CHAPTER – 7

EVOLUTION

Evolutionary Biology is the study of history of life forms on the earth. To understand the changes in flora and fauna that have occurred millions of years on earth we must have a strong understanding of the context of life, that is evolution of earth, the stars, and the universe itself.

Origin of Life

The genesis of life is regarded as a one-of-a-kind occurrence in the history of the cosmos. The universe is made up of a massive cluster of galaxies. Galaxies include stars as well as dust and smoke clouds.

The **Big Bang** Theory seeks to explain the origins of the cosmos. According to this idea, a massive explosion occurs, resulting in the formation of many galaxies.

Earth is thought to have originated some **4.5 billion years ago** in the Milky Way galaxy's solar system. The early Earth had no atmosphere. The earth's surface was coated with water vapour, methane, carbon dioxide, and ammonia emitted by the molten mass.

The sun's UV rays split water into hydrogen and oxygen.
Life arose 500 million years after the Earth's formation.

Theories in support of Origin of Life

- **Greek thinkers** believed that spores brought from other planets were the basic unit of life.
- According to another hypothesis, life emerges from dead and decaying substances such as straw and dirt. This is known as **the hypothesis of spontaneous origin.**
- **Louis Pasture** demonstrated experimentally that life can only come from pre-existing life. Following that, the spontaneous theory of the origin of life is discarded.
- **Oparin and Haldane** argued that the initial form of life may have evolved from non-living organic molecules such as RNA and protein. Chemical evolution precedes the origin of life. At that period, the earth's conditions were as follows:
  (i) high temperatures
  (ii) volcanic eruptions, and
  (iii) reducing atmosphere that comprised of CH_4 and NH_3.

Miller's Experiment: In 1953, S.L. Miller undertook an experiment to demonstrate the origin of life on Earth in a physical environment comparable to that which existed at the time.

Miller created identical temperature and pressure conditions in the laboratory. At 8,000 degrees Celsius, he established an electric discharge in a flask containing CH_4, H_2, NH_3, and water vapour.

After 15 days of electric discharge, he saw the synthesis of amino acids in a flask. Another scientist discovered the creation of sugars, nitrogen bases, colours, and lipids in a similar procedure.

Analysis of meteorite material revealed comparable molecules, indicating that similar processes are taking place elsewhere in space. This experimental evidence for the genesis of life is referred to as the **chemical evolution of life.**

The first non-cellular forms of life may have evolved three billion years ago. They might have been massive molecules like RNA, Protein, and Polysaccharide, among others.

The cellular form of life most likely began as a single cell in an aqueous medium.

Biogenesis is the hypothesis that the initial form of life evolved slowly through evolutionary processes from non-living components.

Brush Up Your Understanding

Q1. In 1953, S.L. Miller undertook an experiment to demonstrate the origin of life on Earth, which of the following was synthesised in Miller's experiment?
(a) Lipids (b) Proteins
(c) Amino acids (d) All of the above

S1. (c)

Q2. The first non-cellular forms of life originated.
(a) 1 billion years back (b) 2 billion years back
(c) 3 billion years back (d) 4 billion years back

S2. (c)

Evidence of evolution: some of the evidence of the evolution of life forms are as follows:

(i) Paleontological evidence: Various ages of rock sediments include remains of various living forms that most likely died during the sediment's development. **Fossils** are the hard remnants of life-forms discovered in rocks. The study found that diverse forms changed through time and that particular living forms had a geological time span. As a result, new types of life have emerged at various points throughout Earth's history.

(ii) **Homologous organs:** Homologous organs are ones that perform distinct functions but have a similar origin and structure. **Humans, cheetahs, bats, and whales, for example, show similarities in the arrangement of bones in their forelimbs,** despite the fact that these forelimbs serve different tasks in these creatures. Because of adaptation to distinct demands, these animals evolved identical structures in opposite orientations. This is referred to as **divergent evolution**.

(iii) **Analogous structures:** They are not morphologically identical organs, yet they serve the same purpose. **For example, the eyes of mammals and octopuses, as well as the flippers of penguins and dolphins.** This is because distinct groups of species have comparable adaptation traits owing to similar environment. This process of evolution is known as **convergent evolution**.

(iv) **Biochemical evidence:** Similarities in proteins and genes that execute the same function in different species suggest a common ancestor. These molecular similarities, like structural similarities, indicate common ancestor.

Brush Up Your Understanding

Q1. The eyes of mammals and octopuses, as well as the flippers of penguins and dolphins are.
(a) Homologous organs (b) Analogous organs
(c) Both (a) and (b) (d) None of the above

S1. (b)

Q2. Homology is based on.
(a) Convergent evolution (b) Divergent evolution
(c) Both (a) and (b) (d) None of the above

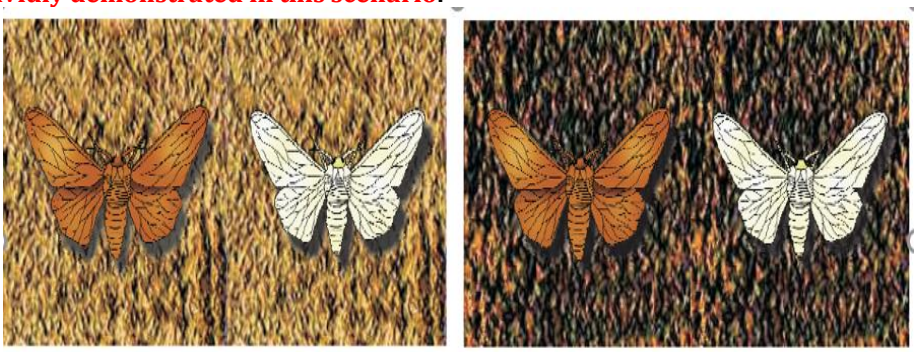
S2. (b)

Evolution by Natural Selection

Industrial Melanism: Natural selection was seen in a peppered moth in England in the 1850s, prior to industrialization **(*Biston betularia*).**

- This moth came in two colours: grey and black (Carbonaria). Before industrialisation in the early nineteenth century, only the grey-colored moths were present; the black ones were uncommon.
- The grey-colored moths were found on tree trunks coated in lichens, allowing them to flee their assailants.
- Later, around 1920, when industries developed, post-industrialization, the lichens died and the tree trunks became black owing to the deposition of industrial soot. Birds may now locate these moths and feast on them.
- As a result, the grey-colored moths were devoured by the birds, but the dark-colored moths fled.
- The coal is currently being replaced by industries, which utilise oil and electricity. This has resulted in less soot generation and, as a result, decreased soot deposition on tree trunks.
- These tree trunks have now become grey once more. As a result, the number of grey-colored moths has grown once more.

Natural selection is vividly demonstrated in this scenario.

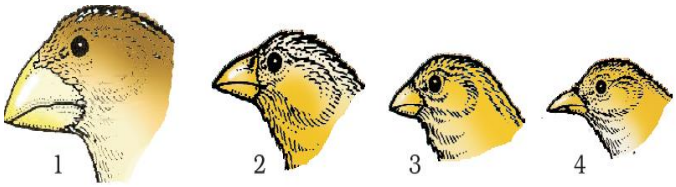


Winged moth and dark moth –winged moth (melanised) on a tree trunk.
(a) In unpolluted area (b) in polluted area.

Evolution by Anthropogenic Selection: e.g. resistance of mosquitoes to pesticides.

DDT was a huge success when it was used to control mosquitoes. The majority of the mosquitos were DDT sensitive and were so eliminated. Few mosquitos in that population acquired resistant to DDT and survived. They grew and now the entire mosquito population developed resistance to DDT.

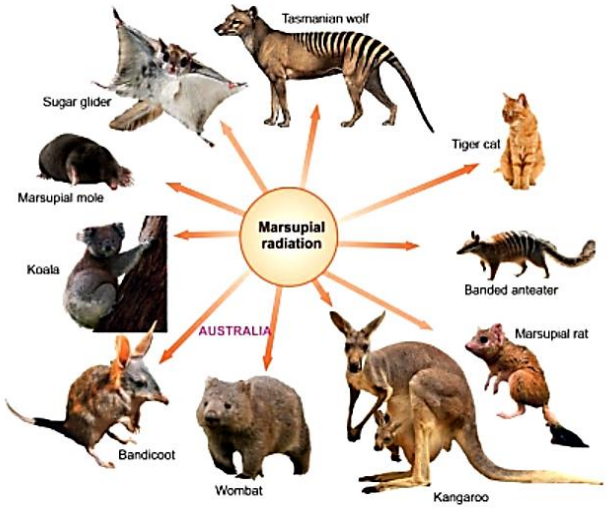
Convergent evolution occurs when more than one adaptive radiation appears to have occurred in a geographically separated location (representing distinct ecosystems), for example, Placental mammals and Australian marsupials.



Variety of beak of finches that Darwin found in Galapagos islands

The same pattern has been found in bacteria that are multidrug resistant as a result of excessive medication and pharmaceutical usage.

Adaptive Radiation: it refers to the process of evolution of diverse species in a specific geographical region that begins at a point and spreads to other parts of geography (habitat). **Darwin's finches** are an excellent illustration of adaptive radiation. Australian marsupials developed from a common ancestor stock, yet all lived on Australian island continents.



Adaptive Radiation of Marsupials of Australia

Brush Up Your Understanding

Q1. Darwin's finches are an example of.
(a) Seasonal fluctuation (b) Saltation
(c) Adaptive radiation (d) All of the above

S1. (c)

Q2. Thomas Malthus work on which of the following influenced Darwin?
(a) Species (b) Community
(c) Area (d) Population

S2. (d)

Biological Evolution: Nature favours the fittest, and fitness is determined by hereditary qualities. Some species have evolved to thrive in hazardous environments. Fitness is the final outcome of one's capacity to adapt to and be chosen by nature.

According to Lamarck, evolution of living forms happened but was driven by the use and misuse of organs. He used giraffes as an illustration of how they evolved their necks by harvesting leaves on lofty trees and had to adjust by elongating their necks.

The two essential principles of **Darwinian Theory of Evolution** are:
(i) branching descent and
(ii) natural selection.

Darwin's theory of natural selection was based on following observation:

- Natural resources are scarce.
- Population growth
- Competition for scarce resources
- Survival for existence.
- Survival of the fittest

Mechanisms of Evolution:

- Hugo deVries proposed the concept of mutation based on his research on **evening primrose** (*Oenothera lamarckiana).*
- A mutation is a substantial change that appears abruptly in a population.
- Darwin variations are modest and directed, whereas mutations are random and directionless.
- Hugo deVries thought that mutation produced speciation, which he referred to as **saltation (single step large mutation).**

Brush Up Your Understanding

Q1. Who of the following brought forth the idea of mutation?
(a) Darwin (b) Ernst Haeckel
(c) Hugo de Varies (d) None of the above

S1. (c)

Q2. Two basic concepts of Darwinian theory are.
(a) Branching descent (b) Natural selection
(c) Both (a) and (b) (d) None of the above

S2. (c)

Hardy-Weinberg Principle

The frequency of occurrence of alleles or genes in a given population can be determined. These frequencies remain constant and even during generation. Hardy-Weinberg concepts were used to describe this information using an algebraic equation.

According to this theory, allele frequencies in a population remain steady and consistent from generation to generation. The gene pool does not change. This is known as genetic equilibrium, and the sum of all allelic frequencies equals 1.

Binomial expansion of $(p + q)^2 = p^2+2pq+q^2=1$ where p and q are the frequencies of allele A and a in a population

The frequency of AA people in a population is simply p^2.

Just put, the likelihood of an allele A with a frequency of p appearing on both chromosomes of a diploid person is simply the product of the probabilities, i.e., p^2. Similarly, aa is q^2, and Aa 2pq. **As a result, $p^2 + 2pq + q^2 = 1$.**

When measuring frequency, the actual value varies, indicating the level of evolutionary changes.

Change of frequency in alleles (Hardy-Weinberg equilibrium) in a population resulted due to evolution.

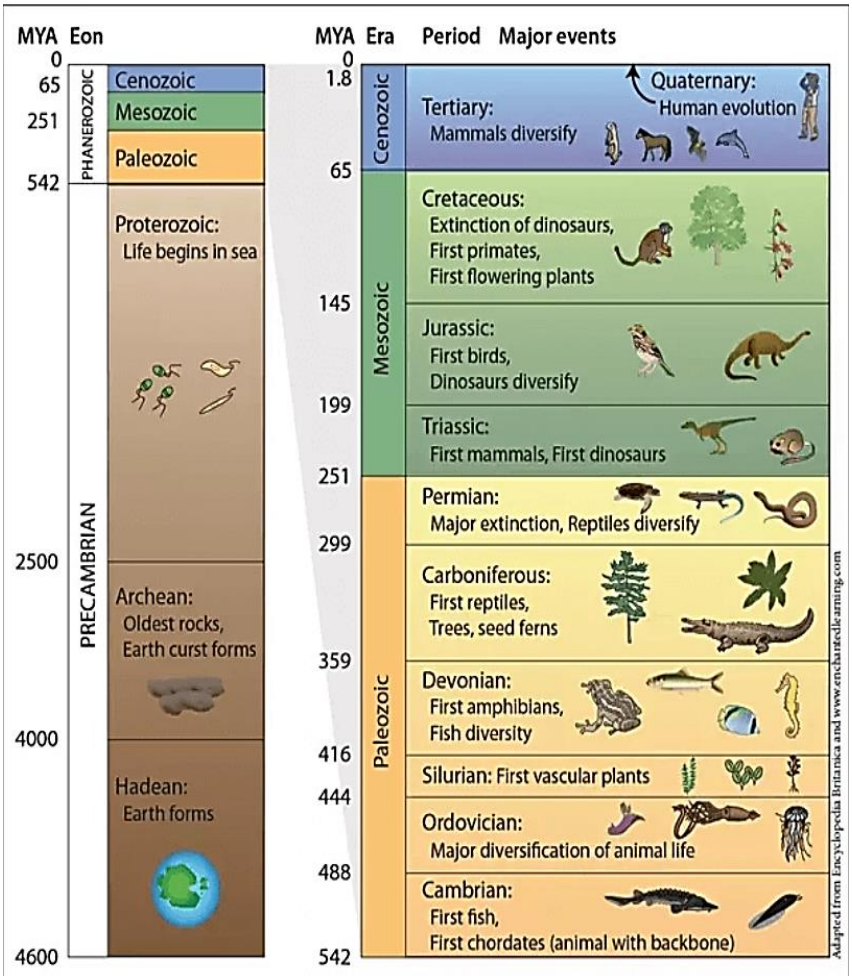
Factors Affecting Hardy-Weinberg principle are:

(i) Gene migration/gene flow
(ii) Genetic drift
(iii) Mutation
(iv) Genetic recombination
(v) Natural selection

During genetic drift, changes in allele frequency might be so diverse in a population sample that they form a separate species. The original drifted population becomes founder and that effect is called **founder effect.**

Brief Account of Evolution

- The earliest cellular form of life evolved on Earth some 2000 million years ago.
- Slowly, single-celled animals evolved into multicellular forms, and by 500 million years ago, invertebrates were developed and active.
- Around 350 million years ago (mya), jawless fish originated.
- Organisms began to spread from the sea to the land. Fish with large and powerful fins may travel on land and return to the water. These lobefin creatures developed into the earliest amphibians.
- These amphibians later evolved into reptiles. They produce shelled eggs. The planet was once dominated by reptiles of all forms and sizes, including fish-like reptiles such as Ichthyosaurs and terrestrial reptiles such as dinosaurs. *Tyrannosaurus rex* was the largest.
- Some of the reptiles developed into birds, while others into mammals. Mammals were viviparous and better at perceiving and avoiding danger



Evolution of plant forms through geological periods

Brush Up Your Understanding

Q1. The allele frequencies in a population according to Hardy Weinberg principle is.

(a) Constant (b) Stable
(c) Both (a) and (b) (d) None of the above

S1. (c)

Q2. Jawless fishes originated.

(a) 150 mya (b) 250 mya
(c) 350 mya (d) 450 mya

S2. (c)

Origin and Evolution of Man

Dryopithecus: evolved in 15 mya. They were hairy and walked like gorillas and chimpanzees. They were more ape-like.

Ramapithecus: they were more man like.

Australopithecus: they lived in East African grasslands. Discovered 2 mya. They hunted with stone weapons and ate fruits.

Homo habilis: this was first human like. Its brain capacity was 650-800cc. They did not eat meat.

Homo erectus: discovered 1.5 mya. They had a large brain with a brain capacity of 900cc.
They ate meat.

Neanderthal man*:* it had a brain capacity of 1400cc and lived near east and central Asia.

They used hides to protect their body and were the first to bury their dead.

Homo sapiens: they arose in Africa and moved to other continents and developed into different races.

SUMMARY

Evolutionary biology is the study of the history of life forms on Earth. Origin of life is believed to be a unique event in the history of universe. The Big Bang Theory attempts to explain the origin of universe. There was no atmosphere on early earth. Water vapor, methane, carbon dioxide and ammonia released from molten mass covered the surface. The UV rays from the sun caused decomposition of water into hydrogen and oxygen. Hydrogen gas being lighter escaped into space. Early Greek believed that units of life called spores were brought to different planets including earth. This theory is called as Panspermia and is still favored by many astronomers. Oparin of Russia and Haldane of England proposed that the first forms of life originated from pre-existing non-living organic molecules (e.g. RNA, protein etc.). Charles Darwin concluded that existing life forms share similarities to varying degrees not only among themselves but also with life forms that existed millions of years ago. Natural selection is the essence of Darwinian Theory about evolution. Fossils provide palaeontological evidence . Ernst Heckel proposed this evidence as evolution based on observation of certain common features during embryonic stage of all vertebrates but are absent in adult. Hugo de Vries worked on evening primrose. He gave the idea of mutations. Hardy Weinberg principle states that the allele frequencies in a population are stable and are constant from generation to generation. Among the stories of evolution of individual species, the story of evolution of modern man is most interesting and appears to parallel evolution of human brain and language.

IMPORTANT POINTERS

Embryological support for evolution was also proposed by Ernst Heckel. This proposal was disapproved on careful study performed by Karl Ernst von Baer.

Whales, bats, Cheetah and human (all mammals) share similarities in the pattern of bones of forelimbs, show divergent evolution. Other examples are vertebrate hearts or brains and the thorn and tendrils of *Bougainvillea* and *Cucurbita* represent homology. Wings of butterfly and of birds show convergent evolution and are analogous organs.

Hardy-Weinberg principle says that allele frequencies in a population are stable and is constant from generation to generation. The gene pool (total genes and their alleles in a population) remains a constant. This is called genetic equilibrium. Sum total of all the allelic frequencies is 1. The first mammals were like shrews. *Dryopithecus and Ramapithecus* existed 15 mya. *Homo habilis* was more man-like. Neanderthal man buried their dead and used hides to protect their body..

MULTIPLE CHOICE QUESTIONS

Q1. What was Louis Pasteur's observation about origin of life?
(a) Life is pre-occupied
(b) Life comes from only from pre-existing life
(c) Life comes only from post-existing life
(d) Nothing can be said about life

Q2. Who among the following proposed that life could have come from pre-existing non-living organic molecules and that formation of life was preceded by chemical evolution?
(a) Louis Pasteur
(b) Miller
(c) Oparin and Haldane
(d) Greek thinkers

Q3. Who among the following supported embryological evolution?
(a) Charles Darwin
(b) Ernst Heckel
(c) Hugo de Varies
(d) Miller

Q4. Who among the following rejected the proposal of Ernst Heckel's embryonic evolution?
(a) Charles Darwin
(b) Lamarck
(c) Karl Ernst von Baer
(d) None of the above

Q5. Who among the following wrote the book Philosophique Zoologique?
(a) Lamarck (b) Haldane
(c) Ernst Heckel (d) Darwin

Q6. Which of the following represents homology?
(a) Cucurbita and Bougainvillea
(b) Whales and bats
(c) Eye of octopus and mammals
(d) Both (a) and (b)

Q7. What do analogous structures like wings of butterfly and birds represent?
(a) Divergent evolution
(b) Adaptive radiation
(c) Convergent evolution
(d) All of the above

Q8. Which of the is a good example of Adaptive Radiation?
(a) Moths
(b) Darwin's finches
(c) Tasmanian wolf
(d) Sugar glider

Q9. Which among the following are the two key concepts of Darwinian Theory of Evolution?
(a) Natural selection
(b) Branching descent
(c) Adaptive radiation
(d) Both (a) and (b)

Q10. Which of the following is correct about Hardy Weinberg Principle?
(a) The principle states that allele frequencies in a population are not stable and is not constant generation after generation
(b) The principle states that allele frequencies in a population stable and is constant generation after generation
(c) Both (a) and (b)
(d) None of the above

Q11. What is gene pool?
(a) Total number of genes in a population
(b) Total number of genes and their alleles in a population
(c) Total number alleles in a population
(d) Frequency of alleles on a gene

Q12. Which among the following was the biggest dinosaur?
(a) Ichthyosaurs
(b) *Tyrannosaurus rex*
(c) Lobefins
(d) Tutara

Q13. What was the brain capacity of *Homo habilis*?
(a) 350-450 cc
(b) 550-650 cc
(c) 650-800 cc
(d) 800-900 cc

Q14. What were the features of *Homo erectus*?
(a) Small brain with 500 cc brain capacity
(b) Large brain with 500 cc brain capacity
(c) Small brain with 900 cc brain capacity
(d) Large brain with 900 cc brain capacity

Q15. Which of the following man used hides to protect their body and buried their dead?
(a) Dryopithecus
(b) Neanderthal
(c) Ramapithecus
(d) Homo habilis

Q16. When dis *Homo sapiens* arose?
(a) 6500o- 75,000 years ago
(b) 75,000-80,000 years ago
(c) 75,000-10,000 years ago
(d) 10,000-12,000 years ago

Q17. Which among the following is correct about Neo-Darwinism?
(a) Mutation is responsible for evolution
(b) Genetic drift is responsible for evolution
(c) Natural drift is responsible for evolution
(d) Adaptive radiation is responsible for evolution

Q18. What type of organs are shown the following picture?

(a) Analogous organs
(b) Homologous organs
(c) Modifies organs
(d) Stripped organs

Q19. What is the cause of Founder's effect in a population?
(a) Mutation
(b) Natural selection
(c) Genetic drift
(d) Gene flow

Q20. The process of evolution of different species in a given geographical area starting from a point and radiating to other areas of habitat is called as.
(a) Saltation
(b) Adaptive radiation
(c) Founder's effect
(d) Divergent evolution

Q21. Which hominid fossil was discovered in Java that had a cranial capacity of 900cc?
(a) Neanderthal man
(b) Ramapithecus
(c) Homo erectus
(d) Homo sapiens

Q22. Where can we see pre-historic cave paintings done by humans?
(a) Uttar Pradesh
(b) Madhya Pradesh
(c) Orissa
(d) West Bengal

Q23. Which of the following is correct about Natural Selection?
(a) It leads to stabilization
(b) It leads to directional change
(c) It leads to disruption
(d) All of the above

Q24. Which of the following shows convergent evolution?
(a) Flippers of Dolphins and penguins
(b) Vertebrae heart and brain
(c) Bones of the for-limbs of cheetah and whales
(d) Tendrils of *Cucurbita* and *Bougainvillea*

Q25. Which of the following is correct about anthropogenic action?
(a) It tells us that evolution is not a directed process
(b) It tells that evolution is a stochastic process
(c) It tells that evolution is based on chance events in nature and chance mutation in an organism.
(d) All of the above

Q26. Who among the following used the term saltation?
(a) Lamarck (b) Ernst Heckel
(c) Haldane (d) deVaries

Q27. Who among the following was of the view that evolution of life forms had occurred by the use and disuse of organs?
(a) Darwin (b) Ernst Heckel
(c) Lamarck (d) Thomas Malthus

Q28. Which among the following can indicate industrial pollution?
(a) Sponges (b) Lichen
(c) Hydra (d) Moth

Q29. When did conifers, cycads and ferns evolved?
(a) Jurassic period
(b) Permian period
(c) Cretaceous period
(d) Devonian period

Q30. Which one of the following is the correct order of geological period from left to right?
(a) Mesozoic, Cenozoic, Palaeozoic
(b) Cenozoic, Palaeozoic, Mesozoic
(c) Palaeozoic, Mesozoic, Cenozoic
(d) Mesozoic, Palaeozoic, Cenozoic

Q31. Which among the following is false statement?
(a) Cycads evolved in Jurassic period
(b) Bryophytes evolved in Palaeozoic
(c) Dicotyledons evolved in Cretaceous period
(d) Lycopods evolved in Permian period

Q32. Which of the following is correct about first mammals?
(a) They were dinosaurs
(b) They were like shrews
(c) They were like fishes
(d) They were reptiles

Q33. What did S.L Miller used in his electric discharge experiment?
(a) Methane, Hydrogen, ammonia and water vapour
(b) Water vapour, Ammonium hydroxide, Hydrogen, methane
(c) Ammonium hydroxide, water vapour, Hydrogen, Methane
(d) Hydrogen, water vapour, oxygen, carbon monoxide

Q34. Who among the following influenced Darwin the most?
(a) Ernst Heckel
(b) Thomas Malthus
(c) S.L Miller
(d) Lamarck

Q35. What is "Fitness" according to Darwin?
(a) Mental Fitness
(b) Physical fitness
(c) Reproductive fitness
(d) Overall fitness

Q36. What are fossils?
(a) They are soft parts of life forms found in rocks
(b) They are hard parts of life forms found in rocks
(c) They are liquid parts of life forms found in rocks
(d) They are soft parts of life forms found in soil

Q37. Where are the fossils generraly found?
(a) Igneous rocks
(b) Metamorphic rocks
(c) Volcanic eruptions
(d) Sedimentary rocks

Q38. What are evidences obtained from fossils called?
(a) Embryological evidence
(b) Palaeontological evidence
(c) Convergent evidence
(d) Divergent evidence

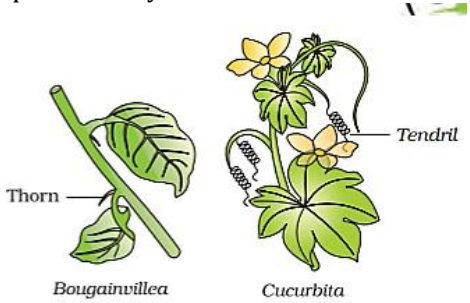
Q39. When did flowering plants evolved?
(a) Triassic period
(b) Tertiary period
(c) Silurian period
(d) Cretaceous period

Q40. Which among the following was a missing link between reptiles and birds?
(a) Dodo (b) Archaeopteryx
(c) Jawless fish (d) Synapsids

Q41. Which of the following is responsible for initiation of evolution?
(a) Mutation
(b) Natural selection
(c) Variation
(d) Genetic drift

Q42. Which among the following lived in the East African grasslands?
(a) Ramapithecus
(b) Australopithecines
(c) Dryopithecus
(d) Neanderthal man

Q43. Look at the picture and answer which type of evolution is represented by the thorns and tendrils of the plants?



(a) Divergent evolution
(b) Convergent evolution
(c) Both (a) and (b)
(d) None of the above

Q44. Which of the following indicated adaptive radiation
(a) Moth and lichen
(b) Eye of octopus and mammals
(c) Placental wolf and Tasmanian wolf marsupial
(d) Dinosaurs

Q45. Which among the following is the earliest geological period in the period of evolution?
(a) Mesozoic (b) Cenozoic
(c) Palaeozoic (d) None of the above

Q46. Who among the following wrote "The Origin of Species"?
(a) Lamarck (b) Darwin
(c) Thomas Malthus (d) Heckel

Q47. Who among the following gave the theory of Pangenesis?
(a) Darwin (b) Lamarck
(c) Miller (d) Malthus

Q48. Which of the following is the Age of Reptiles?
(a) Cenozoic (b) Mesozoic
(c) Palaeozoic (d) None of the above

Q49. Which among the following molecule was absent from the earth's atmosphere, according to scientist Oparin?
(a) Oxygen (b) Water
(c) Carbon di oxide (d) Methane

Q50. What is the age of earth according to the theory of special creation?
(a) 2000 year's old (b) 3000 year's old
(c) 4000 year's old (d) 5000 year's old

ASSERTION AND REASON

Direction: in the following questions, a statement of assertion (A) is followed by a statement of reason (R). Choose the correct option among a, b, c and d.

Q1. Assertion (A): Natural selection is a process in which heritable variations enabling better survival are enabled to reproduce and leave greater number of progeny.
Reason (R): Natural selection can lead to stabilisation, directional change or disruption.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q2. **Assertion (A):** Hardy- Weinberg principle says that allele frequencies in a population are stable and is constant from generation to generation.
Reason (R): Natural selection is a process in which heritable variations enabling better survival are enabled to reproduce and leave greater number of progeny.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q3. **Assertion (A):** Evolution by natural selection, in a true sense would have started when cellular forms of life with differences in metabolic capability originated on earth.
Reason (R): The essence of Lamarckism theory about evolution is natural selection.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q4. **Assertion (A):** This process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats) is called adaptive radiation.
Reason (R): A French naturalist Lamarck had said that evolution of life forms had occurred but driven by use and disuse of organs.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

TRUE AND FALSE

Q1. Excess use of herbicides, pesticides tells us that evolution is a stochastic process based on chance events in nature and chance mutation in the organisms.

Q2. Hugo deVries worked on *Catharanthus roseus* and brought forth the idea of adaptive radiation.

Q3. Saltations are multi-step variations.

Q4. *Australopithecines* probably lived in East African grasslands. Evidence suggested that they buried their dead.

PRACTICE QUESTIONS

Q1. Homo sapiens arose in.
(a) America (b) Australia
(c) China (d) Africa

Q2. Which vertebrates evolved into the first amphibians?
(a) Jawless fishes (b) Lobefins
(c) Salamanders (d) Ichthyosaurus

Q3. Proper burial of dead bodies for the first time started by which pre historic man?
(a) Java man (b) *Homo habilis*
(c) Neanderthal man (d) Australopithecines

Q5. Who lived in near east and central Asia between 1,00,000 - 40,000 years back?
(a) *Homo erectus* *(b) Homo habilis*
(c) Neanderthal man (d) Australopithecines

Q6. Dead remains of organisms found in the earth crust are the.
(a) Palaentological evidences
(b) Morphological evidences
(c) Anatomical evidences
(d) Physiological evidences

Q7. The first human being like prehistoric man was:
(a) Homo sapiens *(b) Homo erectus*
(c) Homo habilis (d) Neanderthal man

Q8. The naturalist who came about with the same ideas that of the Darwin was.
(a) Alfred Nobel (b) Alfred Wallace
(c) Lamarck (d) H. Khorana

Q9. Giraffe's neck and forelimbs get elongated during the course of evolution, due to.
(a) Inheritance of acquired characters
(b) Natural selection
(c) Geographical isolation
(d) Convergent evolution

Q10. In 1953 S. L. Miller created primitive earth conditions in the laboratory and gave experimental evidence for origin of first form of life from pre-existing non-living organic molecules. The primitive earth conditions created include.
(a) Low temperature, volcanic storms, atmosphere rich in oxygen
(b) Low temperature, volcanic storms, reducing atmosphere
(c) High temperature, volcanic storms, non-reducing atmosphere
(d) High temperature, volcanic storms, reducing atmosphere containing CH_4, NH_3 etc.

Q11. Fossils are generally found in.
(a) Sedimentary rocks
(b) Igneous rocks
(c) Metamorphic rocks
(d) Any type of rock

Q12. The bones of forelimbs of whale, bat, cheetah and man are similar in structure, because.
(a) One organism has given rise to another
(b) They share a common ancestor
(c) They perform the same function
(d) They have biochemical similarities

Q13. Palaeontological evidences for evolution refer to the.
(a) Development of embryo
(b) Homologous organs
(c) Fossils
(d) Analogous organs.

Q14. Select the incorrect statements.
(a) Natural selection is a heritable variation & by reproduction leave greater number of progemy
(b) During stabilisation of natural selection more individuals acquire value other than mean character value
(c) By the time of 500 million years ago invertebrates were formed and were active
(d) Reptiles lay thick shelled eggs which do not dry up in sun unlike those of Amphibians

Q15. Hugo Devries worked on.
(a) Oenothera lamarckiana
(b) Lathyrus odoratus
(c) Pisum sativum
(d) Arachis hypogea

Q16. Fossils *of Homo erectus* was discovered in.
(a) Java
(b) Bangladesh
(c) Ethiopia
(d) Tanzania

Q17. Neanderthal man lived near.
(a) East & West Africa
(b) South Africa
(c) North Africa
(d) East & Central Asia

Q18. Who proposed the first form of life from pre-existing non-living organic molecules?
(a) Oparin & Haldane
(b) Stanley Miller & Harold Urey
(c) Lamark & Darwin
(d) Hugo De Vries & Dobzhansky

Q19. Brain capacity of *Homo habilis* was.
(a) 650-800 cc (b) 800-900 cc
(c) 600-1000 cc (d) 900-1100 cc

Q20. Select the true statements.
(a) Ramapithecus and Dryopithecus were existing about 50 million years ago
(b) Ramapithecus was man like while Dryopithecus was more ape like
(c) Ramapithecus was more ape like while Dryopithecus was more man-like
(d) Both (a) and (b)

Q21. Highest brain capacity present in.
(a) Australopithecus
(b) *Homo habilis*
(c) Homo erectus
(d) Neanderthal

Q22. Which reptile went back into water to evolve into fish like reptile?
(a) Ichthyosaurs (b) Calotes
(c) Hemidactylus (d) Alligator

Q23. Presence of coelacanth fish was observed in.
(a) South America
(b) South Africa
(c) North America
(d) North Africa

Q24. The factor that leads to Founder effect in a population is.
(a) Natural selection
(b) Genetic recombination
(c) Mutation
(d) Genetic drift

Q25. In Hardy-Weinberg equation, the frequency of heterozygous individual is represented by.
(a) pq (b) q2
(c) p2 (d) 2pq

Q26. Which of the following had the smallest brain capacity?
(a) Homo sapiens *(b) Homo neanderthalensis*
(c) Homo habilis *(d) Homo erectus*

Q27. *Homo habilis* refers to.
(a) Wandering species (b) Ancient man
(c) Modern man (d) Tool-maker

Q28. Which of the following was not given by Darwin's theory of evolution?
(a) Struggle for existence
(b) Over production
(c) Natural selection
(d) Genetic drift

Q29. Inheritance of acquired characters comes from.
(a) Lamarckism (b) Darwinism
(c) Neo-Lemarckism (d) Neo-Darwinism

Q30. Gene pool is.
(a) Genotype of an individual of a population
(b) Different genes of all individuals of a species found in an area
(c) Pool of artificially synthesised genes
(d) Genes of a genus

ASSERTION AND REASON

Q1. **Assertion (A):** Natural selection is based on certain observations which are factual.
Reason (R): The work of Hugo de Varies on populations influenced Darwin.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q2. **Assertion (A):** Galaxies contain stars and clouds of gas and dust.
Reason (R): The Big Bang theory attempts to explain to us the origin of universe.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q3. **Assertion (A):** Charles Darwin 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.
Reason (R): Charles Darwin came to the above conclusion when he made a voyage around the world on the ship called H.M.S Beagle.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q4. **Assertion (A):** Analogous structures are a result of convergent evolution.
Reason (R): Eye of the octopus and of mammals or the flippers of Penguins and Dolphins are examples of homology.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

SOLUTIONS MULTIPLE CHOICE

S1. **(b)** Louis Pasteur's experimentation demonstrated that life originated from pre-existing life.

S2. **(c)** Oparin and Haldane were of the view that diverse organic molecules could have formed inorganic constituents.

S3. **(b)** Ernst Heckle observation was based on the observation of some features during the embryonic stage that is common to all vertebrates that are absent in adult.

S4. **(c)** Karl Ernst von Baer noted that embryos never pass through the adult stages of other animals.

S5. **(a)** The book was written in 1809by the French naturalist Lamarck.

S6. **(d)** Homology indicates common ancestry, and divergent evolution.

S7. **(c)** Analogous structures are result of convergent evolution, that is different structures evolving for the same function and hence having similarity.

S8. **(b)** Darwin spotted the finces in Galapagos Islands and observed that there were variety of finches in the same island and they evolved on the same island.

S9. **(d)** After a long study made by Darwin, he proposed the two major components of his evolution theory.

S10. **(b)** Hardy Weinberg proposed the principle to find out the frequency of occurrence of alleles of a gene.

S11. **(b)** A constant gene pool is important for maintenance of genetic equilibrium.

S12. **(b)** *Tyrannosaurus rex* was the biggest dinosaur, 20 feet in height and dagger like teeth.

S13. **(c)** *Homo habilis* was called the first human like being and did not eat meat.

S14. **(d)** *Homo erectus* evolved in 1.5 mya.

S15. **(b)** Neanderthal man with brain size of 1400 cc lived in near east and central Asia and used hides to protect their body and buried their dead.

S16. **(c)** *Homo sapiens* arose in Africa 75,000-10,000 years ago.

S17. **(c)** Neo-Darwinism is a combination of natural selection and genetics.

S18. **(b)** homologous organs perform different functions but have same anatomical structure

S19. (c) Gene flow occurs if gene migration occurs multiple times. If the same occurs by chance, then it is called as genetic drift and the original drifted population becomes founders and this effect is called Founders effect.

S20. (b) Darwin observed adaptive radiation and finches on Galapagos islands.

S21. (c) *Homo erectus* was there in 1.5 my, had a large brain and ate meat.

S22. (b) the pre-historic cave painting can be seen at Bhimbetka rock shelter in Raisen district of Madhya Pradesh.

S23. (d) Operation of natural selection on different traits have shown that natural selection leads to above three.

S24. (a) Flippers of Dolphins and penguins show analogy.

S25. (d) Anthropogenic action is revealed by sudden appearance of resistant microbes and resistant varieties of crops by use of excess antibiotics and weedicides and pesticides.

S26. (d) de Varies believed that mutation caused speciation and thus called it saltation.

S27. (c) Lamarck gave examples of Giraffes and explained that evolution occurred due to use and disuse of organs.

S28. (b) Lichen indicate industrial pollution, the growth of which made the white winged moth survived.

S29. (a) Conifers, cycads and ferns evolved in the Jurassic period of the Mesozoic era

S30. (c) In the above era evolution of various seed ferns, conifers and gnetales

S31. (b) Bryophytes evolved in tertiary period of the Cenozoic era.

S32. (b) First mammals were like shrews; their obtained fossils are very small sized.

S33. (a) Methane, Hydrogen, ammonia and water vapour, using this combination he observed formation of amino acids, in similar experiments he also observed formation of pigments, sugar etc.

S34. (b) Thomas Malthus essays influenced Darwin.

S35. (c) According to Darwin, those who are better fit in an environment leave more progeny than others.

S36. (b) Fossils are soft parts of life forms found in rocks and given many evidences of evolution

S37. (d) Study of sedimentary layers indicates geological period in which the fossil of any organism is found

S38. (b) Evidence obtained from planetology indicates that life has arisen at different times in history.

S39. (b) Angiosperms that is the flowering plants evolved in the tertiary period of the Cenozoic era.

S40. (b) Archaeopteryx was considered a transitional link between reptiles and birds.

S41. (c) Variation is considered a force that initiates evolution.

S42. (b) *Australopithecines* hunted with stone weapons but ate fruits.

S43. (a) tendril and thorn are homologus organs and thus represent divergent evolution

S44. (c) Both exhibit adaptive radiation

S45. (c) it was a period of evolution of seed ferns, rhynia type plants, pro-gymnosperms etc.

S46. (b) The book was written by Charles Darwin and is considered to be base of evolutionary biology.

S47. (a) Pangenesis is a developmental theory of heredity given by Charles Darwin in 1868.

S48. (b) During Mesozoic era there were many dinosaurs and were very big in size.

S49. (a) Oxygen was absent from primitive earth's atmosphere according to Oparin.

S50. (c) The theory of special creation that also stated that earth is 4000 years old was strongly challenged in the 19th century.

ASSERTION AND REASON

S1. (a)

S2. (b)

S3. (c) Evolution by natural selection, in a true sense would have started when cellular forms of life with differences in metabolic capability originated on earth. The essence of Darwinism theory about evolution is natural selection.

S4. (b)

TRUE AND FALSE

S1. (True)

S2. (False) Hugo deVries worked on evening primrose and brought forth the idea of mutation.

S3. (False) Evolution for Darwin was gradual while deVries believed mutation caused speciation and hence called it saltation (single step large mutation).

S4. (False) *Australopithecines* probably lived in East African grasslands. Evidence shows they hunted with stone weapons but essentially ate fruit. The Neanderthal man buried their dead.

PRACTICE SOLUTIONS

S1. (d) *Homo sapiens* arose in Africa and moved across continents and developed into distinct races.

S2. (b) animals called lobefins evolved into the first amphibians that lived on both land and water

S3. (c) The *Neanderthal man* with a brain size of 1400cc lived in near east and central Asia between 1,00,000-40,000 years back. They used hides to protect their body and buried their dead.

S5. (c) The Neanderthal man with a brain size of 1400cc lived in near east and central Asia between 1,00,000-40,000 years back

S6. (a) Fossils are body remains of dead plants and animals or their impressions preserved in layers of the Earth and rocks.

S7. (c) *Homo habilis* is the earliest known species in the human lineage. Cranial capacity of them is between 550-650cc.

S8. (b) it was Alfred Wallace, a naturalist who worked in Malay Archipelago had also come to similar conclusions around the same time.

S9. (a) According to Lamarckism, the ancestors of giraffe had small neck and forelimbs and were like horses. They were residing in places with no surface vegetation, therefore, they had to stretch their neck and forelimbs to take the leaves for food. This led to slight elongation of these parts.

S10. (d) Miller took a flask containing a mixture of gases ammonia, methane and hydrogen and passed high frequency spark. A small amount of water was boiled to generate water vapour.

S11. (a) Fossils are mostly found embedded in sedimentary rocks. Of the sedimentary rocks, most fossils occur in shale, limestone and sandstone.

S12. (b) The bones of forelimbs of whale, bate, cheetah, and man are similar in structure because they are homologous organs. The organs which have the same fundamental structure but are different in functions are called homologous organs.

S13. (c) Palaentology is the study of extinct organisms, including their structure, environment, evolution and distribution, as revealed by their fossil remains.

S14. (b) During natural selection, the changes that occur are stabilisation, directional change and disruption.

S15. (a) Hugo de Vries had discovered different morphological forms/abberants/variations in primrose/ *Oenothera lamarckiana*

S16. (a) Fossils discovered in Java in 1891 revealed the next stage, i.e., Homo erectus about 1.5 mya. Homo erectus had a large brain around 900cc.

S17. (a) . The Neanderthal man with a brain size of 1400cc lived in near east and central Asia between 1,00,000-40,000 years back.

S18. (a) Oparin and Haldane proposed that the first form of life could have come from pre-existing, non-living organic molecules.

S19. (a) the first human-like being the hominid was called *Homo habilis*. The brain capacities were between 650-800cc. They probably did not eat meat.

S20. (b) About 15 mya, primates called Dryopithecus and Ramapithecus were existing. They were hairy and walked like gorillas and chimpanzees. Ramapithecus was more man-like while Dryopithecus was more ape-like.

S21. (d) The Neanderthal man has highest brain capacity of 1400 cc.

S22. (a) some land reptiles went back into water to evolve into fish like reptiles probably 200 mya like the Ichthyosaurs.

S23. (a) In 1938, a fish caught in South Africa happened to be a Coelacanth which was thought to be extinct.

S24. (d) When same type of changes occurs by chance, it is called genetic drift. 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 founders and the effect is called founder effect.

S25. (d) According to the Hardy Weinberg law, the allele and genotype frequencies in a population remain constant in the absence of factors responsible for evolution. It states that the sum of all genotype frequencies can be represented as the binomial expansion of the square of the sum of p and q.
This sum is equal to one : $(p+q)2 = p2 + 2pq + q2 = 1$.
Here, p is the frequency of the dominant allele, q is the frequency of the recessive allele and 2pq is the frequency of heterozygotes in the population.

S26. (c) Homo habilis had the smallest brain capacity of 650-800cc.

S27. (d) the first human-like being the hominid and was called *Homo habilis.* The brain capacities were between 650-800cc. They probably did not eat meat.

S28. (d) Darwin's theory of evolution comprised of ideas on overproduction, struggle for existence and natural selection.

S29. (a) Inheritance of acquired characters comes under Lamarckism because it is postulated by Lamarck. Darwinism-Theory of natural selection. Neo-Lamarckism-The body character is the result of interaction of heritable and environmental conditions. Neo Darwinism-Based on genetic variations, natural selection, genetic drift and reproductive isolation.

S30. (b) The gene pool is the set of all or different genes or genetic information, in any population, usually of a particular species. Gene pool indicates the genetic diversity in the population.

ASSERTION AND REASON

S1. (c) the work of Thomas Malthus influenced Darwin.

S2. (a)

S3. (a)

S4. (c) the same structure developed along different directions due to adaptations to different needs is divergent evolution and these structures are homologous and the reverse is true for convergent evolution. Eye of the octopus and of mammals or the flippers of Penguins and Dolphins are examples of analogy.