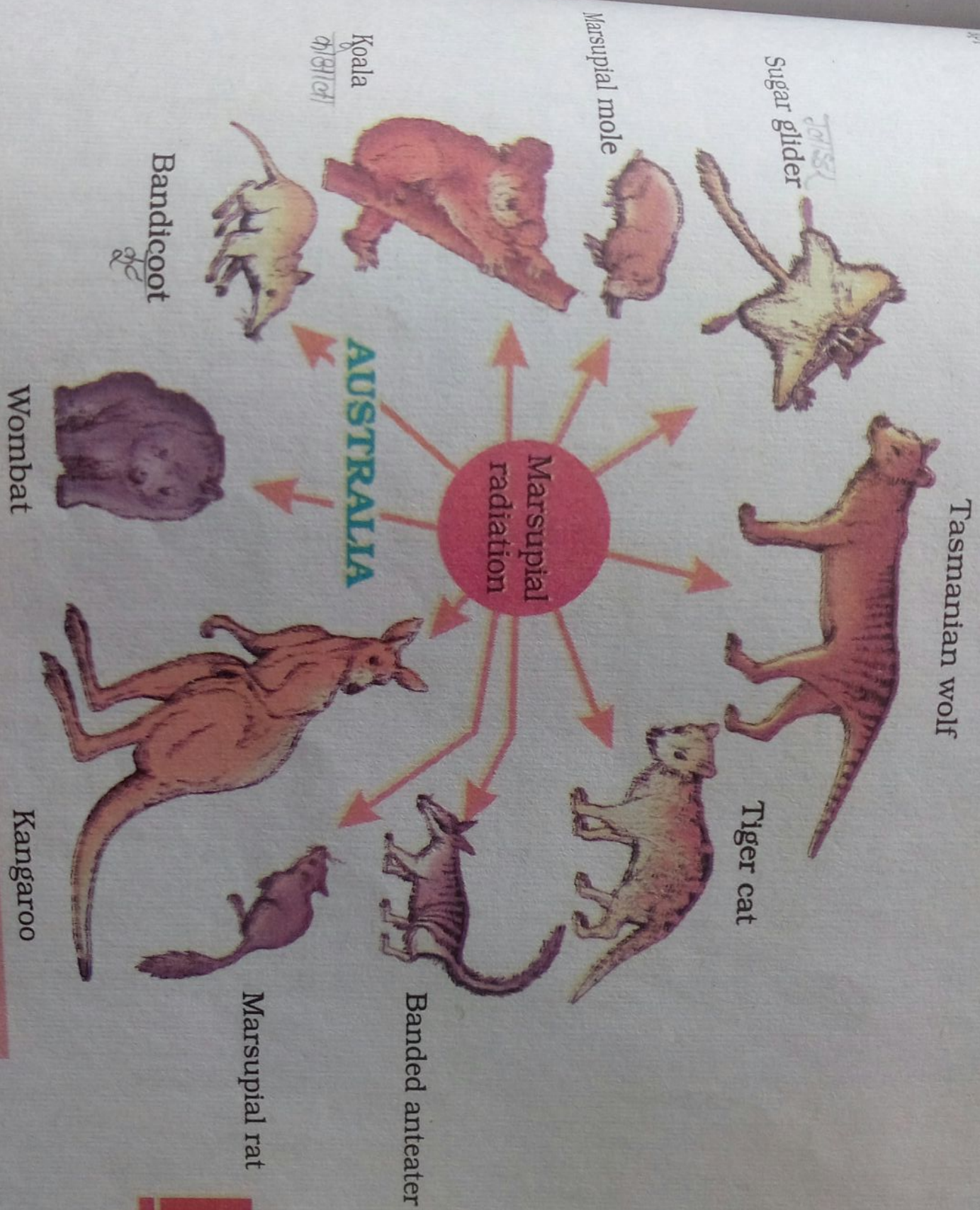


Figure 7.6 Adaptive radiation of marsupials of Australia

Australian marsupials, each with different form other evolved from one ancestral stock, but all within Australian island continents.

when more than one adaptive radiation appeared to have occurred in an isolated geographical area (representing different habitats) we can call this convergent evolving e.g. placental mammals and Australian marsupials.

- ✓ • during his exploration of Galapagos islands, Darwin noticed that there were many varieties of "finches" in the same island.

They varied from normal seed eating varieties to those that ate insects.

This process of evolution starting from a single point and radiating in different directions is called adaptive radiation.

The other ex. for this is the evolution of the Australian marsupials from a single ancestor placental mammals also exhibit similarities to their corresponding marsupial. Ex- placental wolf and the Tasmanian wolf.

When more than one adaptive radiation occurs in an isolated geographical area, the phenomenon is called divergent evolution.

- Adaptive melanism - in England, it was noted that before industrial revolution, the number of white winged moths was more than that of dark melanised moth. However, after industrialisation, there were more of dark melanised moths. The explanation was that after industrialization, the tree trunks became darker with deposits of soot and smoke and hence, the number of dark moths increased in order to protect themselves from predators while the white-winged moths were easily picked up by the predators.

Similarly, the herbicide and pesticide resistant plants and animals and antibiotic resistant bacteria are some of the evidences that point towards evolution (anthropogenic action).

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- The _____ upon _____ their _____
- Another _____ is _____ nature _____ are _____ men _____

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Biological Evolution.

- According to darwin, evolution took place by natural selection.
- The number of life forms depends upon their ability to multiply and their life span.
- Another aspect of natural selection is the survival of the fittest, where nature selects the individuals which are most fit, to adapt to their environment.

Branching descent and natural selection are the two important concepts of Darwin's theory of evolution.

The French naturalist Lamarck observed that evolution occurs due to the use or disuse of particular organs or body parts. Ex. Giraffe, have developed long necks as a result of attempts to eat leaves high up on trees.

- Darwin also observed that variations are inheritable and the species fit to survive the most, leaves more offsprings. Hence, the population's characteristics change, giving rise to the evolution of new div forms.

Mechanism of Evolution

- Darwin did not quite explain how evolution gave rise to different species of the same organism.

- Mendel mentioned about inheritable factors, which influenced the phenotype of an organism.

- Hugo de Varies based on his work on evening primrose suggested that variations occurred due to mutations.

Mutations are random and directionless while the variations that Darwin talked about were small and directional. Hugo de Varies gave the name Saltation (single step large mutation) to the mutations which brought about speciation.

Hardy-Weinberg principle.

- The frequency of occurrence of alleles of a gene in a population remains constant through generations unless disturbances such as mutations, non random mating etc. are introduced.

- Genetic Equilibrium (gene pool remains constant) is a state which

founder effect

provide a baseline to measure genetic change.

- Sum total of all allelic frequencies is 1.
- Individual frequencies are represented as P and q such as in a diploid, where P and q represent the frequency of allele A and a .

The frequency of AA is P^2 , that of aa is q^2 and that of Aa is $2Pq$.

hence, $[P^2 + 2Pq + q^2 = 1]$
which is expansion of $(P+q)^2$

- when the frequency measured is different from that expected, it is indicative and evolutionary change.

Hardy-Weinberg equilibrium is affected by -

- gene flow or gene migration
- genetic drift (changes occurring by chance)
- mutation
- genetic recombination
- natural selection

✓ • Sometimes, the change is allele

founder effect

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frequency is so prominent in the new sample of population that they become a different species and the original drifted population becomes the founder. This effect is called founder effect.

The advantageous mutations that help in natural selection over the generations give rise to new phenotypes and result in Speciation.

Evolution in plants

- cellular life forms occurred on earth about 2000 million years ago.
- Some of these cells had the ability to produce oxygen through reactions similar to photosynthesis.
- Slowly, single celled organism become multicellular.

Sea weeds and some plants probably existed around 320 million years ago.

Evolution in Animals.

- Animals evolved about 500 million years ago. the first of them to evolve were invertebrates
- Jawless fishes evolved around 850 million years ago

- Some of the fishes could go on land, and then come back to water. These were the first amphibians. In 1938, a fish Coelacanth, which was thought to be extinct, was caught in South Africa. This variety of fish called lobe fins, is believed to have evolved into the first amphibians.

Amphibian evolved into reptiles.

- In the next 200 million years, reptiles of different size dominated the earth. However, about 65 million years ago, some of them such as dinosaurs disappeared.
- The first among the mammals were small shrew-like mammals.
- During continental drift when North America joined South America, primitive mammals suffered, but pouched mammals of Australia survived the same drift because of lack of competition from other mammals.

Origin And Evolution of Man

<u>Year</u>	<u>Evolution</u>	<u>characteristics</u>
15 million Years ago	<u>Dryopithecus</u> (ape like) and <u>Panopithecus</u> (man like)	Hairy and walked similar to chimpanzees
3-4 million Years ago	<u>Man like primates</u>	Not tall, but walks straight. (1)
2 million Years ago	<u>Australopithecines</u> also called <u>Homo</u> <u>habilis</u> , lived in <u>East Africa</u>	Used stone weapons and ate fruits. human like with brain capacity of 650-800 cc, not meat eaters. (2)
1.5 million Years ago	<u>Homo erectus</u>	Brain capacity of about 900 cc, were meat eaters.
1,000 - 40,000 Years ago	<u>Neanderthal man</u>	Brain capacity of 1400 cc, used hides agriculture and and human settlements started.
75,000 - 10,000 Years ago	<u>Homo sapiens</u>	

when we compare the skulls of an adult human being, baby chimpanzee, and adult chimpanzee, we observe that skull of baby chimpanzee resembles human being more as compared to adult chimpanzee.

Qus Ans.

① In the presence of antibiotic, the bacteria that are sensitive to it will die. However if there are any mutants in the population, that can somehow survive its effect, they will multiply and increase in numbers. After that, they will live as antibiotic resistant bacteria.

② Scientists have found the fossil of a 60-million year old creature in Morocco, which is the rabbit sized ancestor of the modern day elephant. Paleontologist Emmanuel Gheerbrant discovered the rabbit-size proto-elephant's skull fragments in a basin 60 miles (100 kilometers) east of Casablanca, Morocco. The creature called *Erithium azzou-zorum*, bolsters the case that whole

EXERCISES

1. Explain antibiotic resistance observed in bacteria in light of Darwinian selection theory.
2. Find out from newspapers and popular science articles any new fossil discoveries or controversies about evolution.
3. Attempt giving a clear definition of the term species.
4. Try to trace the various components of human evolution (hint: brain size and function, skeletal structure, dietary preference, etc.)
5. Find out through internet and popular science articles whether animals other than man has self-consciousness.
6. List 10 modern-day animals and using the internet resources link it to a corresponding ancient fossil. Name both.
7. Practise drawing various animals and plants.
8. Describe one example of adaptive radiation.
9. Can we call human evolution as adaptive radiation?
10. Using various resources such as your school Library or the internet and discussions with your teacher, trace the evolutionary stages of any one animal, say horse.

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Zorum, bolsters the case that whole

new orders of mammals were already around less than 6 million years after global catastrophe ended the age of reptiles some 65.5 million years ago

3. Species can be defined as a group of organisms that can interbreed under natural conditions and produce fertile offsprings

4. Name	Features
Doryopithecus	Ape like, canines large, arms and legs are of equal size, ate soft fruits and leaves
Ramapithecus	More man like, canines were small while molars were large, walked more erect, ate seeds and nuts
Australo-pithecus	Man like, canines and incisors were small, walked upright, hunted with stone weapons, ate fruits, brain capacities were between 400 - 600 cc

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Homo habilis

First human like being,
Canines were small, first
tool makers, did not eat
meats, brain capacities
were between 650-800cc.

Homo erectus

Used stone, bone tools for
hunting games, ate meat,
brain capacities
900 cc.

Homo neanderthalensis

Cave dwellers used
furs to protect their
bodies and buried
their dead, brain
capacities 1400cc.

Homo sapiens (Modern human)

high intelligence,
developed art, culture
language etc. cultivated
crops and domesticated
animals

⑤ Self consciousness needs to be defined as the mental link or one's awareness of one self as an individual or of one's own being, actions, or thought. There are many other than humans, which have self consciousness such as dolphins, crow, parrot, chimpanzee, gorilla.

⑥ Animals

- Man
- Dog
- chimpanzee
- Elephant
- horse
- Gorilla
- Camel
- whale
- fish
- cutopus

fossils

- Homo Sapiens
- Lehitocyon
- Dryopithecus
- Moeritheres
- Eohippus
- Dryopithecus
- Protocetus
- Protocetus
- Amundashis
- Belemnite

⑧ Darwin finches of the Galapagos islands is an ex. of adaptive radiation. they once had a common ancestor but as time passed, they underwent evolution and adapted itself according to their food habitat.

⑨ No, human evolution cannot be called adaptive radiation because adaptive radiation is an evolutionary process that produces new species from a single, rapidly diversifying lineage which is not the case with human evolution.

(10) Evolutionary stages of horse.
Eohippus - Mesohippus - Merychippus - Pliohippus - Equus

Evolutionary trend.

1. increase in body size.
2. Elongation of neck.
3. Lengthening of limbs
4. Enlargement of third digit
5. Increase in structural complexity of teeth for feeding on grass.