

EVOLUTION

STUDY-NOTES

Evolutionary Biology is the study of history of life forms on the earth. To understand the evolution in flora and fauna over a period of millions of years on the earth, we must understand the origin of life beginning with the evolution of the earth, stars, and the universe itself.

ORIGIN OF LIFE

- The origin of life is considered a unique event in the history of universe.
- The Big Bang theory talks of a singular huge explosion unimaginable in physical terms. The universe expanded and hence, the temperature came down. Hydrogen and Helium formed sometime later.
- The gases condensed under gravitation and formed the galaxies of the present day universe. In the solar system of the milky way galaxy, earth was supposed to have been formed about 4.5 billion years back.
- There was no atmosphere on early earth. Water vapour, methane, carbon dioxide and ammonia released from molten mass covered the surface.
- The UV rays from the sun broke up water into Hydrogen and Oxygen and the lighter H_2 escaped. Oxygen combined with ammonia and methane to form water, CO_2 and others. The ozone layer was formed. As it cooled, the water vapour fell as rain, to fill all the depressions and form oceans.
- Life appeared 500 million years after the formation of earth, i.e., almost four billion years back.

Theories for the Origin of Life

- **Theory of Panspermia:** Panspermia is a theory suggesting that microbes transmitted to Earth from space are responsible for the origin of life.
- **Theory of spontaneous generation:** For a long time it was also believed that life could originate from decaying and rotting matter like straw, mud etc. This was disproved by Louis Pasteur by his swan-neck flask experiment.
- **Louis Pasteur swan-neck flask experiment**
 - Careful experimentation demonstrated that life comes only from pre-existing life.
 - He showed that in flasks which were sterilised prior to the experiment, life did not originate from killed yeast. At the same time, in a similar flask was left open to air, new living organisms arose from "killed yeast".
 - This disproved the theory of spontaneous generation.
- **Oparin-Haldane theory of origin of life**
 - Oparin of Russia and Haldane of England proposed that the first form of life originated from pre-existing non-living organic molecules (e.g. RNA, protein, etc.).
 - Formation of life was preceded by chemical evolution i.e. formation of diverse organic molecule from inorganic constituents.

Urey and Miller Experiment

- The Conditions of the Earth were
 - High Temperature
 - Volcanic Storms
 - Reducing atmosphere (No oxygen) containing CH_4 , NH_3 etc.

- In 1953 S.L. Miller an American scientist created similar conditions in laboratory scale.
- To simulate conditions of primitive earth he created electric discharge in a closed flask. This raised the temperature up to 800°C.
- He used CH₄, H₂, NH₃ and water vapour inside the flask.
- He observed the formation of amino acids.

Acceptance of Chemical evolution theory (evidences)

- Miller observed the synthesis of amino acids from simple inorganic chemicals. He did this by recreating the conditions that were believed to exist on primitive earth in the laboratory.
- In similar experiments formation of sugars, nitrogen bases, pigment and fats were also observed by other scientists.

Theory of Origin of Species by Natural Selection

- In observations made during a sea voyage in a sail ship called H.M.S. Beagle round the world, Charles Darwin concluded that existing life forms share similarities to varying degrees not only among themselves but also with life forms that millions of years ago existed.
- Many such life forms do not exist anymore. Due to various reasons there have been extinctions of different life forms in the past. There also have been the emergence of new forms of life at different periods of history of earth.
- There has been gradual evolution of life forms. All populations of organisms have variations in characteristics.
- Individuals with characteristics that allow better adaptability survive better in natural conditions (climate, food, physical factors, etc.) and would therefore outbreed others with less favourable characteristics. This ensures the survival of the variety that is most adaptable to change. It leads to the survival and propagation of the fittest organisms in the population as it can survive and outlast change.
- **Survival of the fittest:** The fitness according to Darwin refers ultimately to the ability to survive a change. Therefore only the fittest organisms survive and produce more progeny than others.
- Alfred Wallace, a naturalist who worked in the Malay Archipelago had also come to similar conclusions around the same time.

EVIDENCES FOR EVOLUTION

Paleontological Evidence

- Fossils are remains of hard parts of life-forms found in rocks.
- Different-aged rock sediments contain fossils of different life-forms who probably died during the formation of the particular sediment.
- They represent the extinct organisms (e.g. Dinosaurs).
- A study of different sedimentary layers in which fossils were present indicates the geological period in which they existed.

Comparative Anatomy and Morphological Evidences

- Comparative anatomy and morphology shows similarities and differences among organisms of today and those that existed hundreds of years ago.

Divergent evolution

- When the same structure developed among the species along different directions due to adaptation to different needs. The direction of evolution is called divergent evolution and these structures are **homologous** to each other.
- Different mammals like bats, whales, cheetah and humans share similarities in the pattern of bones of forelimbs. These forelimbs perform different functions in these animals but they have similar anatomical structure – all of them have humerus, radius, ulna, carpals, metacarpals and phalanges in their forelimbs.

Homology indicates common ancestry

- Examples of homologous organs are vertebrate hearts and brains.
- Thorn of *Bougainvillea* and tendrils of *Cucurbita* represent homology.

Convergent Evolution

- Anatomically organisms do not have similar structure though they perform similar function. Hence analogous structures are a result of convergent evolution.
- Wings of butterfly and birds, both appear similar and perform the similar function of flying. Eyes of different organisms like that of octopus and of mammals. Flippers of Penguins and Dolphins. Sweet potato (root modification) and potato (stem modification) for storage of food.

Biochemical evidences

- Similarities in proteins and genes performing a specific function among different organisms give clues regarding common ancestry.

Embryological support for evolution

- 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.
- All vertebrate embryos including human embryo develop a row of vestigial gill slits just behind the head. It is seen that it is a functional organ only in fish. Gills are not found in any other adult vertebrate.
- The embryological evidence was disregarded and disproved by Karl Ernst von Baer on the basis of careful study performed by him. He noted that the similarities in embryos never pass through the adult stages of other animals.

Evolution by natural selection

- A popular example is the change in frequency of moth population in England in 1850.
- Before industrialisation set in more white-winged moths were observed on trees than dark winged or melanised moths.
- After industrialisation i.e. 1920, the proportion was reversed as there were more dark-winged moths in the same area.

Evolution by anthropogenic action

- Excess use of herbicides, pesticides etc., has resulted in selection of the resistant varieties in a much lesser time scale.
- This has also been observed for microbes against which we use antibiotics or drugs.
- Hence resistance in organisms/cells are now appearing in a time scale of months or years and not in centuries.
- These are the examples of evolution by anthropogenic action.
- Evolution is a stochastic process. This is because it is based on random and chance events in nature and chance mutation in the organisms.

ADAPTIVE RADIATION

Darwin's Finches

- Darwin's theory was based on observation of certain birds in the Galapagos Islands. The small black birds he observed have since been called Darwin's Finches.
- He observed that there were many varieties of finches in the same island. All the varieties he came across had evolved on the island itself. They were originally adapted with seed-eating features. From these many other forms evolved with altered beaks depending on the food habit. This enabled them to become insectivorous and vegetarian finches.
- This process of evolution of different species in a given geographical area starting from a point and radiating to other areas of geography is called **adaptive radiation**.

Australian marsupial

- In Australia, it was seen that a number of marsupials had evolved from an ancestral stock but all within the Australian island continent. These marsupials were all different from each other.
- When more than one adaptive radiation appears to have occurred in an isolated geographical area (representing different habitats), it can be called **convergent evolution**.

- Placental mammals in Australia were also seen to exhibit adaptive radiation. They seem to be evolved from a marsupial into various placental mammals. The placental mammals are showed similarities to the ancestral marsupial (e.g. placental wolf and Tasmanian wolf-marsupial).

BIOLOGICAL EVOLUTION

Darwin's theory of evolution

- Natural selection is the essence of Darwinian Theory about evolution. The rate of appearance of new forms is related to the life cycle or the life span. For variations to get selected and evolve there has to be a genetic basis.
- Organisms with favorable variations are better adapted to survive in a hostile environment. Variations result in adaptability. They have a genetic basis and are therefore inherited. Fitness is the ability to adapt to changing environment and thus get selected by the nature.
- The key concepts of Darwinism are:
 - Natural selection: Survival of the fittest by the nature in face of changing environment.
 - Theory of Common Descent: Organisms are descended from common ancestors due to accumulation of variations.

Lamarck theory of evolution (Theory of inheritance of acquired characters)

- French Naturalist Lamarck proposed that evolution of life forms occurs due to use and disuse of organs.
- He explained this theory using giraffes as an example. He claimed that giraffes formed long necks in an attempt to forage leaves on tall trees. Therefore, this character was acquired based on a need to adapt and survive. This acquired character was passed to succeeding generations. Giraffes, therefore, came to develop long necks slowly over the course of many years.

MECHANISM OF EVOLUTION

- Hugo de Vries worked on evening primrose. He gave the idea of **mutations**.
- He stated that mutation causes evolution and not the minor variations that as suggested by Darwin.
- Mutations are sudden, random and directionless while Darwinian variations are small and directional.
- Evolution according to Darwin was slow and gradual whereas Hugo de Vries believed that mutation caused large changes that led to speciation. He therefore called it **saltation** (single step large mutation).
- **Saltation**: It is a large and an abrupt evolutionary change that has been brought about due to sudden large scale mutation.

HARDY-WEINBERG PRINCIPLE

- The principle states that allele frequencies in a population are stable and are 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 principle can be represented mathematically as follows:

$$(p + q)^2 = p^2 + 2pq + q^2 = 1.$$

p and q represent the individual allele frequencies.
Therefore, p^2 = frequency of homozygous condition represented by p
And q^2 = frequency of homozygous alleles represented by q and pq = frequency of heterozygous condition
- Difference in values of p, q and pq indicate the extent of evolutionary change.
- Disturbance in genetic equilibrium (Hardy Weinberg equilibrium) or change of frequency of alleles in a population can then be interpreted as accumulation or change in variations that results in evolution.
- Five factors are known to affect Hardy-Weinberg equilibrium:
 - **Gene migration or gene flow**: When a section of population migrates to another place gene frequencies will change in the original as well as in the new population. New genes /alleles will be added to the new population and the same are lost from the old population.

- **Genetic drift:** Change in gene frequency that occurs due to a random event or by chance. Sometimes, the change in allele frequency is so different in the new sample of population that they become different species original drifted population becomes founders and the effect is called **founder effect**.
- Mutation
- Genetic recombination
- Natural selection

Natural selection can lead to

- **Stabilisation:** In which more individuals acquire mean character value.
- **Directional changes:** Occurs when more individuals acquire value other than the mean character value.
- **Disruption:** More individuals acquire peripheral character value at both ends of the distribution curve.

A BRIEF ACCOUNT OF EVOLUTION

- Approximately 2000 million years ago (mya) the first forms of life appeared on the earth. They were cellular.
- Certain cellular forms developed the ability to photosynthesise and thus release O₂. The atmosphere slowly became rich in oxygen. This in turn promoted the development and evolution of more aerobic forms of organisms.
- Slowly and gradually the single cell organisms started to form multicellular life forms. Around 500 mya invertebrates were formed. The first fish evolved from invertebrates around 350 mya. They were probably jawless fish.
- At around 320 mya sea weeds and few plants evolved and existed.
- Coelacanth, a lobe finned fish, was discovered in South Africa in 1938. It is believed to have evolved into the first amphibious organisms that lived on both land and water. These amphibians were the ancestors of modern day frogs and salamanders.
- The amphibians slowly and gradually evolved into reptiles.
- Reptile eggs do not dry up in sun unlike those of amphibians.
- Giant ferns (Pteridophytes) present on land fell and got buried in soil. As more sediments accumulated on top they started to form coal deposits slowly.
- Some of the reptiles retreated back into water to evolve into fish like reptiles probably 200 mya. e.g. (Ichthyosaurs).
- The biggest land reptiles were the dinosaurs.
- The largest dinosaur *Tyrannosaurus rex* was about 20 feet in height and had huge fearsome dagger like teeth.
- About 65 mya the dinosaurs suddenly underwent mass extinction from the earth. Some of them evolved into birds.
- The first mammals were small and shrew-like. They had small sized fossils.
- Mammals evolved to become viviparous and protected their unborn young inside the mother's body.
- Pouched mammals of Australia survived because of lack of competition from any other mammals. This lack of competition was a result of **Continental Drift**.

ORIGIN AND EVOLUTION OF MAN

- About 15 mya primates such as *Dryopithecus* and *Ramapithecus* existed. They appeared to be similar to gorillas and chimpanzees in their appearance and walking.
- *Ramapithecus* was more similar to man whereas *Dryopithecus* was more similar to apes.
- Few fossils of bones that resemble human bones have been discovered in Ethiopia and Tanzania.
- Two mya **Australopithecines** existed. They most likely lived in East African grasslands.
 - They used stone weapons for hunting.
 - Essentially they had a fruit-based diet.
- The first human-like organism was the hominid and was called *Homo habilis*.
 - Brain capacity was 650 – 800 cc.
 - They also survived on plant-based diet and did not eat meat.

- Fossils discovered in Java in 1891 seemed to be of the next stage i.e. *Homo erectus*.
 - They evolved about 1.5 mya.
 - They had large brain with a capacity around 900 cc.
 - They probably ate meat.

Neanderthal man

- Brain size was around 1400 cc.
- Lived in east and central Asia between 1,00,000–40,000 years back.
- They developed use of animal hides to protect their body.
- Buried their dead members.

Homo sapiens

- Arose in Africa and migrated across continents and developed distinct races.
- During ice age 75,000-10,000 years ago modern *Homo sapiens* arose.
- Pre historic cave art developed about 18,000 years ago.
- Agriculture came around 10,000 years back and human settlement started.

QUESTION BANK

MULTIPLE CHOICE QUESTIONS

1. "Continuity of germplasm" theory was given by
 (a) deVries (b) Weismann (c) Darwin (d) Lamarck
2. Evolution is
 (a) progressive development of a race
 (b) history and development of race alongwith variations
 (c) history of race
 (d) development of race
3. Theory of inheritance of acquired characters was given by
 (a) Wallace (b) Lamarck (c) Darwin (d) deVries
4. 'Origin of species' was written by
 (a) Oparin (b) Weismann (c) Lamarck (d) Darwin
5. Parallelism is
 (a) adaptive divergence
 (b) adaptive divergence of widely separated species
 (c) adaptive convergence of widely different species
 (d) adaptive convergence of closely related groups
6. Which was absent in the atmosphere at the time of origin of life?
 (a) NH₃ (b) H₂ (c) O₂ (d) CH₄
7. The first organisms were
 (a) chemoautotrophs (b) chemoheterotrophs (c) autotrophs (d) eukaryotes
8. Weismann cut off tails of mice generation after generation but tails neither disappeared nor shortened showing that
 (a) Darwin was correct
 (b) Tail is an essential organ
 (c) Mutation theory is wrong
 (d) Lamarckism was wrong in inheritance of acquired characters

9. The most apparent change during the evolutionary history of *Homo sapiens* is traced in
 (a) Walking upright (b) Shortening of jaws
 (c) Remarkable increase in the brain size (d) Loss of body hair
10. What was the most significant trend in the evolution of modern man (*Homo sapiens*) from his ancestors?
 (a) Upright posture (b) Shortening of jaws
 (c) Binocular vision (d) Increasing brain capacity
11. The extinct human who lived 1,00,000 to 40,000 years ago, in Europe, Asia and parts of Africa, with short stature, heavy eye brows, retreating forehead, large jaws with heavy teeth, stocky bodies and a lumbering gait and stooped posture was
 (a) Cro-magnon humans (b) *Ramapithecus*
 (c) *Homo habilis* (d) Neanderthal human
12. The most significant trend in the evolution of modern man (*Homo sapiens*) from his ancestors?
 (a) Increasing cranial capacity (b) Upright posture
 (c) Shortening of jaws (d) Binocular vision
13. Which of the following had the smallest brain capacity?
 (a) *Homo sapiens* (b) *Homo neanderthalensis* (c) *Homo habilis* (d) *Homo erectus*
14. Genetic drift is change of
 (a) gene frequency in same generation (b) appearance of recessive genes
 (c) gene frequency from one generation to next (d) None of these
15. Theory of natural selection dwells on
 (a) role of environment in evolution
 (b) natural selection acting on favourable variations
 (c) changes in gene complex resulting in inheritable variations
 (d) None of these
16. Which one does not favour Lamarckian concept of inheritance of acquired characters?
 (a) Lack of pigment in cave dwellers
 (b) Absence of limbs in snakes
 (c) Presence of webbed toes in aquatic birds
 (d) Melanisation of peppered moth in industrial areas
17. Basic principles of embryonic development were pronounced by
 (a) Von Baer (b) Weismann (c) Haeckel (d) Morgan
18. Correct order is
 (a) Palaeozoic → Archaeozoic → Coenozoic (b) Archaeozoic → Palaeozoic → Proterozoic
 (c) Palaeozoic → Mesozoic → Coenozoic (d) Mesozoic → Archaeozoic → Proterozoic
19. Evolutionary convergence is development of
 (a) common set of characters in group of different ancestry
 (b) dissimilar characters in closely related groups
 (c) common set of characters in closely related groups
 (d) random mating
20. Homologous organs are
 (a) wings of insects and bat (b) gills of fish and lungs of rabbit
 (c) pectoral fins of fish and fore limbs of horse (d) wings of grasshopper and crow
21. Random genetic drift in a population probably results from
 (a) large population size (b) highly genetically variable individuals
 (c) interbreeding within this population (d) constant low mutation rate

22. Two geographical regions separated by high mountains are
 (a) Oriental and Australian (b) Palaearctic and Oriental
 (c) Nearctic and Palaearctic (d) Neotropical and Ethiopian
23. Golden age of dinosaurs/Age of reptiles was
 (a) Mesozoic (b) Coenozoic (c) Palaeozoic (d) Psychozoic
24. The presence of gill slits, in the embryos of all vertebrates, supports the theory of
 (a) biogenesis (b) recapitulation (c) metamorphosis (d) organic evolution
25. One of the following is a link between plants and animals
 (a) *Euglena* (b) Bacteria (c) *Paramecium* (d) *Trichonympha*
26. The homologous organs are those that show similarity in
 (a) size (b) origin (c) function (d) appearance
27. Frequency of a character increases when it is
 (a) recessive (b) dominant (c) inheritable (d) adaptable
28. Which one is irrelevant to evolution of man?
 (a) Perfection of hand for tool making
 (b) Change of diet from hard nuts/roots to soft food
 (c) Increased ability to communicate or develop community behaviour
 (d) Loss of tail
29. Extremities, tail and ear are relatively shorter in animals living in cooler regions as compared to those inhabiting warmer zones. This is
 (a) Bergman's rule (b) Jordan's rule (c) Gloger's rule (d) Allen's rule
30. Identify the correct sequence in which the following substances have appeared during the course of evolution of life on the earth
 (a) glucose, amino acids, nucleic acids, proteins
 (b) ammonia, amino acids, proteins, nucleic acids
 (c) water, amino acids, nucleic acids, enzymes
 (d) amino acids, ammonia, phosphates, nucleic acids
31. de Vries gave his mutation theory on organic evolution while working on
 (a) *Pisum sativum* (b) *Drosophila melanogaster*
 (c) *Oenothera lamarckiana* (d) *Althea rosea*
32. Which one of the following amino acid was not found to be synthesised in Miller's experiment?
 (a) Aspartic acid (b) Glutamic acid (c) Alanine (d) Glycine
33. Industrial melanism as observed in peppered moth proves that
 (a) the true black melanic forms arise by a recurring random mutation
 (b) the melanic form of the moth has no selective advantage over lighter form in industrial area
 (c) the lighter form moth has no selective advantage either in polluted industrial area or non-polluted area
 (d) melanism is a pollution generated feature
34. When two species of different genealogy come to resemble each other as a result of adaptation, the phenomenon is termed
 (a) divergent evolution (b) micro-evolution
 (c) co-evolution (d) convergent evolution

35. The concept of chemical evolution is based on
- crystallisation of chemicals
 - interaction of water, air and clay under intense heat
 - effect of solar radiation on chemicals
 - possible origin of life by combination of chemicals under suitable environmental conditions
36. Select the correct statement from the following.
- Darwinian variations are small and directionless.
 - Fitness is the end result of the ability to adapt and gets selected by nature.
 - All mammals except whales and camels have seven cervical vertebrae.
 - Mutations are random and directional.
37. Adaptive radiation refers to
- adaptations due to geographical isolation
 - evolution of different species from a common ancestor
 - migration of members of a species to different geographical areas
 - power of adaptation in an individual to a variety of environment
38. Which one of the following is incorrect about the characteristics of protobionts (coacervates and microspheres) as envisaged in the abiogenic origin of life?
- They were able to reproduce.
 - They could separate combinations of molecules from the surroundings.
 - They were partially isolated from the surroundings.
 - They could maintain an internal environment.
39. In the case of peppered moth (*Biston betularia*) the black-coloured form became dominant over the light-coloured form in England during industrial revolution. This is an example of
- protective mimicry
 - inheritance of darker colour character acquired due to the darker environment
 - natural selection whereby the darker forms were selected
 - appearance of the darker coloured individuals due to very poor sunlight
40. In general, in the developmental history of a mammalian heart, it is observed that it passes through a two-chambered fish-like heart, three-chambered frog-like heart and finally to a four-chambered stage. To which hypothesis can this above cited statement be approximated?
- Hardy-Weinberg law
 - Lamarck's principle
 - Biogenetic law
 - Mendelian principles
41. Genetic drift operates only in
- smaller populations
 - larger populations
 - Mendelian populations
 - island populations
42. Darwin's theory of pangenesis shows similarity with theory of inheritance of acquired characters then what will be correct according to it?
- Useful organs become strong and developed while useless organs become extinct. These organs help in struggle for survival.
 - Size of organs increase with ageing.
 - Development of organs is due to will power.
 - There should become physical basis of inheritance.
43. Similarities in organisms with different genotype indicates
- micro-evolution
 - macro-evolution
 - convergent evolution
 - divergent evolution

44. In which condition the gene ratio remains constant for any species?
 (a) Sexual selection (b) Random mating
 (c) Mutation (d) Gene flow
45. Sequence of which of the following is used to know the phylogeny?
 (a) mRNA (b) rRNA (c) tRNA (d) DNA
46. As per Hardy-Weinberg principle, in the algebraic expression $p^2 - 2pq + q^2 = 1$, p^2 represents
 (a) frequency of allele A (b) frequency of allele a
 (c) frequency of A and a (d) frequency of all the alleles
47. Darwin's finches are a good example of
 (a) Industrial melanism (b) Connecting link
 (c) Adaptive radiation (d) Convergent evolution
48. Evolution of different species in a given area starting from a point and spreading to other geographical areas is known as
 (a) Migration (b) Divergent evolution (c) Adaptive radiation (d) Natural selection
49. Variation in gene frequencies within populations can occur by chance rather than by natural selection. This is referred to as
 (a) Genetic flow (b) Genetic drift (c) Random mating (d) Genetic load
50. The process by which organisms with different evolutionary history evolve similar phenotypic adaptations in response to a common environmental challenge is called
 (a) Natural selection (b) Convergent evolution (c) Non-random evolution (d) Adaptive radiation
51. The tendency of population to remain in genetic equilibrium may be disturbed by
 (a) random mating (b) lack of migration
 (c) lack of mutations (d) lack of random mating
52. According to Darwin, the organic evolution is due to
 (a) Intraspecific competition
 (b) Interspecific competition
 (c) Competition within closely related species
 (d) Reduced feeding efficiency in one species due to the presence of interfering species
53. A population will not exist in Hardy-Weinberg equilibrium if
 (a) there are no mutations (b) there is no migration
 (c) the population is large (d) individuals mate selectively
54. Which one of the following sets includes only the vestigial structures in man?
 (a) Body hair, olecranon process, coccyx, patella
 (b) Wisdom teeth, mammary glands, coccyx, patella
 (c) Coccyx, nictitating membrane, vermiform appendix, ear muscles
 (d) Coccyx, body hair, ear ossicles, vermiform appendix
55. Which one of the following pairs has homologous organs?
 (a) Pectoral fins of a fish and forelimbs of a horse (b) Wings of a bat and wings of cockroach
 (c) Air sac of fish and lungs of frog (d) Wings of a bird and wings of a butterfly
56. Darwin's finches provide excellent evidence in favour of evolution. This evidence comes from the field of
 (a) Biogeography (b) Anatomy (c) Embryology (d) Palaeontology
57. Which is not a vestigial part in humans?
 (a) Segmental muscles of abdomen (b) Fingernails
 (c) Third molar (d) Coccyx

58. Occurrence of endemic species in South-America and Australia is due to
 (a) these species have been extinct from other regions (b) continental separation
 (c) there is no terrestrial route to these places (d) retrogressive evolution
59. Half-life period of C14 is about
 (a) 500 yr (b) 5730 yr (c) 50 yr (d) 5×10^4 yr
60. According to fossils discovered up to present time origin and evolution of man was started from
 (a) France (b) Java (c) Africa (d) China
61. Which of the following is homologous organ?
 (a) Wings of birds and locust (b) Wings of birds (sparrow) and pectoral fins of fish
 (c) Wings of bat and butterfly (d) Legs of frog and cockroach
62. In which era reptiles were dominant?
 (a) Coenozoic era (b) Mesozoic era (c) Palaeozoic era (d) Archaeozoic era
63. Convergent evolution is illustrated by
 (a) dogfish and whale (b) rat and dog
 (c) bacterium and protozoan (d) starfish and cuttle fish
64. One of the important consequences of geographical isolation is
 (a) no change in the isolated fauna (b) preventing speciation
 (c) speciation through reproductive isolation (d) random creation of new species
65. Which one of the following statements is correct?
 (a) Stem cells are specialised cells.
 (b) There is no evidence of the existence of gills during embryogenesis of mammals.
 (c) All plant and animal cells are totipotent.
 (d) Ontogeny repeats phylogeny.
66. The finches of Galapagos islands provide an evidence in favour of
 (a) special creation (b) evolution due to mutation
 (c) retrogressive evolution (d) biogeographical evolution
67. Which one of the following experiments suggests that simplest living organisms could not have originated spontaneously from non-living matter?
 (a) Larvae could appear in decaying organic matter.
 (b) Microbes did not appear in stored meat.
 (c) Microbes appeared from unsterilized organic matter.
 (d) Meat was not spoiled, when heated and kept sealed in a vessel.
68. Thorn of *Bougainvillea* and tendril of *Cucurbita* are examples of
 (a) analogous organs (b) homologous organs
 (c) vestigial organs (d) retrogressive evolution
69. Select the incorrect statement from the following.
 (a) Small population size results in random genetic drift in a population.
 (b) Baldness is a sex-linked trait.
 (c) Linkage is an exception to the principle of independent assortment in heredity.
 (d) Galactosemia is an inborn error of metabolism.
70. Industrial melanism is an example of
 (a) defensive adaptation of skin against ultraviolet radiations
 (b) drug resistance
 (c) darkening of skin due to smoke from industries
 (d) protective resemblance with the surroundings

71. The eye of octopus and eye of cat show different patterns of structure, yet they perform similar function. This is an example of
- Homologous organs that have evolved due to convergent evolution
 - Homologous organs that have evolved due to divergent evolution
 - Analogous organs that have evolved due to convergent evolution
 - Analogous organs that have evolved due to divergent evolution
72. Forelimbs of cat and lizard used in walking; forelimbs of whale used in swimming and forelimbs of bats used in flying are an example of
- Analogous organs
 - Adaptive radiation
 - Homologous organs
 - Convergent evolution
73. Which one of the following are analogous structures?
- Wings of bat and wings of pigeon
 - Gills of prawn and lungs of man
 - Thorns of *Bougainvillea* and tendrils of *Cucurbita*
 - Flippers of dolphin and legs of horse
74. The wings of a bird and the wings of an insect are
- homologous structures and represent convergent evolution
 - homologous structures and represent divergent evolution
 - analogous structures and represent convergent evolution
 - phylogenetic structures and represent divergent evolution
75. Industrial melanism is an example of
- Neo Lamarckism
 - Neo Darwinism
 - Natural selection
 - Mutation
76. In recent years, DNA sequences (nucleotide sequence) of mtDNA and Y-chromosomes were considered for the study of human evolution, because
- they can be studied from the samples of fossil remains
 - they are small and, therefore, easy to study
 - they are uniparental in origin and do not take part in recombination
 - their structure is known in greater detail
77. Which one of the following describes the homologous structures correctly?
- Organs appearing only in embryonic stage and disappearing later in the adult
 - Organs with anatomical similarities, but performing different functions
 - Organs with anatomical dissimilarities, but performing same functions
 - Organs that have no function now, but had an important function in ancestors
78. What kind of evidence suggested that man is more closely related with chimpanzee than with other hominoid apes?
- Evidence from DNA from sex chromosomes only
 - Comparison of chromosomes morphology only
 - Evidence from fossil remains and the fossil mitochondrial DNA alone
 - Evidence from DNA extracted from sex chromosomes, autosomes and mitochondria
79. Age of fossils in the past was generally determined by radio-carbon method and other method involving radioactive elements found in the rocks. More precise methods, which were used recently and led to the revision of the evolutionary periods for different groups of organisms, include
- study of carbohydrates/proteins in fossils
 - study of the condition of fossilization
 - Electron Spin Resonance (ESR) and fossil DNA
 - study of carbohydrates/proteins in rocks

80. Presence of gills in the tadpole of frog indicates
 (a) fishes were amphibious in the past (b) fishes evolved from frog-like ancestors
 (c) frogs will have gills in future (d) frogs evolved from gilled ancestors
81. The first fish evolved from invertebrates on the earth were jawless. It was around
 (a) 500 mya (b) 320 mya (c) 350 mya (d) 200 mya
82. An important evidence in favour of organic evolution is the occurrence of
 (a) analogous and vestigial organs (b) homologous organs only
 (c) homologous and analogous organs (d) homologous and vestigial organs
83. Evolutionary history of an organism is known as
 (a) Ancestry (b) Palaeontology (c) Ontogeny (d) Phylogeny
84. Which one of the following is regarded as the direct ancestor of modern man?
 (a) *Homo erectus* (b) *Ramapithecus* (c) *Homo habilis* (d) Cro-magnon man
85. Which one of the following statements about fossil human species is correct?
 (a) Fossils of *Homo neanderthalensis* have been found recently in South America.
 (b) Neanderthal man and Cro-magnon man did exist for sometime together.
 (c) *Australopithecus* fossils have been found in Australia.
 (d) *Homo erectus* was preceded by *Homo habilis*.
86. Common origin of man and chimpanzee is best shown by
 (a) banding pattern in chromosomes number 3 and 6 (b) cranial capacity
 (c) binocular vision (d) dental formula
87. Which one of the following statements is correct?
 (a) Cro-magnon man's fossil has been found in Ethiopia.
 (b) *Homo erectus* is the ancestor of man.
 (c) Neanderthal man is the direct ancestor of *Homo sapiens*.
 (d) *Australopithecus* is the real ancestor of modern man.
88. Which of the following primate is the closest relative of humans?
 (a) Rhesus monkey (b) Orangutan (c) Gorilla (d) Gibbon
89. *Homo sapiens* evolved during
 (a) Pleistocene (b) Oligocene (c) Pliocene (d) Miocene
90. Which one of the following features is closely related with the evolution of humans?
 (a) Loss of tail (b) Shortening of jaws (c) Binocular vision (d) Flat nails
91. Which of the following is closest relative of man?
 (a) Chimpanzee (b) Gorilla (c) Orangutan (d) Gibbon
92. There are two opposing views about origin of modern man. According to one view *Homo erectus* in Asia were the ancestors of modern man. A study of variation of DNA however, suggested African origin of modern man. What kind of observation on DNA variation could suggest this?
 (a) Greater variation in Asia than in Africa (b) Greater variation in Africa than in Asia
 (c) Similar variation in Africa and Asia (d) Variation only in Asia and no variation in Africa
93. Jurassic period of the Mesozoic era is characterised by
 (a) radiation of reptiles and origin of mammal-like reptiles
 (b) dinosaurs become extinct and angiosperms appear
 (c) flowering plants and first dinosaurs appear
 (d) gymnosperms are dominant plants and first birds appear

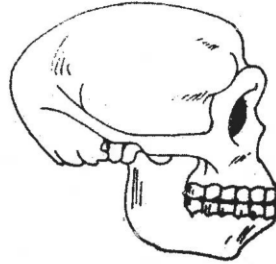
94. Among the human ancestors the brain size was more than 1000 cc in
 (a) *Homo neanderthalensis* (b) *Homo erectus*
 (c) *Ramapithecus* (d) *Homo habilis*
95. In a random mating population in equilibrium, which of the following brings about a change in gene frequency in a non-directional manner?
 (a) Migration (b) Mutation (c) Random drift (d) Selection
96. Darwin in his 'Natural Selection Theory' did not believe in any role of which one of the following in organic evolution?
 (a) Discontinuous variations (b) Parasites and predators as natural enemies
 (c) Survival of the fittest (d) Struggle for existence

INPUT-TEXT BASED QUESTIONS

Read the following paragraphs and answer the following questions.

- I. The essence of Darwinian theory about evolution is natural selection. The rate of appearance of new forms is linked to the life cycle or the life span. Microbes that divide fast have the ability to multiply and become millions of individuals within hours. A colony of bacteria growing on a given medium has built-in variation in terms of ability to utilise a feed component. A change in the medium composition would bring out only that part of the population that can survive under the new conditions. In due course of time this variant population outgrows the others and appears as new species.
1. On the basis of above, which statement can be concluded as the best?
 (a) Homology indicates common ancestry.
 (b) The origin of life is unique.
 (c) Nature selects for fitness which is inherited.
 (d) Evolution of life forms is driven by use and disuse of organs.
 2. Evolution by natural selection is given by
 (a) Darwin (b) Lamarck (c) Thomas Malthus (d) De Vries
 3. The two key concepts of Darwinian Theory of Evolution are
 (a) Branching Descent and Acquired characters
 (b) Branching Descent and Natural selection
 (c) Over production and Natural selection
 (d) Competition and Use of organs
 4. Which of the following statements is/are correct on the basis of above paragraph?
 (i) Mutation causes evolution.
 (ii) Adaptive ability is inherited in organisms.
 (iii) Evolution by natural selection started with cellular forms of life.
 (iv) Appearance of new forms of life is related to lifespan of the organism.
 (a) (i), (ii) and (iv) (b) (iii) and (iv)
 (c) (ii), (iii) and (iv) (d) (i) and (ii)
 5. Darwin defined the evolution as
 (a) The Law of use and disuse (b) Descent with modification
 (c) Law of inherited traits (d) Progressive behaviour of organism
- II. *Homo sapiens* arose in Africa and moved across continents and developed into distinct races. During ice age between 75,000-10,000 years ago modern *Homo sapiens* arose. Pre-historic cave art developed about 18,000 years ago. One such cave paintings by Pre-historic humans can be seen at Bhimbetka rock shelter in Raisen district of Madhya Pradesh.

- Earlier primates were hairy and walked like gorillas and chimpanzees. Those primates were
 - Dryopithecus* and *Australopithecus*
 - Dryopithecus* and *Ramapithecus*
 - Australopithecus* and *Ramapithecus*
 - Dryopithecus* and *Ardipithecus*
- Evidences show that they hunted with stone weapons but essentially ate fruits. They were probably not taller than 4 feet but walked up right. They were probably
 - Dryopithecus*
 - Ramapithecus*
 - Australopithecus*
 - Homo erectus*
- Look at the diagram.



This skull was discovered in Java, where the brain size was large and probably they ate meat. It was

- Homo erectus*
- Homo habilis*
- Homo sapiens*
- Homo ergaster*

- The first human like organism was
 - Homo erectus*
 - Homo habilis*
 - Homo sapiens*
 - Homo ergaster*
- Human evolution is marked by a significant *increase* in the total brain size relative to body size. Why did brain size increase? Which of the following is/are true?
 - Cognitive abilities of human being
 - Increase in the number of neurons in the brain
 - Large size of the body and body parts
 - Bipedal locomotion
 - (i), (iii) and (iv)
 - (i) and (ii)
 - (ii) and (iii)
 - (i), (ii) and (iii)

III. During Darwin's journey to Galapagos Islands, he observed an amazing diversity of creatures. Of particular interest, small black birds later called Darwin's Finches amazed him. He realised that there were many varieties of finches in the same island. All the varieties, he conjectured, evolved on the island itself. From the original seed-eating features, many other forms with altered beaks arose, enabling them to become insectivorous and vegetarian finches. 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. Darwin's finches represent one of the best examples of this phenomenon.

- Another similar example of adaptive radiation can be seen in
 - Giraffes
 - Australian Marsupials
 - Indian tigers
 - Tasmanian wolf
- Another scientist who has given the theory of the 'survival of the fittest'
 - Alfred wallace
 - Lamarck
 - Aristotle
 - Hugo de Vries
- Darwin received Noble prize for his work in the year
 - 1882
 - 1830
 - 1845
 - 1860
- Which one of the following phenomena supports Darwin's concept of natural selection in organic evolution?
 - Development of transgenic animals
 - Production of 'Dolly', the sheep by cloning
 - Prevalence of pesticide resistant insects
 - Development of organs from 'stem cells' for organ transplantation

ANSWERS

1. (b)	2. (b)	3. (b)	4. (d)	5. (b)	6. (c)	7. (a)	8. (d)	9. (c)	10. (d)
11. (d)	12. (a)	13. (c)	14. (c)	15. (b)	16. (d)	17. (a)	18. (c)	19. (a)	20. (c)
21. (c)	22. (b)	23. (a)	24. (b)	25. (a)	26. (b)	27. (d)	28. (d)	29. (d)	30. (b)
31. (c)	32. (b)	33. (a)	34. (d)	35. (d)	36. (b)	37. (b)	38. (d)	39. (c)	40. (c)
41. (a)	42. (d)	43. (b)	44. (b)	45. (b)	46. (a)	47. (c)	48. (c)	49. (b)	50. (b)
51. (d)	52. (b)	53. (d)	54. (c)	55. (a)	56. (a)	57. (b)	58. (b)	59. (b)	60. (c)
61. (b)	62. (b)	63. (a)	64. (c)	65. (d)	66. (d)	67. (d)	68. (b)	69. (b)	70. (d)
71. (c)	72. (c)	73. (b)	74. (c)	75. (c)	76. (c)	77. (b)	78. (d)	79. (c)	80. (d)
81. (c)	82. (d)	83. (d)	84. (d)	85. (d)	86. (a)	87. (b)	88. (c)	89. (a)	90. (b)
91. (a)	92. (b)	93. (d)	94. (a)	95. (c)	96. (a)				

EXPLANATION

1. According to this theory 'only the characters influencing the germ cells get inherited'. There occurs inheritance of germplasm (protoplasm of germ cells), but the protoplasm of somatic cells is not transmitted to the offspring and hence, it cannot pass on the acquired characters to the next generation.
65. Ontogeny is the growth (size change) and development (shape change) of an individual organism; phylogeny is the evolutionary history of a species.

Input-Text Based Answers

I.	1. (c)	2. (a)	3. (b)	4. (c)	5. (b)
II.	1. (b)	2. (c)	3. (a)	4. (b)	5. (b)
III.	1. (b)	2. (a)	3. (a)	4. (c)	