Very Short Answer Questions (PYQ)

[1 Mark]

Q.1. Name the scientist who disproved spontaneous generation theory.

Ans. Louis Pasteur disproved the theory of spontaneous generation.

Q.2. What did Louis Pasteur's experiment on 'killed yeast' demonstrate? Name the theory that got disproved on the basis of his experiment.

Ans. Louis Pasteur demonstrated that life comes only from pre-existing life. The theory of spontaneous generation was disproved on the basis of his experiment.

Q.3. Write the hypothetical proposals put forth by Oparin and Haldane.

OR

State two postulates of Oparin and Haldane with reference to origin of life.

Ans. Oparin and Haldane proposed that life originated from pre-existing non-organic molecules and the diverse organic molecules were formed from these inorganic constituents by chemical evolution *i.e.*, formation of life was preceded by chemical evolution.

Q.4. State the significance of the study of fossils in evolution.

Ans. Fossils represent extinct organisms. They show life forms restricted to certain geological time spans existing in the past./Show ancestry of present day organisms./Are connecting links between two groups of organisms. (*Any one*)

Q.5. The microscopic pollen grains of the past are obtained as fossils. Mention the characteristic of the pollen grains that makes it happen.

Ans. Exine, the outermost hard layer is chemically composed of sporopollenin, which is highly resistant to high temperature, strong acids, alkali and enzymes.

Q.6. Are flippers of penguin and dolphin homologous or analogous? What type of evolution has brought such a similarity in them?

Ans. They are analogous. Convergent evolution brought similarity in them.

Q.7. Are the wing of a bird and the forelimb of a horse homologous or analogous? Name the type of evolution that explains the development of such structures.

Ans. They are homologous organs. Divergent evolution has brought similarity in them.

Q.8. Write the similarity between the wing of a butterfly and the wing of a bat. What do you infer from the above with reference to evolution?

Ans. Wings of a bird and a bat perform the same function of flying despite their structural dissimilarity. This infers that they are analogous organs. It can be inferred that it is of convergent evolution.

Q.9. "Sweet potato tubers and potato tubers are the result of convergent evolution." Justify the statement.

Ans. Sweet potato tuber is a modified root whereas potato tuber is a modified stem. These are anatomically different structures but perform the same function of food storage. Therefore, they are the result of convergent evolution.

Q.10. Comment on the similarity between the wing of a cockroach and the wing of a bird. What do you infer from the above, with reference to evolution?

Ans. They are similar in function. Thus we infer that these organs are analogous which has resulted in convergent evolution.

Q.11. Comment on the similarity between the flippers of dolphins and penguins, with reference to evolution.

Ans. Similarity between the flippers of dolphins and penguins is that they perform similar functions though structurally different. Thus, they are analogous organs. These are the result of convergent evolution.

Q.12. Why are analogous structures a result of convergent evolution?

Ans. Analogous structures are not anatomically similar, i.e., they do not have common ancestors and evolve for similar function in the same habitat. Therefore, they are said to be a result of convergent evolution.

Q.13. Mention the type of evolution that has brought the similarity as seen in potato tuber and sweet potato.

Ans. Convergent evolution.

Q.14. Why are the wings of a butterfly and of a bat called analogous?

Ans. The wings of a butterfly and bat are called analogous organs because they are similar in function and differ in their structural details and origin.

Q.15. Are the thorns of *Bougainvillea* and tendrils of *Cucurbita* homologous or analogous? What type of evolution has brought such a similarity in them?

Ans. They are homologous organs. Divergent evolution has brought such a similarity in them.

Q.16. What role does an individual organism play as per Darwin's theory of natural selection?

Ans. An individual organism passes on the variations, mutations and adaptations from one generation to another.

Q.17. What is "fitness of an individual" according to Darwin?

Ans. According to Darwin, "fitness of an individual" is the ability of an organism to survive and pass on its genes to future generations.

Q.18. State a reason for the increased population of dark coloured moths coinciding with the loss of lichens (on tree barks) during industrialisation period in England.

Ans. Natural selection or survival of fittest.

Q.19. According to deVries what is saltation?

Ans. According to de Vries, saltation is single step (large) mutation.

Q.20. Mention how is mutation theory of Hugo de Vries different from Darwin's theory of natural selection.

Ans. According to Hugo de Vries, new species arise due to single step large mutation whereas according to Darwin, evolution occurs gradually by the method of natural selection.

Q.21. According to Hardy-Weinberg's principle, the allele frequency of a population remains constant. How do you interpret the change of frequency of alleles in a population?

Ans. Change of frequency of alleles in a population will result in natural selection leading to the evolution.

Q.22. What does Hardy-Weinberg equation $p^2 + 2pq + q^2 = 1$ convey?

Ans. Hardy–Weinberg equation conveys genetic equilibrium, *i.e.*, sum total of all allelic frequencies is 1.

Q.23. Name the common ancestor of the great apes and man.

Ans. *Dryopithecus/Ramapithecus.*

Q.24. State the significance of biochemical similarities amongst diverse organism in evolution.

Ans. Biochemical similarities indicate evolution from common or shared ancestry

Q.25. State the significance of *Coelacanth* in evolution.

Ans. It is an ancestor of amphibians.

Q.26. Write the probable differences in eating habits of *Homo habilis* and *Homo erectus*.

Ans.

Homo habilis did not eat meat. They were vegetarian.
Homo erectus ate meat. They were meat eater.

Q.27. Rearrange the human activities mentioned below as per the order in which they developed after the modern Homo sapiens came into existence during ice age:

i. Human settlement
ii. Prehistoric cave art
iii. Agriculture

Ans.

The order of activities is as follows:

i. Pre-historic cave art
ii. Agriculture
iii. Human Settlement

Q.28. When does a species become founders to cause founder effect?

Ans. When the change in the alleles frequency is so different in the new sample of population that they become a different species, the original drifted population becomes founder.

Q.29. Identity the examples of convergent evolution from the following:

i. Flippers of penguins and dolphins
ii. Eyes of octopus and mammals
iii. Vertebrate brains

Ans.

i. Flippers of penguins and dolphins
ii. Eyes of octopus and mammals

Q.30. Identify the examples of homologous structures from the following:

i. Vertebrate hearts
ii. Thorns in *Bougainvillea* and tendrils of *Cucurbita*.
iii. Food storage organs in sweet potato and potato.

Ans.

i. Vertebrate hearts
ii. Thorns in *Bougainvillea* and tendrils of *Cucurbita*.

Very Short Answer Questions (OIQ)

[1 Mark]

Q.1. What is evolutionary biology?

Ans. Evolutionary biology is the study of events of evolutionary history of life forms on earth.

Q.2. What do you mean by biogenesis?

Ans. Biogenesis states that life originates from pre-existing life.

Q.3. What is cosmozoic theory of origin of life?

Ans. According to this theory, life came from other planets or outer space in the form of units of life called spores.

Q.4. Who proposed the theory of chemical evolution?

Ans. Oparin and Haldane.

Q.5. Name the theory by which earth is said to originate.

Ans. The Big Bang theory.

Q.6. What do you mean by theory of spontaneous generation?

Ans. According to this theory living organisms arose from decaying and rotting matter.

Q.7. Who gave the first experimental proof for chemical evolution of life?

Ans. Stanley Miller and Harold Urey.

Q.8. What are the end products of the experiment by Miller?

Ans. Amino acids.

Q.9. Name any two vertebrate body parts that are homologous to human forelimbs.

Ans. Wings of birds and forelimbs of horse.

Q.10. What do you mean by adaptive radiation?

Ans. It is the evolutionary process in which different species starting from a common point in a geographical area radiate to other geographical areas.

Q.11. What is divergent evolution?

Ans. It is the evolutionary process by which same structures developed differently due to different needs.

Q.12. Define homology.

Ans. It refers to the similarity of structural design, anatomy and embryology of organs of different groups of plants and animals.

Q.13. What is fossil?

Ans. Fossils are the remains or impressions of ancient organisms preserved in sedimentary rocks or other media.

Q.14. How do we compute the age of a fossil?

Ans. By radiocarbon dating.

Q.15. What is paleontology?

Ans. The systematic and scientific study of fossils is called paleontology.

Q.16. What are the key concepts of Darwinian theory of evolution?

Ans. Two key concepts of Darwinism are:

i. Branching descent
ii. Natural selection.

Q.17. Give a biological term for single step large mutation.

Ans. Saltation.

Q.18. A biogeographical evidence in favour of organic evolution is provided by

a. *Archaeopteryx*
b. Modern horse
c. Darwin's finches
d. Python

Ans. Darwin's finches.

Q.19. What causes speciation according to Hugo de Vries?

Ans. Mutation.

Q.20. Name the scientist who also came to similar conclusion as Darwin.

Ans. Alfred Wallace.

Q.21. Life originated from earth's inorganic atmosphere in past but not today. Suggest two reason.

Ans.

i. Presence of free oxygen in present day atmosphere.
ii. Existence of living organisms.

Q.22. How can you suggest that biochemistry gives evidence for organic evolution?

Ans. In the same species or group of organisms, similar type of proteins are found, thus supporting organic evolution.

Q.23. When we say "survival of the fittest", does it mean that

a. those which are fit only survive, or
b. those that survive are called fit.

Ans. Those individuals which survive and reproduce in their respective environment are called fit.

Q.24. What is Hardy–Weinberg principle?

Ans. It is the principle which states that gene frequency in a population remains stable and constant from generation to generation.

Q.25. What is evolution according to Hardy–Weinberg?

Ans. According to Hardy–Weinberg, the disturbance in genetic equilibrium is the result of evolution.

Q.26. Name the earliest fossil of pre-historic man.

Ans. *Ramapithecus.*

Q.27. What is founder effect?

Ans. 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 founder and the effect is called founder effect.

Q.28. If the frequency of one allele is '*p*' and for another, it is '*q*' for one gene, what will be the formula to calculate allele frequency in future generations according to Hardy– Weinberg genetic equilibrium?

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

Q.29. What is gene migration?

Ans. When a section of population migrates, it results in addition of new genes or alleles to one population and their loss to another population. This is called gene migration.

Q.30. Define genetic drift.

Ans. A sudden change in gene frequency by chance alone rather than by natural selection is called genetic drift.

Q.31. Name the first organism that invaded land.

Ans. Plants.

Q.32. Name the ancestor of bryophytes.

Ans. *Chlorophyta.*

Q.33. In which geological time period did bryophytes appear on earth?

Ans. Carboniferous period of paleozoic era.

Q.34. Name the period of geological history when lycopod flourished.

Ans. Jurassic period of mesozoic era.

Q.35. Name the descendants of seed fern.

Ans. Cycad and dicots.

Q.36. Name the ancestor of modern amphibian.

Ans. *Coelacanth.*

Q.37. What are the major divisions of history of earth?

Ans. Eras, period and epoch.

Q.38. What were the first mammals like?

Ans. The first mammals were like shrews.

Q.39. Give the scientific term to the fish-like reptiles.

Ans. *Ichthyosaurs.*

Q.40. Name the two forms of extinct reptiles that evolved from synapsids.

Ans. *Pelycosaurs* and *Therapsids*.

Q.41. Name the immediate reptilian (extinct) ancestor of mammals.

Ans. *Therapsid.*

Q.42. Give the scientific term of first human-like ancestor.

Ans. *Homo habilis.*

Q.43. Name the ancestor of Homo habilis.

Ans. *Australopithecus.*

Q.44. By what Latin name the first hominid was known?

Ans. *Homo habilis.*

Q.45. Mention brain capacities of Homo habilis and Neanderthal man.

Ans. The brain capacity of *Homo habilis* is 650–800 cc and Neanderthal man is 1400 cc.

Q.46. Among *Ramapithecus, Australopithecous* and *Homo habilis*, who probably did not eat meat?

Ans. *Homo habilis.*

Q.47. Where did life appear first?

Ans. Life appeared for the first time in sea.

Q.48. Who proposed that life comes only from pre-existing life?

Ans. Louis Pasteur.

Q.49. When did first cellular form of life appear?

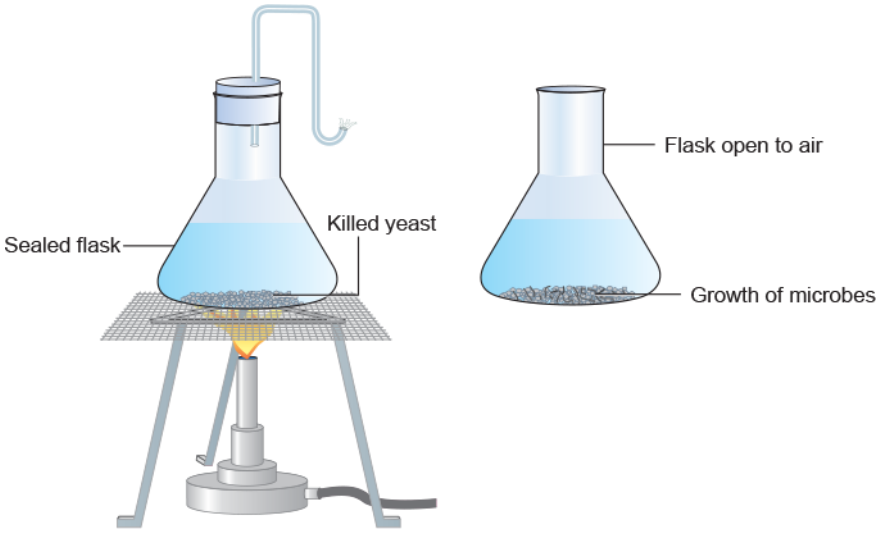
Ans. 2000 million years ago.

Short Answer Questions-I (PYQ)

[2 Marks]

Q.1. Describe the experiment that helped Louis Pasteur to dismiss the theory of spontaneous generation of life.

Ans. Two pre-sterilised flasks with killed yeast were taken. One of the flask was sealed, and the other was open to kept air. Differential growth of life were observed in the two flasks. Life was found only in the open flask.



Q.2. Write the Oparin and Haldane's hypothesis about the origin of life on Earth. How does meteorite analysis favour this hypothesis?

Ans. The hypothesis stated that life originated from pre-existing non-living organic molecules (e.g., RNA, protein, etc.). When the meteorites were analysed, it was observed that presence of similar compounds was confirmed which conclude that similar process is going on elsewhere in the space.

Q.3. Mention the contribution of S.L. Miller's experiments on Origin of Life.

Ans. S.L. Miller created an environment in laboratory similar to the one that existed before life originated. In a closed flask containing CH_4, H_2, NH_3 and water vapour at 800°C, electric discharge was created. The conditions were similar to those in primitive atmosphere. After a week, they observed presence of amino acids and complex molecules like sugars, nitrogen bases, pigments and fats in the flask. This provided experimental evidence for the theory of chemical origin.

Q.4. Convergent evolution and divergent evolution are the two concepts explaining organic evolution. Explain each one with the help of an example.

OR

Differentiate between divergent and convergent evolution. Give one examples of each.

Ans.

Convergent evolution: When more than one adaptive radiation appeared to have occurred in an isolated geographical area and two or more groups of unrelated animals resemble each other for similar mode of life or habitat, it is called convergent evolution, *e.g*., Australian marsupials, placental mammals.

Divergent evolution: In some animals, the same structures developed along different directions due to adaptations to different needs. This is known as divergent evolution. For example, forelimbs of whales, bats, cheetah and human perform different functions but have similar anatomical structure with similar bones arranged in similar segments.

Q.5. Explain convergent evolution with the help of two examples.

Ans. Different structures evolved similarly due to same functions. This is called convergent evolution.

Examples:

i. Wings of butterfly and birds.
ii. Sweet potato (root modification) and potato (stem modification).

Q.6. What is divergent evolution? Explain taking an example of plants.

OR

Explain divergent evolution with two examples.

Ans.

Some structures developed along different directions due to adaptations to different needs performing different functions. This is called divergent evolution. Examples:

i. Forelimbs of whales, bat, cheetah and humans have similar pattern of bones.
ii. Thorns of *Bougainvillea* and tendrils of *Cucurbita* are modifications of stem.

Q.7.

i. Forelimbs of Cheetah and mammals
ii. Flippers of dolphins and penguins
iii. Wings of butterflies and birds
iv. Forelimbs of whales and mammals

Ans.

(*i*) and (*iv*) exhibit divergent evolution.
There pairs have similar anatomical structure or origin but perform different functions.

Q.8.

a. **Select the homologous structures from the combinations given below:**
    i. **Forelimbs of whales and bats**
    ii. **Tuber of potato and sweet potato**
    iii. **Eyes of octopus and mammals**
    iv. **Thorns of Bougainvillea and tendrils of Cucurbita**
b. **State the kind of evolution they represent.**

Ans.

a. (*i*) Forelimbs of whales and bats. (*iv*) Thorns of *Bougainvillea* and tendrils of *Cucurbita*.
b. Divergent evolution.

Q.9. How do homologous organs represent divergent evolution? Explain with the help of a suitable example.

Ans.

Organs with similar structure or same origin developed along different directions due to adaptation or different needs, to perform different functions are called homologous organs.
For example, the fore limbs of some animals (Vertebrates) like whales, bats, cheetah and human have similar anatomical structure (*i.e.*, humerus, radius, ulna, carpals, metacarpals and phalanges) develop differently to meet different need and to perform different functions.

Q.10.

a. **Select the analogous structures from the combinations given below:**
    i. **Forelimbs of whales and bats**
    ii. **Eyes of octopus and mammals**
    iii. **Tuber of sweet potato and potato**
    iv. **Thorns of *Bougainvillea* and tendrils of *Cucurbita*.**
b. **State the kind of evolution they represent.**

Ans.

a. (*ii*) and (*iii*) are analogous structures.
b. Convergent evolution.

Q.11. Identify the following pairs as homologous or analogous organs:

i. Sweet potato and potato
ii. Eye of octopus and eye of mammals
iii. Thorns of *Bougainvillea* and tendrils of *Cucurbits*
iv. Forelimbs of Bat and Whale

Ans.

(*i*) and (*ii*): Analogous (*iii*) and (*iv*): Homologous.

Q.12. Branching descent and natural selection are the two key concepts of Darwinian theory of evolution. Explain each concept with the help of a suitable example.

Ans.

Branching descent: Different species descending from the common ancestor get adapted in different habitats, *e.g.*, Darwin's finches—varieties of finches arose from grain eaters; Australian marsupials evolved from common marsupial.

Natural selection: It is a process in which heritable variations enable better survival of the species to reproduce in large number, *e.g.*, white moth surviving before the industrial revolution and black moth surviving after industrial revolution; long-necked giraffe survived the evolution process; DDT-resistant mosquitoes survive. (*Any suitable example*)

Q.13. How is Darwin's concept of evolution different from that of de Vries?

Ans.

S.No.	Darwin's concept of evolution	de Vries' concept of evolution
(*i*)	Continuous variations among individuals of a species is the basis of evolution.	Mutations are the basis of evolution.
(*ii*)	Darwinian variations are gradual.	de Vries' mutation appear all of a sudden.

Q.14. Explain adaptive radiation with the help of a suitable example.

Ans. Adaptive Radiation

- It is the evolutionary process in which different species starting from a common point in a geographical area radiate to other geographical areas. Examples:
  i. **Darwin's finches**
     - Darwin observed many varieties of finches in the same island.
     - All varieties had evolved from original seed-eating finches.
     - With alteration in beaks some became insectivorous and some vegetarian.

Q.15. Why are the wings of butterfly and birds said to be analogous organs? Name the type of evolution of which the analogous organs are a result of.

Ans. Wings of butterfly and birds are not anatomically similar structures though they perform similar functions. Hence, they are called analogous structures. Analogous organs result from convergent evolution.

Q.16. What do you infer from the resemblance between flying squirrel and flying phalanger with reference to their evolution?

Ans. Evolution of marsupial mammals has resulted in flying phalanger through adaptive radiation. Evolution of placental mammals has led to the evolution of a flying squirrel (independently). The resemblance between the two proves convergent evolution.

Q.17. "Post-industrialisation, the population of melanised moth increased in England at the expense of white-winged moths." Provide explanations.

Ans. Pre-industrialisation period had more white winged moth against grey lichens on tree trunks. During industrialisation large amount of soot and smoke deposited on tree trunks, making the bark dark. Against the dark background white moths could easily be preyed upon. Melanised moth could camouflage against dark bark. This natural selection increased their number.

Q.18. Explain the increase in the numbers of melanic (dark winged) moths in the urban areas of post-industrialisation period in England.

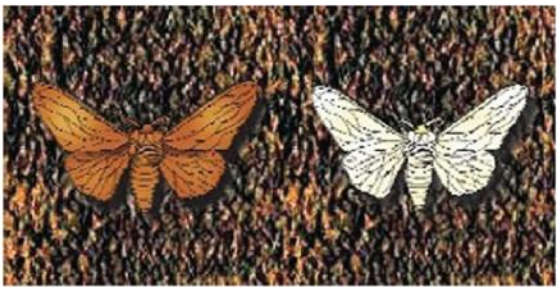
Ans. During post-industrialisation period, the tree trunks became dark due to accumulation of industrial smoke and soot. Under this condition the white-winged moth was easily spotted by the predators against the dark background. Whereas the dark-winged or melanised moth camouflaged against the dark background and survived.

Q.19. In England, during the post-industrialised period, the count of melanic moths increased in urban areas but remained low in rural areas. Explain.

Ans. Industrial melanism:

- In England, before industrialisation, white-winged moths were more in number than darkwinged moths.
- But after industrialisation, dark-winged moths became more in number than white-winged moths.
- This is because during industrialisation, the tree trunks covered by white lichens became dark due to deposition of dust and coal particles.
- As a result, white-winged moths could be easily picked up by predators from the dark background and dark-winged moths survived.

Q.20.



(*a*) (*b*)

What do these pictures 'a' and 'b' illustrate with reference to evolution? Explain.

Ans.

a. A white-winged moth and dark-winged moth on a tree trunk in an unpolluted area.
b. A white-winged moth and a dark-winged moth on a tree trunk in a polluted area.

These pictures depict industrial melanism. In England, it was observed before industrialisation that white-winged moth were more than dark-winged moth. But the situation reversed after industrialisation.

Q.21. Explain the interpretation of Charles Darwin when he observed a variety of small black birds on Galapagos Islands.

Ans.

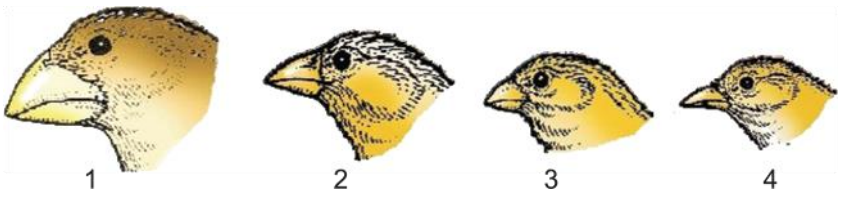
In Galapagos Islands, the small black birds amazed Darwin and he later called them finches. He realised that there were many varieties of finches in the same island. All the varieties evolved on the island itself. This process of evolution was called adaptive radiation, According to Darwin this evolution was based on available resources, food and space. There is survival of the fittest.

Q.22. How do Darwin's finches illustrate adaptive radiation?

Ans. Darwin during his journey to Galapagos Islands observed that there were many varieties of small black birds later called Darwin's finches.

- 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.

Q.23.



a. Write your observations on the variations seen in the Darwin's finches shown above.
b. How did Darwin explain the existence of different varieties of finches on Galapagos Islands?

Ans.

a. By the process of evolution many other forms with altered beaks, arose from the original seed-eating features, enabling them to become insectivorous and vegetarian finches.
b. Darwin explained it as the process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats), called adaptive radiation.

Q.24. Anthropogenic action can hasten the evolution. Explain with the help of a suitable example.

Ans.

Excessive use of herbicides, pesticides, etc., has only resulted in selection of resistant varieties in a much lesser time scale which is equally true for microbes against which we employ antibiotics or drugs against eukaryotic organisms/cells. As a result of which resistant organisms/cells are appearing in a time scale of months or years and not centuries. For example, when the DDT was used for the first time, maximum mosquitoes died but few survived due to variation in a population. These mosquitoes show resistance to DDT and survived to reproduce successfully in the presence of DDT and gradually such mosquito population become DDT resistance, following natural selection.

Q.25. With the help of any two suitable examples explain the effect of anthropogenic actions on organic evolution.

Ans. Industrial melanism:

- In England, before industrialisation, white-winged moths were more in number than darkwinged moths.
- But after industrialisation, dark-winged moths became more in number than white-winged moths.
- This is because during industrialisation, the tree trunks covered by white lichens became dark due to deposition of dust and coal particles.

- As a result, white-winged moths could be easily picked up by predators from the dark background and dark-winged moths survived .

Chemical resistance:

- Excessive use of herbicides and pesticides has resulted in evolution of resistant varieties of microbes in much lesser time scale.
- As a result, pathogenic bacteria are appearing in very short period.

Q.26. According to the Darwinian theory, the rate of appearance of new forms is linked to their life cycles. Explain.

Ans.

Microbes have a very short life cycle and divide fast. They can produce millions of organisms within few hours. Thus, it is easy to see variant population in less span of time. On the other hand, higher organisms have a long time span and the variations are not visible fast.

Q.27. What does the following equation represent? Explain.

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

Ans.

The equation represents Hardy-Weinberg's Principle which states that allele frequencies in a population are stable and is constant from generation to generation. 1 represents stable allelic frequency indicating no evolution occurring. *p* represents frequency of homozygous dominant (AA), 2 *pq* represents frequency of heterozygous (Aa) and *q* represents frequency of homozygous recessive (aa).

Q.28. State Hardy–Weinberg principle of genetic equilibrium. Knowing that genetic drift disturbs this equilibrium, mention what does this disturbance in genetic equilibrium lead to.

Ans. Hardy–Weinberg principle states that gene pool remains constant, *i.e.*, the allele frequencies in a population are stable and remains constant from generation to generation. Genetic drift refers to change in allele frequencies of a population occurring by chance. The change in allele frequency may be so different that the population becomes a different species. This effect is called founder effect.

Q.29. Discovery of lobefins is considered very significant by evolutionary biologists. Explain.

Ans. Lobefins were fish-like animals with stout and strong fins that lived both on water as well as on land. Their discovery is significant as they prove that amphibians have evolved from fish-like organisms. Lobefins are ancestors of modern day frogs and salamanders.

Q.30.

a. Rearrange the following in an ascending order of evolutionary tree: reptiles, salamanders, lobefins, frogs.
b. Name two reproductive characters that probably make reptiles more successful than amphibians.

Ans.

a. Lobefins, frogs, salamanders, reptiles
b. Reptiles are more successful than amphibians as:
    i. reptiles lay eggs on land.
    ii. reptiles lay thick shelled eggs which do not dry up in sun unlike those of amphibians.

Short Answer Questions-I (OIQ)

[2 Mark]

Q.1. What was the composition of the primitive atmosphere that favoured abiotic origin of life on earth?

Ans. The primitive earth or primordial earth contained large amounts of hydrogen, nitrogen, water vapour, ammonia and gases evolved from molten lava but no free oxygen was found. The primitive atmosphere was reducing which favoured abiotic origin of life.

Q.2. What are we referring to when we say 'simple organisms' or 'complex organisms'?

Ans. These are the terms to classify organisms according to their evolutionary history. Simple organisms have simple structural and functional organisation and are considered primitive, whereas complex organisms have complex structural and functional organisation and are said to have arise from simple organisms.

Q.3. Who proposed the theory of origin of life? What were the conditions prevailing about 3.6 billion years ago, to create life on primitive earth?

Ans. Oparin and Haldane proposed the theory of origin of life. Initially, on the primitive earth there was no atmosphere. The volcanic eruption and molten mass released water vapour, methane, carbon dioxide, and ammonia which formed earth's atmosphere. The earth's atmosphere was reducing one, *i.e.*, no free oxygen was present. Huge amount of energy was liberated from lightning, and UV rays as there was no ozone layer.

Q.4. What is Oparin–Haldane theory? Can life be originated abiotically inside the laboratory today?

Ans.

Oparin–Haldane's theory states that the first life form originated from non-living organic molecules like RNA, protein, etc. Yes, life can be originated abiotically inside the laboratory under controlled conditions.

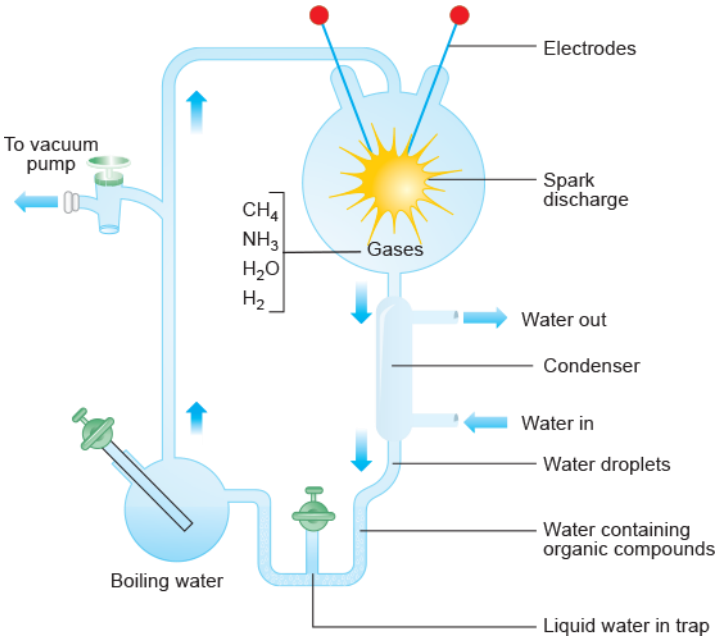
Q.5. What is meant by abiotic synthesis? Who proposed the idea and who supported it experimentally?

Ans.

Abiotic synthesis means origin of life from non-living constituents, *i.e.*, chemical evolution of life states that diverse organic molecules were synthesised from inorganic constituents. These complex organic molecules adapt to autocatalyst property, *i.e.*, self-duplication or self-replication. This idea was proposed by Oparin and Haldane. It was experimentally proved by Urey and Miller.

Q.6. Diagrammatically represent the experimental set up that proves Oparin–Haldane hypothesis.

Ans.



Diagrammatic representation of Miller's experiment

Q.7. What is the study of fossils called? Mention any three points how the fossils throw light on past life.

Ans.

Study of fossils is called paleontology.
The fossils throw light on past life in following ways:

i. Distribution of fossil gives information about habitat of an organism.
ii. Establishes phylogenetic links.
iii. Some fossils provide evidence of connecting link.
iv. Age of the organisms can be determined by fossils.
v. Fossils also throw light on morphology and anatomy of past life.

Q.8. During an excavation assignment, scientists collected pollen grains of a plant preserved in deeper layers of soil. Analyse the properties of pollen grains which help in the fossilization.

Ans.

Pollen has an outer layer called exine which is made of sporopollenin.
It is the most resistant organic material known. It can withstand high temperature, strong acids and alkali as well. No enzyme that degrades sporopollenin is so far known.

Q.9. Define homologous organ. Give one example of an organ homologous to hand of man.

Ans.

The organs with same structural design and developmental origin but differing in their functions are called homologous organs. Forelimbs of human being are homologous to forelimbs of whales and bats.

Q.10. Define analogous organ. Give one example of an organ analogous to human hand.

Ans.

The organs with different structural designs and developmental origin but performing similar functions are called analogous organs. Trunk of an elephant is analogous to human hand.

Q.11. Give one example of analogy and homology in plants.

Ans.

Homology: Tendrils of *Cucurbita* and thorns of *Bougainvillea*.
Analogy: Sweet potato (root modification) and potato (stem modification) to store food.

Q.12. What is meant by analogous organ? Taking a suitable example, explain how they support the theory of organic evolution.

Ans.

The organs which have different developmental origin and structural design but perform similar functions are called analogous organs. The wings of birds and insects are analogous organs indicating that they have different ancestors but show a convergent evolution.

Q.13. What is meant by homologous organ? Taking suitable example, explain how they support the theory of organic evolution.

Ans.

The organs which have same basic structural design and development origin but differ in their uses and functions are called homologous organs. The forelimbs of some animals have similar anatomical structure. They possess humerus, radius, ulna, carpals, metacarpals and phalanges in their forelimbs, *e.g.*, forelimbs of man, whales, bats, cheetah, indicates that they have common ancestors, thus supporting organic evolution.

Q.14. Amongst pea tendrils, *Opuntia* spines, lemon thorns, and *Cucurbita* tendrils, which are homologous structures? Why do you call them homologous?

Ans.

Opuntia spines and pea tendrils are homologous because both are leaf modifications. Lemon thorns and *Cucurbita* tendrils are homologous because both are modified stems having same basic design and developmental origin but different functions.

Q.15. How do you consider tendrils of *Cucurbita* and thorns of *Bougainvillea* as homologous structure?

Ans.

Both of them are stem modifications and thus are structurally similar but both have different functions. Thus, they are homologous structures as tendrils and thorns both arise in axillary position and hence are modified branches but tendrils help in climbing and thorns protect the plant.

Q.16. What is speciation? List any two events leading to speciation.

Ans.

The process involving formation of new species from the existing species is called speciation.
Two events leading to speciation are:

i. Interbreeding among different populations or species.
ii. Migration.

Q.17. What was Lamarck's theory of evolution? Explain the theory by quoting an example.

Ans.

Lamarck's theory of evolution states that use and disuse of an organ can bring about a change in that organ which is then acquired and passed on to the next generation, *e.g.*, the long neck of giraffe was explained by Lamarck, as an outcome of these animal to stretch their neck constantly to eat the leaves from the upper branches of the trees.

Q.18. Define biogeography. How do Darwin's finches provide the biogeographical evidence in favour of evolution?

Ans.

The study of distribution of various organisms in different parts of the earth is called biogeography. All the varieties of Darwin's finches have evolved on the same island itself from a common seed-eating ancestor due to adaptive radiation.

Q.19. Give two examples of biogeographical evidence in favour of evolution.

Ans.

i. Darwin's finches
ii. Australian marsupials

Q.20. How do Darwin's finches illustrate adaptive radiation?

Ans.

Original stock of seed eating finches migrated to different habitats (of Galapagos Islands), adapted to different feeding methods, by altered beak structure, evolved into different types of finches.

Q.21. Explain the concept of differential reproduction as a major component of theory of natural selection.

Ans. The rate of reproduction among the different individuals in a population varies. Some produce more offsprings and some produce only few offsprings. This biological phenomenon is called differential reproduction. So, the reproductively fit individual produces more offsprings than other. They are thus selected by nature to survive and evolve into new species.

Q.22. Protein synthesis machinery revolves around RNA but in the course of evolution it was replaced by DNA. Justify.

Ans. Since RNA was unstable and prone to mutations, DNA evolved from RNA with chemical modifications that makes it more stable.

DNA has double stranded nature and has complementary strands. These further resist changes by evolving a process of repair.

Q.23. What is the significance of *Archaeopteryx* in the study of organic evolution?

Ans.

Archaeopteryx is a connecting link between reptiles and birds. It shows features of both birds and reptiles giving an evidence that birds have evolved from reptiles.

Q.24. Explain briefly how the principle of natural selection can be applied to the development of resistance in mosquitoes for DDT.

Ans. When DDT was used for the first time, maximum mosquitoes died but few survived due to variation in the population. These mosquitoes showed resistance to DDT and survived to reproduce successfully in the presence of DDT and gradually such mosquito population became DDT resistant due to natural selection.

Q.25. How does Darwin's theory of Natural Selection explain the appearance of new forms of life on earth?

Ans.

Darwinian theory of evolution

- Charles Darwin, based on his observations during a sea voyage around the world in the ship H.M.S. Beagle, concluded the following:
- Varying degrees of similarities can be observed between existing life forms and those that existed millions of years ago.
- There has been **gradual evolution** of life forms with new forms arising at different periods of history.
- Any population has built-in variations in characteristics which adapt it better to environment.
- The characteristics which enable some populations or individuals to survive better in natural conditions (climate, food, physical factors) would out-breed others **(Survival of the fittest)**.
- Those populations which are better fit (reproductively fit) in an environment will be selected by nature and will survive more **(Natural selection)**.
- Adaptability is inherited and fitness is the end result of ability to adapt and get selected by nature.

Q.26. Birds have evolved from reptiles. How does paleontology provide evidence in support of the above statement?

Ans. The fossil *Archaeopteryx* is a connecting link between reptiles and birds and provide evidence that birds have evolved from reptiles. Its features are:

i. It has beak and wings like that of a birds.
ii. It has teeth and scales like that of a reptiles.

Q.27. What do you understand by differential reproduction and reproductive isolation? In what context are these term used?

Ans.

Differential reproduction: The phenomenon in which all organisms who reach reproductive stage reproduce with varying degree of success, some reproduce more offsprings and some reproduce only few and other reproduce none depending upon their degree of fitness.
Reproductive isolation: The biological phenomenon in which the individual belonging to same species reproduce among themselves, to maintain the species integrity. Both these terms are used in reference to natural selection.

Q.28. If abiotic origin of life is in progress on a planet other than earth, what should be the condition there? Explain.

Ans. The atmosphere will be reducing, *i.e.*, no free oxygen will be present. There must be continuous supply of energy like that from lightning, thunder, volcanic eruption and stellar radiation. The presence of autocatalyst or self-replicating molecules is essential.

Q.29. What must have provided energy for the warmth for life to originate on primitive earth? Name the first organism to release oxygen into the atmosphere.

Ans. Energy for life to originate must have been provided by heat, cosmic rays and lightning. Cyanobacteria was the first organism to release oxygen into the atmosphere.

Q.30. While creation and presence of variation is directionless, natural selection is directional as it is in the context of adaptation. Comment.

Ans. Creation and variation occur in a sexually reproducing population as a result of crossing-over during meiosis and random fusion of gametes. It is however the organisms that are selected over a period of time which are determined by the environmental conditions. In other words, the environment provides the direction with respect to adaptations so that the organisms are more and more fit in terms of survival.

Q.31. Gene flow occurs through generations and can occur across language barriers in humans. If we have a technique of measuring specific allele frequencies in different population of the world, can we not predict human migratory patterns in pre-history and history? Do you agree or disagree? Provide explanation to your answer.

Ans. Yes, I agree. Gene flow occurs through generations. By studying specific allele frequencies, we can predict the human migratory patterns in pre-history and history. Studies have used specific genes/chromosomes/mitochondrial DNA to trace the evolutionary history and migratory patterns of humans. (The project is known as the Human Genographics Project).

Q.32. In a certain population, the frequency of three genotypes is an followers.
Genotypes: BB Bb bb
Frequency: 22% 62% 16%
What is the likely frequency of B and b alleles?

Ans.

Frequency of B allele = all of BB + ½ of Bb = 22 + 31 = 53%
Frequency of b allele = all of bb + ½ of Bb = 16 + 31 = 47%.

Q.33. How can you say the lobefin fish were the ancestors of amphibian?

Ans. Lobefins fish have stout and strong fins, so they can move on land and swim in water to maintain a dual lives like amphibians.

Q.34. Fill in the blank (*i*), (*ii*), (*iii*), (*iv*) with name of the mammals of Australia.

Placental mammal	Marsupial mammal
Anteater	(*i*)
(*ii*)	Spotted cuscus
Bob cat	(*iii*)
(*iv*)	Tasmanian wolf

Ans.

i. Numbat
ii. Lemur
iii. Tasmanian tiger cat
iv. Wolf

Short Answer Questions-II (PYQ)

[3 Marks]

Q.1. State the theory of Biogenesis. How does Miller's experiment support this theory?

Ans. The theory of biogenesis states that a living organism arises from another living organisms.

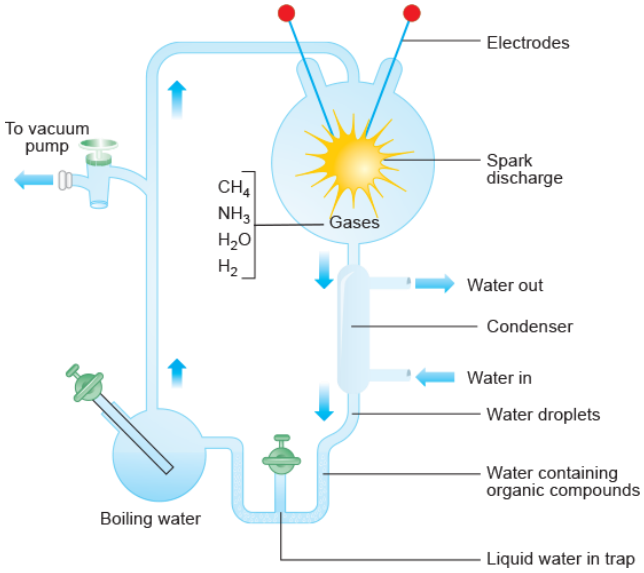
For Miller's experiment

Experimental evidence of chemical evolution/Miller's experiment

- Experiment was performed by S.L. Miller and H.C. Urey in 1953.
- **Experimental set-up:** In a closed flask containing CH_4, H_2, NH_3 and water vapour at 800°C, electric discharge was created. The conditions were similar to those in primitive atmosphere.
- **Observations:** After a week, they observed presence of amino acids and complex molecules like sugars, nitrogen bases, pigments and fats in the flask.
- **Conclusions:.**
  - i. It provides experimental evidence for the theory of chemical origin.
  - ii. It showed that the first non-cellular form of life was created about 3 billion years ago.
  - iii. It showed that non-cellular biomolecules exist in the form of DNA, RNA, polysaccharides and protein.

Q.2. Diagrammatically represent the experimental set up that proved Oparin-Haldane hypothesis.

Ans.

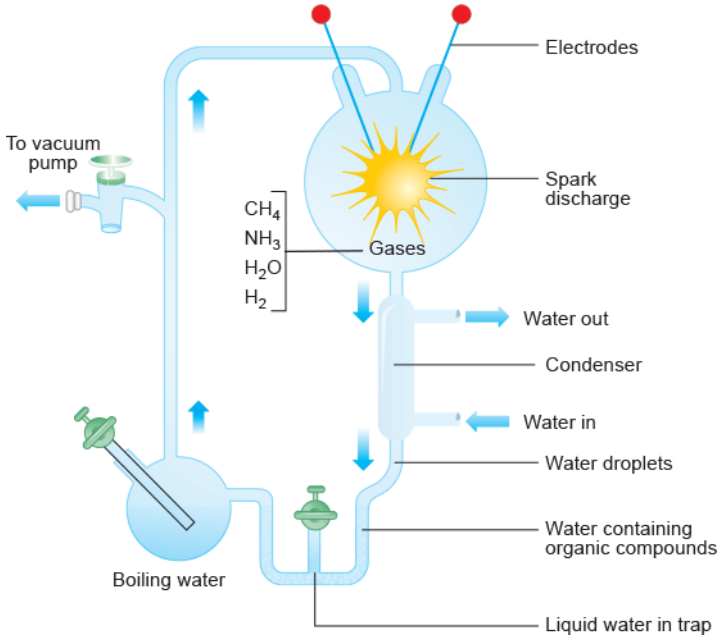


Diagrammatic representation of Miller's experiment

Q.3. Describe the experiment of S.L. Miller on the origin of life. Write the conclusion drawn at the end of the experiment.

Ans.

Experimental evidence of chemical evolution/Miller's experiment



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- **Conclusions:.**
  i. It provides experimental evidence for the theory of chemical origin.
  ii. It showed that the first non-cellular form of life was created about 3 billion years ago.
  iii. It showed that non-cellular biomolecules exist in the form of DNA, RNA, polysaccharides and protein.

Q.4. State the contribution of Louis Pasteur in understanding the origin of life on earth. Explain the procedure that he followed to arrive at his conclusion.

Ans.

Louis Pasteur dismissed the theory of spontaneous generation and demonstrated that life came from pre-existing life. He took two long-necked flasks. He left one flask with a

straight neck and the other was bent to from an ‘S’ shape. He put sterile broths in both the flasks. He placed killed yeast in pre-sterilised bent flask and the other flask was left open to air.

After several weeks he observed that the straight neck flask was discoloured and cloudy, while the curved flask had not changed. Thus he concluded that the germs in air were able to fall unobstructed down the straight necked flask while they got trapped in the curved flask.

Q.5. How do fossils help us in understanding the evolutionary history?

Ans. Paleontological evidences

- The study of fossil is called **paleontology**.
- **Fossils** are the remains or impressions of past organisms preserved in sedimentary rocks or other media.
- Different-aged rock sediments in earth’s crust indicate the presence of fossils of different life forms which died during the sediment formation.
- A variety of fossils ranging from the modern organisms to extinct organisms can be observed.
- By studying the different sedimentary layers, the geological time period in which the organism existed can be predicted.

Q.6. What are analogous structures? How are they different from homologous structures? Provide one example for each.

OR

Differentiate between homology and analogy. Give one example of each.

Ans.

Homology	**Analogy**
1. Organisms having the same structure developed along different directions due to adaptations/ different functions. 2. Result of divergent evolution. 3. Indicates common ancestry. 4. Anatomically same structures. 5. **Example:** Forelimbs of whale—bats—cheetah—human// Thorns of *Bougainvillea* and tendrils of *cucurbits*	1. Different structures having the same function (in different organisms). 2. Result of convergent evolution. 3. Does not indicate common ancestry. 4. Anatomically different structures. 5. **Example:** Wings of butterfly and birds, Sweet potato and potato

Q.7.

a. **What is adaptive radiation?**
b. **Explain with the help of a suitable example where adaptive radiation has occurred to represent convergent evolution.**

OR

What is adaptive radiation? When can adaptive radiation be referred to as convergent evolution? Give an example.

Ans.

a. The process of evolution of different species in a given geographical area starting from a point and radiating to other areas of geography (habitats) is called adaptive radiation.
b. When more than one adaptive radiation occurs in an isolated geographical area (representing different habitats), it can be called as convergent evolution.
   For example, similarity between some individual members of placental mammals and marsupial mammals argues strongly that they are the result of convergent evolution. These animals have similar forms because of evolution in different, isolated areas because of similar selective pressures in similar environments. This means marsupials in Australia resemble placental mammals in the rest of the world. They evolved in isolation after Australia separated from other continents.

Q.8.

a. **Explain adaptive radiation with the help of a suitable example.**
b. **Cite an example where more than one adaptive radiations have occurred in an isolated geographical area. Name the type of evolution your example depicts and state why it is so named.**

Ans.

a. Adaptive radiation can be observed in black birds of Galapagos islands, which are also called Darwin's finches. These birds evolved on the island itself from the original seed eating features. Many forms with offered beaks arose which enabled them to become insectivorous and vegetarian in different habitats of the island.
b. More than one adaptive radiation have occurred in Australian marsupials and placental mammals.
   The example depicts convergent evolution. It is named so, because more than one adaptive radiation occurred in isolated geographical area.

Q.9. Describe the three different ways by which Natural Selection can affect the frequency of a heritable trait in a population.

Ans. Natural selection: Heritable variations that enable survival of the fittest will leave greater number of progeny. Natural selection can have following three effects:

a. **Stabilisation:** Larger number of individuals acquire mean character value so peak gets higher and narrower.
b. **Directional change:** Large number of individuals acquire value other than mean character value so peak shifts in one direction.
c. **Disruption:** Large number of individuals acquire peripheral character values at both ends of the distribution curve and hence 2 peaks are formed.

Q.10. How does industrial melanism support Darwin's theory of Natural Selection? Explain.

Ans. Before industrial revolution the environment was unpolluted. The lichens on the barks of trees were pale. The white-winged moths could easily camouflage, while the dark-winged were spotted out by the birds for food. Hence, they could not survive. After industrial revolution the lichens became dark (due to soot deposit). This favoured the dark-winged moths while the white-winged were picked by birds. The population of the former which was naturally selected increased.

Q.11. Differentiate between the explanations given by Darwin and de vries respectively on the mechanism of evolution.

Ans.

S. No.	Darwin's evolution	de Vries' evolution
(*i*)	According to Darwin, evolution was gradual (stepwise).	According to de Vries, evolution occurred in a single step (saltation).
(*ii*)	Variations and natural selection occurs through a number of generations and are responsible for speciation.	Single step mutation caused speciation.
(*iii*)	Darwin's variations are small and directional.	de Vries' mutations are random and directionless.

Q.12. $p^2 + 2pq + q^2 = 1$. Explain this algebraic equation on the basis of Hardy Weinberg's principle.

Ans. In a diploid if p represents the frequency of allele A and q represents the allele frequency of a, then frequency of AA individuals in a population is p^2 . Similarly of aa is q^2 and of Aa is $2pq$. Hence $p^2 + 2pq + q^2 = 1$. This is a binomial expansion of $(p+q)^2$.

According to Hardy–Weinberg principle, total genes and their alleles in a population or gene pool remains constant. This is called genetic equilibrium. Sum total of all the allelic frequencies is 1 [$p+q = 1/(p+q)^2 = 1$].

Q.13. How does Darwin's theory of Natural Selection explain the appearance of new forms of life on earth?

Ans.

Darwin's theory of natural selection:

- Varying degrees of similarities can be observed between existing life forms and those existing millions of years ago.
- There has been gradual evolution of life forms with new forms arising at different periods of history.
- Any population has built-in variations in characteristics which adapt it better to the environment.
- The characteristics which enable some populations or individuals to survive better in natural conditions (climate, food, physical factors) would out-breed others (Survival of the fittest).
- Those populations which are better fit (reproductively fit) in an environment will be selected by nature and will survive more (Natural selection).
- Adaptability is inherited and fitness is the end result of ability to adapt and get selected by nature.

Q.14.

a. How does the Hardy–Weinberg's expression ($p^2 + 2pq + q2 = 1$) explain that genetic equilibrium is maintained in a population?
b. List any two factors that can disturb the genetic equilibrium.

Ans.

a.

i. Sum total of all the allele frequencies is 1: Let there be two alleles *A* and a in a population. The frequencies of alleles *A* and *a* are *p* and *q*, respectively. The frequency of *AA* individual in a population is *p*2 and it can be explained that the probability that an allele *A* with a frequency of *P* appear on both the chromosomes of a diploid individual is simply the product of the probabilities, *i.e.*, p^2 . Similarly, the frequency aa is q^2 and that of *Aa* is 2*pq*. $p^2 + 2pq + q^2 = 1$, where p^2 represents the frequency of homozygous dominant genotype, 2*pq* represents the frequency of the heterozygous genotype and represents the frequency of the homozygous recessive.

ii. Genetic equilibrium states the status of evolution. If there is some fluctuation or disturbance in genetic equilibrium or Hardy–Weinberg equilibrium, *i.e.*, change of frequencies of alleles in a population then it can predicted that evolution is in progress.

b. Factors that affect Hardy–Weinberg equilibrium:

i. Gene migration or gene flow
ii. Genetic drift

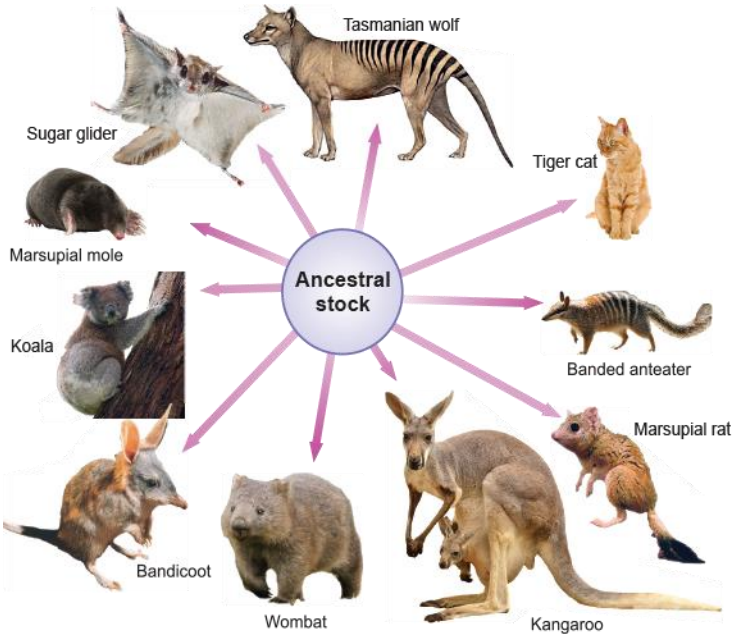
iii. Mutation

Q.15. What is disturbance in Hardy-Weinberg genetic equilibrium indicative of? Explain how it is caused.

Ans. Disturbance in Hardy-Weinberg equilibrium is an indicator of change of frequency of allele in a population, resulting in evolution.
It is caused by any of the following factors:

i. Genetic drift
ii. Gene flow or gene migration
iii. Mutation
iv. Genetic recombinations
v. Natural selection

Q.16. Name and explain the evolutionary concept represented in the illustration given below:



Ans.

The illustration represents adaptive radiation.
For explanation, refer to Basic Concepts Point 6(*iii*).

Q.17. Evolution is a change in gene frequencies in a population in response to changes in the environment in a time scale of years and not centuries. Justify this statement with reference to DDT. How does the theory of Hugo de Vries support this?

Ans.

When DDT was used for the first time, maximum mosquitoes died but few survived due to variation in a population. These mosquitoes show resistance to DDT and survived to reproduce successfully in the presence of DDT and gradually such mosquito population become DDT resistant within a time span of few years.
According to Hugo de Vries, evolution is caused by sudden large differences in the population and not minor variations.

Q.18. Rearrange *Ramapithecus, Australopithecus* and *Homo habilis* in the order of their evolution on the Earth. Comment on their evolutionary characteristics.

Ans. The order of evolution on the earth is:

Ramapithecus → *Australopithecus* → *Homo habilis*

Ramapithecus were hairy and walked–like gorilla and chimpanzees. They were more man like.
Australopithecus hunted with stone weapons and ate fruit.
Homo habilis had a brain capacity 650-800 cc and probably did not eat meat.

Q.19. Write the characteristics of *Ramapithecus, Dryopithecus*, and Neanderthal man.

Ans.

Ramapithecus: hairy, walked–like gorillas and chimpanzees, more man like.
Dryopithecus: hairy, walked–like gorillas and chimpanzees, more ape-like.
Neanderthal man: brain size is 1400c, used hides to protect their body, buried their dead.

Q.20. Answer the following questions.

Q. State Oparin–Haldane's hypothesis.

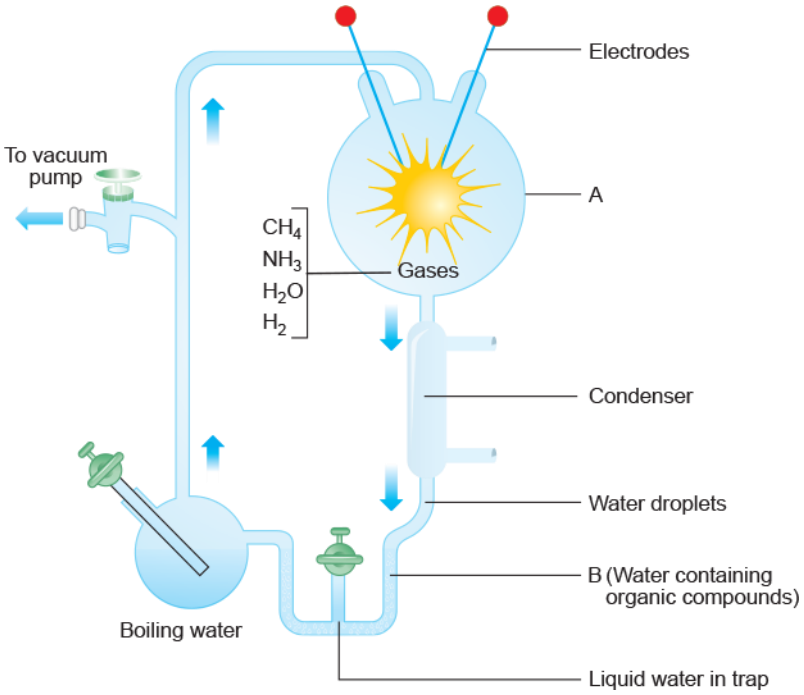
Ans. Oparin-Haldane's hypothesis states that life could have come from pre-existing non-living organic molecules and that formation of life was preceded by chemical evolution.

Q. How does S.L. Miller's experiment supports it?

Ans.

i. It provides experimental evidence for the theory of chemical origin.
ii. It showed that the first non-cellular form of life was created about 3 billion years ago.
iii. It showed that non-cellular biomolecules exist in the form of DNA, RNA, polysaccharides and protein.

Q.21. Given below is a diagrammatic representation of the experimental set-up used by S.L. Miller for his experiment:

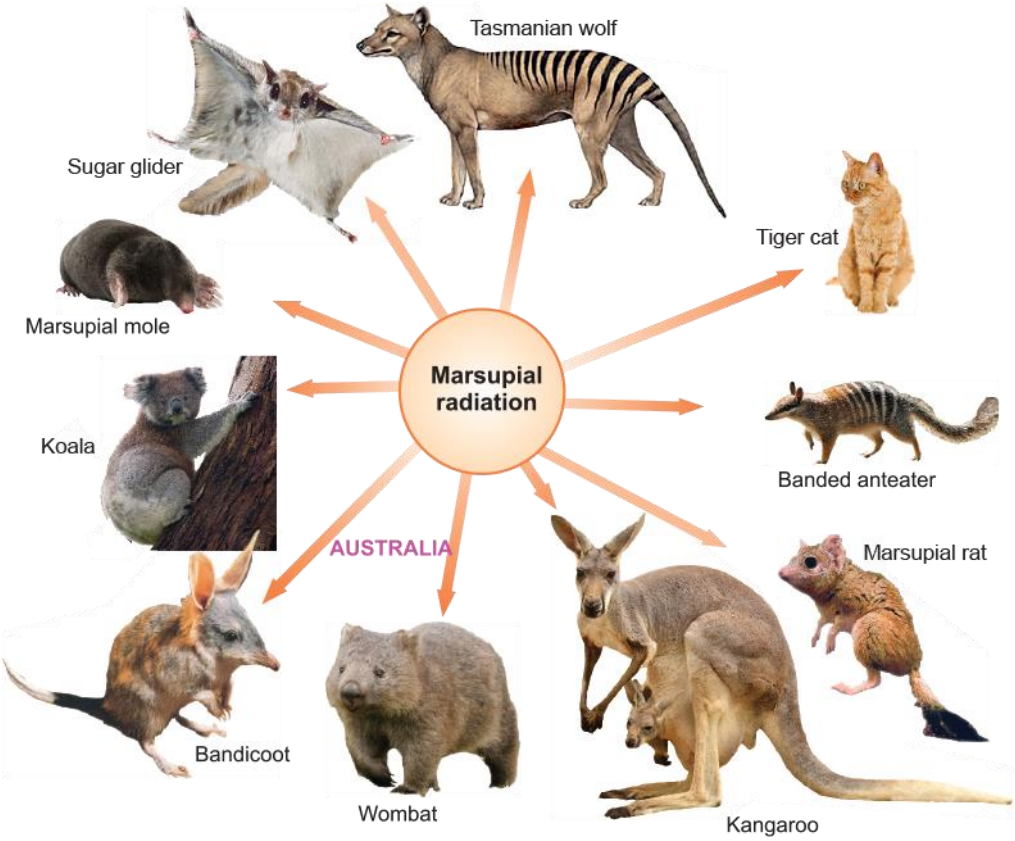


a. Write the names of different gases contained and the conditions set for the reaction in the flask 'A'.
b. State the type of organic molecule he collected in the water at 'B'.
c. Write the conclusion he arrived at.

Ans.

a. The gases obtained are CH_4, H_2, NH_3 and water vapour. The closed flask, electric discharge was created at 800°C.
b. Amino acids were collected in the water at 'B'.
c. He arrived at the conclusion that life came from pre-existing non-living organic molecules and that formation of life was preceded by chemical evolution.

Q.22.



a. **Mention the specific geographical region where these organisms are found.**
b. **Name and explain the phenomenon that has resulted in the evolution of such diverse species in the region.**
c. **Explain giving reasons the existence of placental wolf and Tasmanian wolf sharing the same habitat.**

Ans.

a. Australia.
b. Adaptive radiation (Divergent evolution) has resulted in this evolution. The process of evolution of different species in a given geographical area starting from a point and radiating to other areas of geography (habitats) is called adaptive radiation. It is the development of different functional structures from a common ancestral form.
c. Placental wolf and Tasmanian wolf share similar habitat due to convergent evolution and evolved into unrelated group of organisms.

Q.23. Since the origin of life on Earth, there were five episodes of mass extinction of species.

i. **How is the 'Sixth Extinction', presently in progress, different from the previous episodes?**
ii. **Who is mainly responsible for the 'Sixth Extinction'?**

iii. List any four points that can help to overcome this disaster.

Ans.

i. The current species extinction rate are estimated to be 100-1000 times faster than in the pre-human times.
ii. Human activities.
iii.
   a. Preventing habitat loss and fragmentation
   b. Checking overexploitation
   c. Preventing alien species invasion
   d. Preventing co-extinction
   e. Conservation/Preservation of species.

Short Answer Questions-II (OIQ)

[3 Marks]

Q.1. Whose theory was put to test by Miller and Urey and what was the theory? How did their experiment give due to abiotic origin of life on earth?

Ans. Urey and Miller tested the theory of Oparin and Haldane, which states that life originated on the earth through physiochemical processes of atoms combining to form molecules which in turn react to produce inorganic and organic compounds. Miller and Urey created the similar environment as described by Oparin and Haldane in laboratory using glass apparatus and tubes. They took CH_4, NH_3, H_2O, H_2 and water vapour for their experiment and supplied electric discharge using cathode in a closed flask at 800°C. After a week, it was observed that a number of complex organic molecules have originated, *e.g.*, some sugars, nitrogen bases, amino acids and lipids. When the meteorites were analysed, it was observed that presence of similar compounds was confirmed which conclude that similar process is going on elsewhere in the space.

Q.2. What are fossils? Mention any two ways in which the study of fossils support biological evolution of an organism.

Ans. Fossils are the remains or impressions of pre-historic organisms preserved in sedimentary rocks or other media.

Two ways in which study of fossils support biological evolution:

i. The study of *Archaeopteryx* reveals that birds have evolved from reptiles. This shows fossils provide evidence for evolution.
ii. Phylogeny can be constructed from fossils.
iii. The habitat and behaviour of extinct organisms can be inferred from well-preserved fossils.

Q.3. What is natural selection? How is artificial selection different from natural selection? Give one example each from plants and animals where artificial selection has operated.

Ans. The nature builds some pressure on the population of a species and as a result few individuals are eliminated and few adapt to adjust with changes and become fit. This biological phenomenon is called natural selection.

S. No.	Natural selection	Artificial selection
(*i*)	It is a natural phenomenon.	It is the practice done by man.
(*ii*)	As a result only fit individual increases in a population.	As a result commercially high yielding and disease resistance varieties increase.

Artificial selection have been operated in the followings cases:
Plants: Cabbage, wheat.
Animals: High milk yielding varieties of cows.

Q.4. Write in what context did Darwin use the terms 'fitness', 'survival' and 'selection' while elaborating on the mechanism of evolution.

Ans. According to Darwin, fitness refers to reproductive fitness. A fit species will leave more progenies. This will result in greater chances of survival.
Greater the number of progenies which will survive, more they will be selected by nature to continue the species. This is called natural selection.

Q.5. What type of organs eye of an Octopus and that of a human called? Give another example from the animal group and one from the plants of such organs. Name and explain the evolutionary process they exhibit.

Ans. These organs are called analogous organs. Another example from animal group is flippers of penguins and dolphins or eye of octopus and mammals
In plants, these organs can be seen in sweet potato (root modification) and potato (stem modification).
They are anatomically dissimilar structure though they perform similar function. This type of evolution is called convergent evolution.

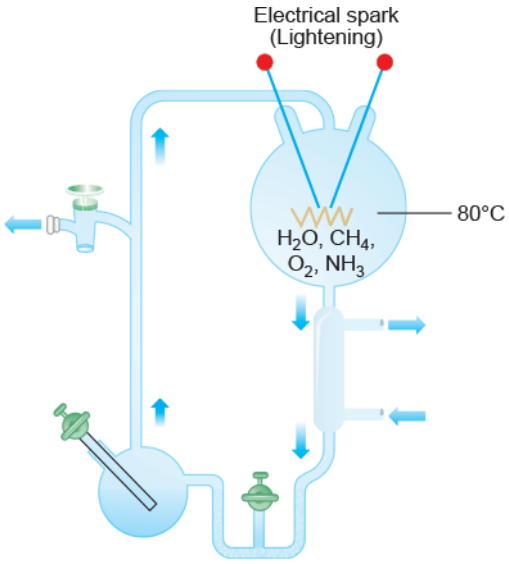
Q.6.

a. **Name the ancestors of progymnosperm.**
b. **Name the ancestors of herbaceous and arborescent lycopod.**
c. **Name the ancestors of cycads.**

Ans.

a. *Psilophyton*
b. *Zosterophyllum*
c. Progymnosperm.

Q.7. A student was simulating Urey and Millers experiment to prove the origin of life. The set up used by the student is given



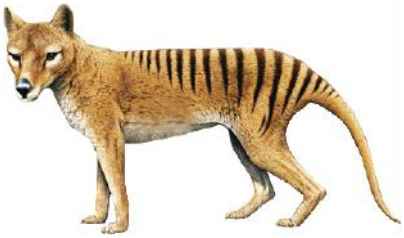
a. Find out the reasons why he could not get desired results.
b. What conclusion was drawn by Urey and Miller through this experiment?
c. Compare the conclusion drawn with the theory of spontaneous generation.

Ans.

a. He could not get desired results because:
   i. O_2 was used instead of H_2.
   ii. Temperature maintained was 80°C instead of 800°C.
b. It was concluded that life could have come from pre-existing non-living organic molecules and their formation was preceded by chemical evolution.
c. Urey and Miller observed formation of amino acids when in a closed flask CH_4, H_2, NH_3 and water vapour were heated at 800°C in presence of electric discharge. Analysis of meteorite content also reveals similar compounds indicating that similar process are occurring elsewhere in space (Chemical evolution). Urey and Miller proved that life originated abiogenetically whereas theory of spontaneous generation emphasised that units of life called spores were transferred to different planets including Earth.

Q.8. Refer to the figure given below and answer the questions that follow:

Wolf



Tasmanian wolf

a. Recognize and explain the process by which Tasmanian wolf evolved.
b. Give one example of an animal that has evolved along with Tasmanian wolf.
c. Compare and contrast the two animals shown?

Ans.

a. Adaptive radiation: It is the process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats).
b. Tiger cat/banded ant eater/Marsupial rat
c. Wolf is a placental mammal, whereas Tasmanian wolf is a marsupial mammal.

Long Answer Questions (PYQ)

[5 Marks]

Q.1.

a. Differentiate between analogy and homology giving one example each of plant and animal respectively.
b. How are they considered as an evidence in support of evolution?

Ans.

In some animals, the same structure developed along different directions due to adaptations to different needs This is divergent evolution and is called homology. Homology indicates common ancestry. For example, vertebrate hearts or brains. In plants also, the thorn and tendrils of *Bougainvillea* and *Cucurbita*represent homology. Wings of butterfly and of birds look alike. They are not anatomically similar structures though they perform similar functions. Analogy results from convergent evolution in which different structures evolve for the same function and hence have similarity. Sweet potato (root modification) and potato (stem modification) is another example for analogy.

Q.2. Explain the salient features of Hugo de Vries theory of mutation. How is Darwin's theory of natural selection different from it? Explain.

Ans.

Salient features of theory of Hugo de Vries:

i. Mutations cause evolution.
ii. New species originate due to large mutations.
iii. Evolution is a discontinuous process and not gradual.
iv. Mutations are directionless,
v. Mutations appear suddenly.
vi. Mutations exhibit their effect immediately.

S. No.	Darwin's Theory of Natural Selection	Vries Theory of Mutation
(*i*)	He believed that minor variations cause evolution. Darwinian variations are small and directional.	He believed that mutation causes evolution.
(*ii*)	He believed evolution to be gradual.	He believed sudden mutations caused evolution.

Q.3.

a. **How did Darwin explain adaptive radiation? Give another example exhibiting adaptive radiation.**
b. **Name the scientist who influenced Darwin and how?**

Ans.

a. During his journey Darwin went to Galapagos Islands. There he observed an amazing diversity of creatures. Of particular interest were small black birds, later called Darwin's Finches which 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 example is Australian marsupials.
b. Thomas Malthus influenced Darwin.
   According to Malthus, population size grows exponentially (due to maximum reproduction). However, the population size remains limited due to limited natural resources which leads to competition.

Q.4. Fitness is the end result of the ability to adapt and get selected by nature. Explain with suitable example.

Ans. Fitness is based on certain characteristics which are inherited and the ability to adapt to the changing environment. It is the end result of adaptation because a fit individual survives and unfit individuals are eliminated from the population. Individuals continuously compete with each other in a population for food, space and light. The one which is better adapted and naturally selected by nature survives and reproduces.

For example, industrial evidence: It is a case of natural selection.
In England, it was observed before industrialisation that white-winged moths were more than dark-winged moths. But the situation became reversed after industrialisation. During preindustrialisation, the tree trunks were covered by white lichens and on white-background darkcoloured moths can be picked up. During post industrialisation, the tree trunks were covered by dust, coal particles and thus became dark. On such trunks, white moths could be easily picked up. Thus, it was found that industrial melanism supports evolution by natural selection.

Q.5.

a. **Explain the process of natural selection that leads to speciation.**

b. List the three different ways in which this process operates in nature. Explain any one of the processes.

Ans.

(a)

- There has been **gradual evolution** of life forms with new forms arising at different periods of history.
- Any population has built-in variations in characteristics which adapt it better to environment.
- The characteristics which enable some populations or individuals to survive better in natural conditions (climate, food, physical factors) would out-breed others **(Survival of the fittest)**.
- Those populations which are better fit (reproductively fit) in an environment will be selected by nature and will survive more **(Natural selection)**.
- Adaptability is inherited and fitness is the end result of ability to adapt and get selected by nature.

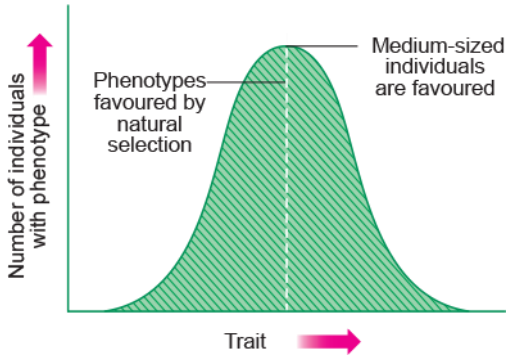
(b) Natural selection is based on following factual observations:

- Limited natural resources.
- Stable population size except seasonal fluctuation.
- Varying characteristics of members of a population.
- Most of the variations are inherited.

Q.6.

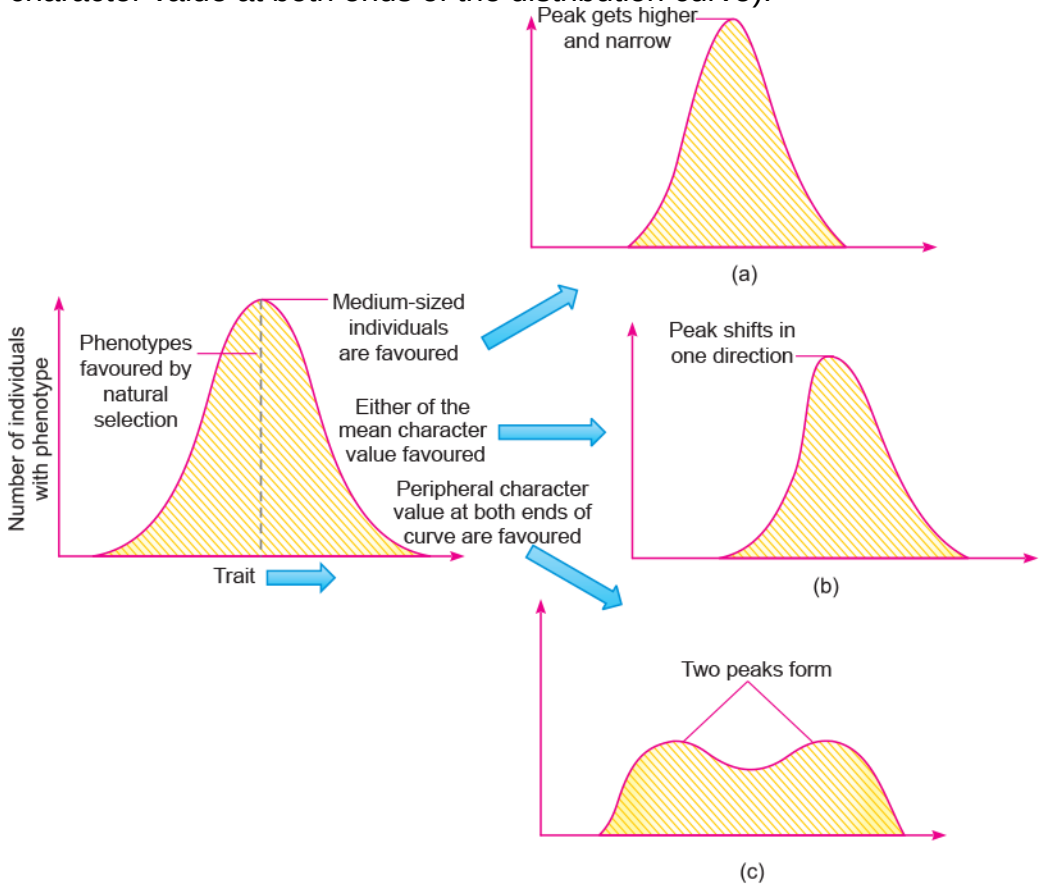
a. Write the Hardy–Weinberg principle.

b. **Explain the three different ways in which natural selection can affect the frequency of a heritable trait in a population shown in the graph given below.**



Ans.

a. Hardy–Weinberg principle states that the gene pool (total genes and their alleles in a population) remains constant, *i.e.*, the allele frequencies in a population are stable and constant from generation to generation. This biological phenomenon is called genetic equilibrium.
b. Natural selection can lead to stabilisation (in which more individuals acquire mean character value), directional change (more individuals acquire value other than the mean character value) or disruption (more individuals acquire peripheral character value at both ends of the distribution curve).



Diagrammatic representation of the operation of natural selection on different traits: (a) Stabilising (b) Directional and (c) Disruptive

Q.7.

a. Describe Hardy-Weinberg's principle.
b. How do variation lead to speciation?
c. How is the genetic equilibrium affected by the variations leading to speciation?

Ans.

a. Refer to Basic Concepts Point 8.

b. Accumulation of small and directional variation over the generations become heritable. This enables better survival. The variant species reproduce and leave greater number of progeny, ultimately forming a new species.

c. As per genetic equilibrium the sum total of all the allelic frequencies in a population is 1. Change of frequency of alleles in a population, due to variation causes disturbance in the genetic equilibrium resulting in speciation (evolution).

Q.8. How does the process of natural selection affect Hardy-Weinberg equilibrium? Explain. List the other four factors that disturb the equilibrium.

Ans.

Factors Affecting Hardy–Weinberg Equilibrium

i. **Gene migration or gene flow:** When individuals migrate to another place or population, new genes or alleles are added to new population and are lost from old population, in turn changing the frequencies. When gene migration occurs many times, it is called **gene flow**.

ii. **Genetic drift:** Changes occurring in frequencies by chance is called **genetic drift**. Sometimes, due to changes in allele frequency in new population, some form a different species. This effect is called **founder effect** and the original drifted population is called **founder**.

iii. **Mutation:** Advantageous mutations lead to new phenotypes and over few generations, result in **speciation**.

iv. **Genetic recombination:** During gametogenesis, variations due to recombination result in new phenotypes.

v. **Natural selection:** Heritable variations that enable survival of the fittest will leave greater number of progeny. Natural selection can have following three effects:
   a. **Stabilisation:** Larger number of individuals acquire mean character value so peak gets higher and narrower.
   b. **Directional change:** Large number of individuals acquire value other than mean character value so peak shifts in one direction.
   c. **Disruption:** Large number of individuals acquire peripheral character values at both ends of the distribution curve and hence 2 peaks are formed.

Q.9.

a. How does Hardy−Weinberg equation explain genetic equilibrium?

b. Describe how does this equilibrium get disturbed which may lead to founder effect.

Ans.

a. Hardy-Weinberg equation is $p^2 + 2pq + q^2 = 1$. This means that the sum total of all the allelic frequencies is 1. In a diploid, p^2 means that the probability an

allele *AA* with a frequency of *p* appear on both the chromosomes of a diploid individual will be p^2 . Similarly of allele aa is q^2 , and of *Aa* is 2*pq*.

b. The equilibrium gets disturbed due to genetic drift which refers to the changes in allele frequencies of a population occurring by chance. The change in allele frequency may be so different that the population becomes a different species, the original population becomes founders and such an effect is called founder effect.

Q.10.

a. Name the primates that lived about 15 million years ago. List their characteristic features.

b.

i. Where was the first man-like animal found?

ii. Write the order in which Neanderthals, *Homo habilis* and *Homo erectus* appeared on earth. State the brain capacity of each one of them.

iii. When did modern *Homo sapiens* appear on this planet?

Ans.

a. Primates called *Dryopithecus* and *Ramapithecus* lived 15 million years ago. Their characteristic features are:

i. They were hairy and walked like gorillas and chimpanzees.

ii. *Ramapithecus* was more man-like.

iii. *Dryopithecus* was more ape-like.

b.

i. First man-like animal was found in Ethiopia and Tanzania.

ii. The order of appearance from the earliest to the latest is:
Homo habilis, Homo erectus, Neanderthals.
The brain capacity of *Homo habilis* is 650–800 cc, of *Homo erectus* is 900 cc and of Neanderthals is 1400 cc.

iii. Modern *Homo sapiens* appeared between 75,000–10,000 years ago.

Q.11. Answer the following questions.

Q. What was proposed by Oparin and Haldane on origin of life? How did S.L. Miller's experiment support their proposal?

Ans. Theory of chemical evolution or Oparin–Haldane theory: This theory states that life originated from pre-existing non-living organic molecules (e.g., RNA, protein, etc.). S.L. miller conducted an experiment where he created conditions similar to primitive atmosphere in a flask like high temperature, reducing atmosphere consisting of HCl, NH3, etc. When an electric discharge was created at 800°C, after a week presence of amino acids and complex molecules like sugars, nitrogen bases, pigments, fats were observed in the flask.

Q. Which human chromosome has (i) maximum number of genes, and which one has (ii) fewest genes?

Ans. Chromosome 1 has most genes (2968) and the Y chromosome has fewest genes (231).

Q. Write the scientific importance of single nucleotide polymorphism identified in human genome.

Ans. This information promises to revolutionise the processes of finding chromosomal locations for disease-associated sequences and tracing human history.

Q.12. Answer the following questions.

Q. Explain "founder effect".

Ans. 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 founder and the effect is called founder effect.

Q. State Oparin and Haldane Hypothesis.

Ans. Oparin–Haldane's theory states that the first life form originated from non-living organic molecules like RNA, protein, etc.

Q. Describe Stanley and Miller's experiment and give its significance.

Ans.

Experimental evidence of chemical evolution/Miller's experiment

- Experiment was performed by S.L. Miller and H.C. Urey in 1953.
- **Experimental set-up:** In a closed flask containing CH_4, H_2, NH_3 and water vapour at 800°C, electric discharge was created. The conditions were similar to those in primitive atmosphere.
- **Observations:** After a week, they observed presence of amino acids and complex molecules like sugars, nitrogen bases, pigments and fats in the flask.
- **Conclusions:.**
  i. It provides experimental evidence for the theory of chemical origin.
  ii. It showed that the first non-cellular form of life was created about 3 billion years ago.
  iii. It showed that non-cellular biomolecules exist in the form of DNA, RNA, polysaccharides and protein.

Q.13. Answer the following questions.

Q. What are fossils? How are they an evidence for evolution?

Ans. Fossils are remains or impression of hard parts of life-forms that existed in past. They are found in rocks.

Study of fossils in different sedimentary layers indicates the geological periods in which they existed and showed that life forms varied over time.

Q. "Anthropogenic action can lead to evolution." Explain with the help of an example.

Ans. Excess use of herbicides, pesticides, etc., has only resulted in selection of resistant varieties in a much lesser time scale. This is also true for microbes against which we employ antibiotics or drugs against eukaryotic organisms/ cell. Hence, resistant organisms/cells are appearing in a time scale of months or years and not centuries. These are examples of evolution by anthropogenic action.

Q.14. Answer the following questions.

Q. Natural selection operates when nature selects for fitness. Explain.

Ans. Natural resources are limited, populations are stable in size, members of a population vary in characteristics even though they look superficially similar. Theoretically, population will increase exponentially but the population sizes in reality are limited thus leading to competition. Only the ones which are fit and adapt themselves are able to survive. They grow at the cost of others and flourish. This was called as natural selection by Darwin.

Q. The rate of appearance of new forms is linked to the lifespan of an organism. Explain with the help of a suitable example.

Ans. According to Darwin, the fitness of an organism is measured by its reproductive ability. Also the appearance of new forms is linked to the lifespan of an organism. The greater its lifespan, the more it can reproduce and hence, greater new forms would appear. This can be observed in the development of dark-winged moths due to industrial melanism.

Excess use of herbicides, pesticides, etc., has only resulted in selection of resistant varieties in a much lesser time scale. This is also true for microbes against which we employ antibiotics or drugs against eukaryotic organisms/ cell. Hence, resistant organisms/cells are appearing in a time scale of months or years and not centuries. These are examples of evolution by anthropogenic action.

Q.15. Answer the following questions.

Q. Write and explain the conclusion Darwin arrived at after observing the variations seen in the beaks of finches during his sea voyage.

Ans. Charles Darwin, based on his observations during a sea voyage around the world in the ship H.M.S. Beagle, concluded the following:

- Varying degrees of similarities can be observed between existing life forms and those that existed millions of years ago.

- There has been gradual evolution of life forms with new forms arising at different periods of history.
- Any population has built-in variations in characteristics which adapt it better to environment.
- The characteristics which enable some populations or individuals to survive better in natural conditions (climate, food, physical factors) would out-breed others (Survival of the fittest).
- Those populations which are better fit (reproductively fit) in an environment will be selected by nature and will survive more (Natural selection).
- Adaptability is inherited and fitness is the end result of ability to adapt and get selected by nature.

Q. Marsupials and Australian placental mammals exhibit convergent evolution. Explain how.

Ans. A number of marsupials, each different from the other evolved from an ancestral stock, but all within the Australian island continent. Placental mammals in Australia also exhibit adaptive radiation in evolving into varieties of such placental mammals each of which appears to be 'similar' to a corresponding marsupial (e.g., Placental wolf and Tasmanian wolf).

Q.16. Answer the following questions.

Q. Explain Darwinian theory of evolution with the help of one suitable example. State the two key concepts of the theory.

Ans. According to Darwin, evolution took place by selection. The rate of appearance of new forms is linked to the life cycle at the life span. Some organisms are better adapted to survive in an otherwise hostile environment (Survival of the fittest). For example, antibiotic resistance in bacteria. When a bacterial population was grown on an agar plate containing antibiotic penicillin, the colonies sensitive to penicillin die, whereas the ones resistant to penicillin survived due to adaptation. Key concepts of the theory are

i. Branching descent
ii. Natural selection

Q. Mention any three characteristics of Neanderthal man that lived in near east and central Asia.

Ans. Characteristics of Neanderthal man:

i. Their brain size was 1400 cc.
ii. They used hides to protect their bodies.
iii. They buried their dead

Q.17. Answer the following questions.

Q. How do the observations made during moth collection in pre- and post-industrialized era in England support evolution by Natural Selection?

Ans. Industrial melanism:

- In England, before industrialisation, white-winged moths were more in number than dark-winged moths.
- But after industrialisation, dark-winged moths became more in number than white-winged moths.
- This is because during industrialisation, the tree trunks covered by white lichens became dark due to deposition of dust and coal particles.
- As a result, white-winged moths could be easily picked up by predators from the dark background and dark-winged moths survived.

Q. Explain the phenomenon that is well represented by Darwin's finches other than natural selection.

Ans. The process of evolution of different species in a given geographical area starting from a point, radiating to other areas of geography (habitats) is called adaptive radiation. Finches evolved in the same island from original seed eating features. Many other altered beaks arose enabling them to became insectivorous and vegetarian finches.

Q.18. Answer the following questions.

Q. Describe Hardy-Weinberg Principle.

Ans.

- This principle states that allelic frequencies in a population are stable and remains constant from generation to generation, *i.e.,* gene pool (total number of genes and their alleles in a population) is constant. This is called genetic equilibrium or Hardy–Weinberg equilibrium.
- It can be expressed as $p^2 + 2pq + q^2 = 1$ where p and q are frequencies of different alleles.
- Disturbances in genetic equilibrium results in evolution.

Q. List any four factors which affect genetic equilibrium.

Ans.

- Gene migration or gene flow
- Genetic drift
- Mutation
- Genetic recombination

Q. Describe Founder effect.

Ans. Genetic drift: Changes occurring in frequencies by chance is called genetic drift. Sometimes, due to changes in allele frequency in new population, some form a different species. This effect is called founder effect and the original drifted population is called founder.

Q.19. Amswer the following questions.

Q. List the various causes of variations in the progeny of the population.

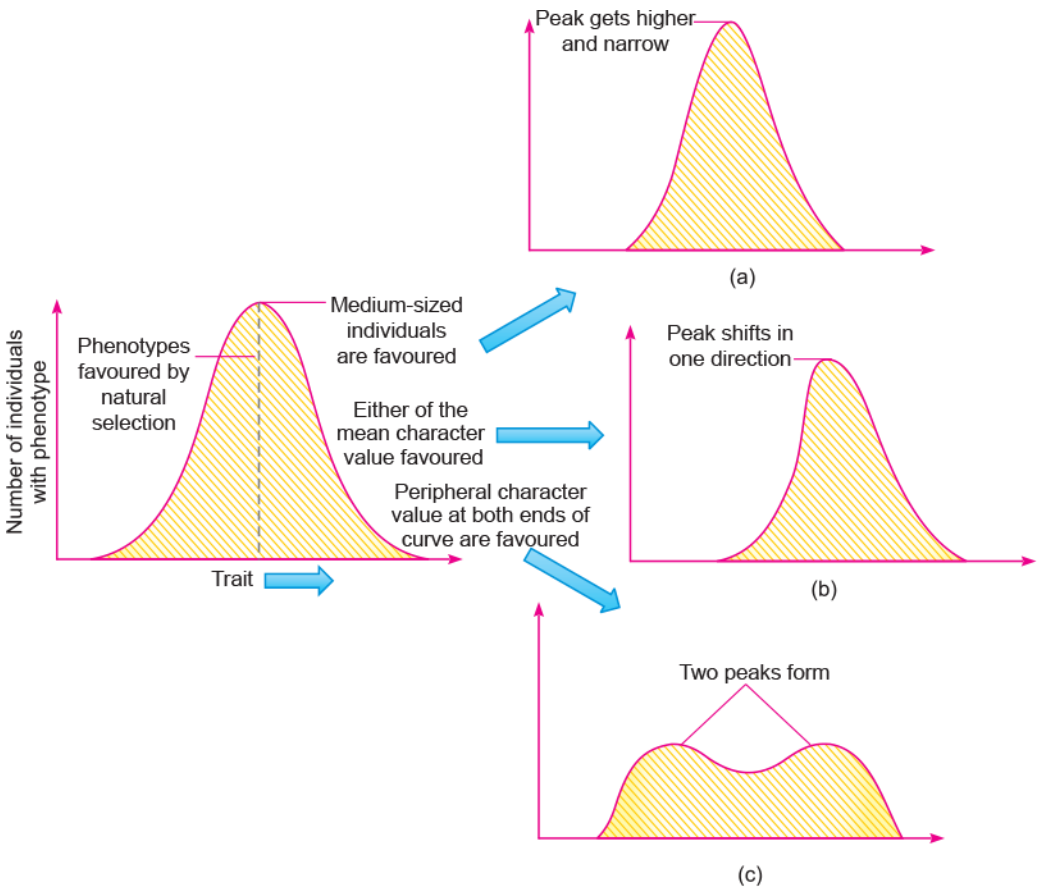
Ans. The various causes of variation are :

i. Gene migration or gene flow
ii. Genetic drift
iii. Mutuation
iv. Genetic recombination
v. Natural selection

Q. Describe the three different ways in which the natural selection operates in nature with regard to organic evolution.

Ans. Natural selection: Heritable variations that enable survival of the fittest will leave greater number of progeny. Natural selection can have following three effects:

a. **Stabilisation:** Larger number of individuals acquire mean character value so peak gets higher and narrower.
b. **Directional change:** Large number of individuals acquire value other than mean character value so peak shifts in one direction.
c. **Disruption:** Large number of individuals acquire peripheral character values at both ends of the distribution curve and hence 2 peaks are formed.



Diagrammatic representation of the operation of natural selection on different traits:(a) Stabilising (b) Directional and (c) Disruptive

Long Answer Questions (OIQ)

[5 Marks]

Q.1. Describe Miller and Urey's experiment, along with the product obtained. What is the significance of this experiment?

Ans. Experimental evidence of chemical evolution/Miller's experiment

- Experiment was performed by S.L. Miller and H.C. Urey in 1953.
- **Experimental set-up:** In a closed flask containing CH_4, H_2, NH_3 and water vapour at 800°C, electric discharge was created. The conditions were similar to those in primitive atmosphere.
- **Observations:** After a week, they observed presence of amino acids and complex molecules like sugars, nitrogen bases, pigments and fats in the flask.
- **Conclusions:.**
  i. It provides experimental evidence for the theory of chemical origin.

ii. It showed that the first non-cellular form of life was created about 3 billion years ago.
iii. It showed that non-cellular biomolecules exist in the form of DNA, RNA, polysaccharides and protein.

Q.2. Show that Darwin's natural selection is based on natural observation, with an example for each.

Ans.

i. The resources of the nature are limited, so the size of population of a species is limited.
ii. The size of the population is fixed, except for some seasonal fluctuations.
iii. Each and every member of a population shows variation for every character.
iv. It is found in microbial or bacterial population growing in a culture that if everybody in a population reproduces to its maximum capacity, the population will grow exponentially.
v. The population size in an ecosystem is limited–due to competition among individuals for limited resources and only those fit individuals utilise the resources at the cost of other to reproduce.
Darwin suggested that nature creates some pressure on the population which eliminates some individuals and some better adapted ones survive. This natural pressure at each and every generation creates some small variation in a population, accumulation of which for many generations leads to origin of new species.

Q.3. Trace the origin and evolution of Man.

Ans. Evolution of Man

Human Ancestors	**Time of Origin**	**General FeaturesGeneral Features**
Dryopithecus	25 mya	Ape-like, hairy, arms and legs of same length, large brain, ate soft fruits and leaves, walked like gorillas and chimpanzees.
Ramapithecus	15 mya	More man-like, walked more erect, teeth like modern man.
Australopithecus	2 mya	Fossils found in Tanzania and Ethiopia, man-like primates, 4 feet tall, walked upright, ate fruit, hunted with stone weapons, brain capacity was 400–600 cc.
Homo habilis	2 mya	Fossils found in East Africa, first human-like being, brain

		capacity 650–800 cc, did not eat meat.
Homo erectus(Java man)	1.5 mya	Fossils found in Java, brain capacity 900 cc, ate meat.
Homo sapiensneanderthalensis(Neanderthal man)	100,000–40,000year ago	Fossils found in east and central Asia, brain size 1400 cc, used hides to protect body, buried their dead.
Homo sapiens(Modern man)	75,000–10,000years ago	Developed cave art, agriculture, started human civilisation.

Q.4. Describe the evidence of evolution from comparative anatomy and morphology?

Ans. Morphological and comparative anatomical evidences

- The phylogenetic history can be revealed by comparative study of external and internal structures.
- The organs with same structural design and origin but different functions are called **homologous organs**. For example, the forelimbs of some animals like whales, bats and cheetah have similar anatomical structure, *i.e.*, humerus, radius, ulna, carpals, metacarpals and phalanges.
- Due to different needs, some structures developed differently. This is called **divergent evolution**.
- Other examples include vertebrate hearts or brains in animals; thorn and tendrils of *Bougainvillea* and cucurbita in plants.
- The organs which are anatomically different but functionally similar are called **analogous organs**. For example, wings of butterfly and birds.
- Due to same function, different structures evolve similarly. This is called **convergent evolution**.
- Other examples include eye of octopus and mammals; flippers of penguins and dolphins; sweet potato (root modification) and potato (stem modification).