CHAPTER

7 EVOLUTION

Syllabus

➢ ***Evolution:*** *Origin of life; biological evolution and evidences for biological evolution (paleontology, comparative anatomy, embryology and molecular evidences); Darwin's contribution, modern synthetic theory of evolution; mechanism of evolution - variation (mutation and recombination) and natural selection with examples, types of natural selection; Gene flow and genetic drift; Hardy - Weinberg's principle; adaptive radiation; human evolution.*

Chapter Analysis

List of Topics		2016		2017		2018
		D	OD	D	OD	D/OD
Origin of Life	• Experiment of Louis Pasteur • Oparin Haldane Theory	1 Q (3 M)			1 Q (1 M)	
Evidences of Evolution	• Homologous and analogous structure • Evidences of natural selection + Darwin Finches (Adaptive radiation)		1 Q (3 M)	1 Q (5 M)		1 Q (3 M)
Biological Evolution	• Darwin's Theory of natural selection			1 Q (3 M)		
Mechanism of Evolution	• Saltation	1 Q (1 M)				
Hardy Weinberg Principle				1 Q (3 M)		1 Q (2 M)
Brief account of evolution				1 Q (2 M)		
Origin and evolution of Man			1 Q (1 M)		1 Q (3 M)	1 Q (1 M)

- *On the basis of above analysis, it can conclude that Analogous and homologous structures with examples, Darwin's theory of natural selection, Darwin finches (adaptive radiation), Oparin Haldane theory, Saltation, Louis Pasteur experiment, human evolution and evolutionary significance of animals are the most important topics of this chapter.*

TOPIC-1
Origin of Life on Earth and Various Related Evidences

Revision Notes

➢ **Introduction**
- Evolution is an orderly change from one form to another.
- **Evolutionary Biology :** Study of history of development of newer life forms from pre-existing ones.

TOPIC - 1
Origin of Life on Earth and Various Related Evidences .... **P. 174**

TOPIC - 2
Evolutionary Theories, It's Mechanism and Evolution of Man .... **P. 190**

➢ **Origin of Life**
- Big Bang Theory states that universe originated about 20 billion years ago by a thermonuclear explosion (big bang) of a dense entity.
- The earth was formed about 4.5–5 billion years ago.
- There was no atmosphere on early earth.
- Water vapour, CH_4, CO_2 & NH_3 released from molten mass covered the surface.

$$H_2O \rightarrow H_2 + O_2$$
$$NH_3 + O_2 \rightarrow \text{water}$$
$$CH_4 + O_2 \rightarrow CO_2$$

- Then the ozone layer was formed.
- As it cooled, the water vapour condensed to fell as rain to form oceans.

➢ **Theories of Origin of Life**

(i) Abiogenesis states that life originated from simple organic compound :
- It states that life came out of decaying and rotting matter like straw, mud, etc.
- **Louis Pasteur** (1864) demonstrated that life comes from pre-existing life and dismissed abiogenesis theory
- He showed that in pre-sterilized flasks, life did not come from killed yeast while in another flask open to air, new living organisms arose.
- **Abiogenesis -** It states that life originated from simple organic compound.

(ii) Biogenesis
- It was proposed by **Francisco Redi, Spallanzani** and **Louis Pasteur**.
- It states that life originates from pre-existing life.

(iii) Cosmic Theory (Theory of Panspermia)
- It states that the units of life (spores) were transferred to different planets including earth.

(iv) Theory of Special Creation
- It states that living & non-living things are created by some supernatural power (God).

(v) Theory of Chemical Evolution of life
- It was proposed by **Oparin** and **Haldane**.
- It states that the first form of life was originated from non-living inorganic and organic molecules such as CH_4, NH_3, H_2O, sugars, proteins, nucleic acids, etc.
- "Abiogenesis first, but biogenesis ever since".
- **Two hypothetical proposals of Oparin-Haldane's theory are :**
  - **(i) Chemical evolution** from inorganic to organic molecules.
  - **(ii) First life** formed by assembly and interaction of organic molecules.
- This theory is also known as primary abiogenesis. It took place only once.

➢ **Urey-Miller Experiment**
- **Harold Urey** & **Stanley Miller** conducted an experiment to prove theory of chemical evolution.
- They created a condition similar to that of primitive earth (*i.e.* high temperature, volcanic storms, reducing atmosphere devoid of oxygen but containing compounds of carbon, hydrogen, nitrogen and water.
- They made electric discharge in a closed flask containing CH_4, NH_3, H_2 and water vapour at 800° C.
- As a result, some amino acids were formed.
- In similar experiments, others observed formation of sugars, nitrogen bases, pigments and fats.
- First non-cellular form of life originated 3 billion years ago.
- They were RNA, proteins, polysaccharides etc.

➢ **Evolution of Life Forms – Various Theory**
- Based on observations made during a sea voyage in a survey ship called H.M.S. Beagle round the world, **Charles Darwin** concluded that existing living forms share similarities to varying degrees not only among themselves but also with life forms that existed millions of years ago.
- There had been extinctions of different life forms in the years gone by just as new forms of life, arose at different periods of history of earth.
- There has been gradual evolution of life forms due to variation in characteristics.
- Those characteristics which enable some to survive better in natural conditions (climate, food, physical factors etc.) would outbreed others that are less-endowed to survive under such natural conditions or fitness of the individual or population.
- The fitness, according to Darwin, refers ultimately and only to reproductive fitness.
- Hence, those who are better fit in an environment, leave more progeny than others.
- These therefore, will survive more and hence are selected by nature.
- He called it natural selection and implied it as a mechanism of evolution.

- **Alfred Wallace**, a naturalist who worked in Malay Archipelago also came to similar conclusions around the same time.
- All the existing life forms share similarities and share common ancestors.
- However, these ancestors were present at different periods in the history of earth.
- The geological history of earth closely correlates with the biological history of earth.

➢ **Evidences for Evolution**

1. Paleontological Evidences

- The study of fossils is known as paleontology.
- Fossils are remnants of life forms or the parts found preserved in rocks (earth crust).
- Fossils are written documents of evolution.
- **Significance of Fossils**

(a) To study phylogeny (evolutionary history or race history) *e.g*. Horse evolution.

(b) To study the connecting link between two groups of organisms *e.g*. *Archaeopteryx* having reptilian and avian characteristics.

(c) To study about extinct animals *e.g*. Dinosaurs.

(d) To study about geological period by analyzing fossils in different sedimentary rock layers. The study showed that life forms varied over time and certain life forms are restricted to certain geological time spans.

2. Morphological and Anatomical Evidences

- Comparative anatomy and morphology evidences showed that different forms of animals have some common structural features. This can be explained as follows :

(a) Homologous Organs and Homology

- Homologous organs are the organs having fundamental similarity in structure and origin but different in functions. This phenomenon is called homology. *e.g*. Human hand, Whale's flippers, Bat's wings, and Cheetah's foot.
- All these perform different functions but are constructed on the same fundamental plan.
- Homology can be seen in skeleton (*e.g*. humerus, radius, ulna, carpals, meta-carpals & phalanges), heart, blood vessels, excretory system, brain, etc.

- **Homology in Plants :**

(i) The thorns of *Bougainvillea* and tendrils of *Cucurbita*.

(ii) The origin of homologous organs is due to divergent evolution.

(iii) The divergent evolution is the process by which related species become less similar in order to survive and adapt in different environmental conditions.

(iv) Homology indicates common ancestry.

(b) Analogous Organs and Analogy

- Analogous organs are the organs having similar function but different structure and origin. This phenomenon is called analogy.
- **Examples**

(i) Wings of insects (formed of a thin flap of chitin) and wings of birds (modified forelimbs).

(ii) Eyes of Octopus (retina from skin) and mammals (retina from embryonic brain).

(iii) Flipper of Penguins and Dolphins.

(iv) Sweet potato (modified root) and Potato (modified stem).

(v) Trachea of insects (from ectoderm) and lungs of vertebrates (from endoderm).

- The origin of analogous organs is due to convergent evolution.
- The convergent evolution is the process by which unrelated species become more similar in order to survive and adapt in similar environmental conditions.

3. Adaptive Radiation (Biogeographical Evidences)

- Adaptive radiation (evolution by adaptation) is the evolution of closely related species in a given geographical area starting from a point. *e.g.*

(a) Darwin's finches (seen in Galapagos Islands).

(b) Australian marsupials.

(c) Placental mammals in Australia.

- When more than one adaptive radiation occur in an isolated geographical area, this leads to convergent evolution *e.g*. Australian Marsupials and Placental mammals.

4. Biochemical Evidences

- Similarities in proteins and genes.
- Similarities in other biomolecules and metabolism.

5. **Evidences for Evolution by Natural Selection**
   - Natural selection is the process by which the organisms that are best suited for their environment survive and reproduce.
   - **Examples of natural selection : Industrial Melanism (In England):**

Before Industrialization (1850s):
- There were more white winged moths (*Biston betularia*) on trees than dark winged or melanised moths (*Biston carbonaria*).
- **Reason :** White coloured lichen covered the trees. In that background the white winged moths survived but the dark coloured moths were easily spotted out and picked out by predators.

After industrialization (1920) :
- More dark winged moths and less white winged moths.
- **Reason :** The tree trunks became dark due to pollution by industrial smoke and soot. No growth of lichens. Under this condition the white winged moth did not survive because the predators identified them easily against dark background. Dark winged moth survived because of suitable dark background.
- Excess use of herbicides, pesticides, antibiotics or drugs, etc. resulted in selection of resistant varieties (Natural selection by anthropogenic action).

IMPORTANT DIAGRAM

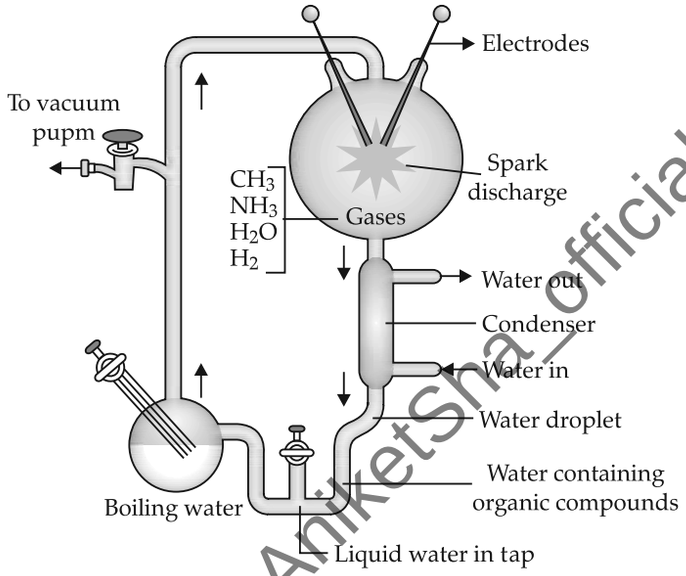


Fig 7.1: Miller and Urey's Experiment

Very Short Answer Type Questions (1 mark each)

Q. 1. State a reason for the increased population of dark coloured moths with the loss of lichens (on tree barks) during industrialization period in England.

U **[Delhi Set-I, III 2015]**

Ans. During industrialization period in England the lichens got wiped out due to air pollution and tree trunks became dark due to industrial smoke so that the dark coloured moths could camouflage in the dark background without any risk of predation. Thus, they escaped predation, survived and therefore increased in population, whereas white winged moth did not survive due to predation and industrial pollution. **1**

[CBSE Marking Scheme, 2015]

Detailed Answer :

Industrialisation caused air pollution, produced excessive smoke and caused the darkening of tree trunks. Because in the dark coloured background, the dark coloured moths could camouflage themselves, thus, they escape from predation and survived resulting in their increase in population. White winged moths were easily spotted by predators and eliminated. This is due to natural selection because dark coloured moths were better suited to the changed environment and thus survived.

Commonly Made Error

- Many students fail to write the correct explanation. Some important terms like Natural selection are missed.

Answering Tip

- Always use biological/technical terms rather than common names. Use correct spelling of biological terms.

Q. 2. Why are analogous structures, a result of convergent evolution ?

U **[Outside Delhi Set-II, 2014]**

Ans. Analogous structures are a result of convergent evolution because they are not anatomically similar structures though they perform similar functions. **1**

[CBSE Marking Scheme, 2014]

Detailed Answer :

Analogous structures are said to be the result of convergent evolution because, though they perform a similar function but they are different in their structural details and origin *e.g.* wings of insects, birds and bats.

Answering Tip

- Convergent and divergent evolution should be properly correlated with analogous and homologous organs.

Q. 3. Identify the examples of convergent evolution from the following :

(i) Flippers of penguins and dolphins

(ii) Eyes of octopus and mammals

(iii) Vertebrate brains R **[Delhi Set-I, 2013; [Delhi Set-I, Comptt. 2012]**

Ans. Flippers of penguins and dolphins and Eyes of octopus and mammals . **1**

Q. 4. Identify the examples of homologous structure from the following :

(i) Vertebrate hearts.

(ii) Thorns of *Bougainvillea* and tendrils of *Cucurbita.*

(iii) Food storage organs in potato and sweet potato

A **[Delhi Set II, 2013]**

Ans. (i) Vertebrate hearts.

(ii) Thorns of *Bougainvillaea* and tendrils of *Cucurbita* are homologous organs. They are similar in origin but different in function. They indicate common ancestry and divergent evolution. **1**

Answering Tip

- Learn differences between homologous and analogous organs in a tabular form along with examples for better understanding and retention.

Q. 5. "Sweet potato tubers and potato tubers are the result of convergent evolution." Justify the statement. U **[Delhi Set-III, 2013]**

Ans. Sweet potato tuber is a root modification and potato tuber is a stem modification but they show convergent evolution because both of them are unrelated and perform the functions similar like storage of food and vegetative reproduction. **1**

AI **Q. 6. 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 ?** U **[Delhi Set-I, 2012]**

Ans. Similar in function (fly) / different in structure and origin / analogous organs, convergent evolution.

[CBSE Marking Scheme, 2012] ½ + ½

Detailed Answer :

Wings of a bird and a bat perform the same function of flying despite their structural dissimilarity. This infers that they are analogous organs and are the result of convergent evolution. **1**

Q. 7. State the significance of the study of fossils in evolution. A **[Delhi Set-II, 2012]**

Ans. Fossils represent extinct organisms.

Fossils show life forms restricted to certain geological time spans existing in the past.

Fossils show ancestry of present day organisms.

Some of the fossils are the connecting link between two groups of organisms. **1**

Q. 8. State the significance of biochemical similarity amongst diverse organisms in evolution.

A **[Delhi Set-III, 2012]**

Ans. The **biochemical similarities** in proteins and genes performing a given function among diverse organisms gives a clue that they **share a common ancestry as** evolution of diverse group of organisms. **1**

Q. 9. Comment on the similarity between the wings of a cockroach and the wings of a bird. What do you infer from the above with reference to evolution ?

A **[Outside Delhi Set-I, 2012]**

Ans. (i) The wings of a bird and the wings of a cockroach are analogous organs because these organs are used for flying.

(ii) They are different in structure. Each has evolved from a separate ancestral population as a means of more efficient mode of locomotion. **½ + ½ = 1**

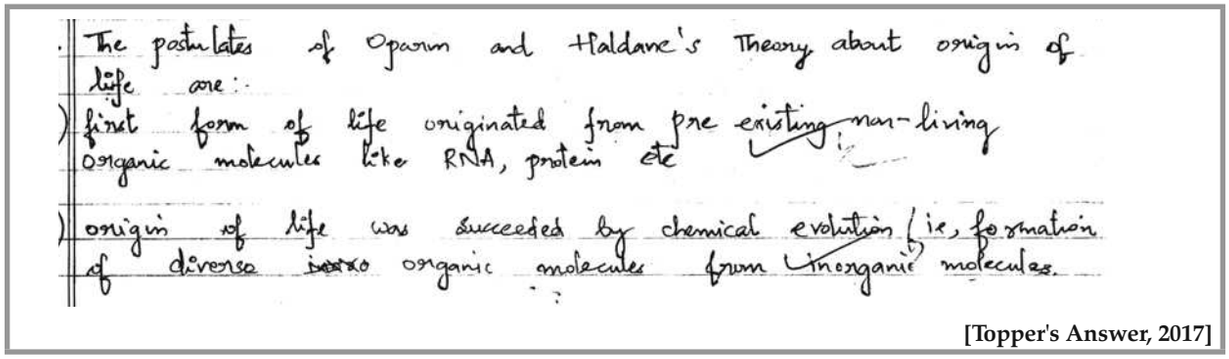
AI **Q. 10. State two postulates of Oparin and Haldane with reference to origin of life.**

R **[Outside Delhi - 2017, Set - I, II]**

Ans. (i) First form of life could have come from pre-existing non-living organic molecules such as RNA & Protein. ½

(ii) Formation of life was preceded by chemical evolution or formation of diverse organic molecules from inorganic constituents. **[CBSE Marking Scheme, 2017]** ½

OR


The postulates of Oparin and Haldane's Theory about origin of life are:
1) first form of life originated from pre existing non-living organic molecules like RNA, protein etc
2) origin of life was succeeded by chemical evolution (ie, formation of diverse ~~intro~~ organic molecules from inorganic molecules.

[Topper's Answer, 2017]

Answering Tip

- Answers should be specific and precise.

Q. 11. Name the type of evolution that has resulted in the development of structures like wings of butterfly and bird. What are such structures called.

R **[Delhi Set-II, Comptt., 2014]**

Ans. Convergent evolution.

Such structures are called analogous structures. **1**

Q. 12. Write the term used for resemblance of varieties of placental mammals to corresponding marsupials in Australia. R **[Delhi Set-I Comptt. 2013]**

Ans. Adaptive radiation. **1**

Q. 13. Name the scientist who disproved the spontaneous generation theory. R **[Delhi 2010]**

Ans. Louis Pasteur disproved the theory of spontaneous generation. He proved biogenesis. **1**

Answering Tip

- Learn names of scientists with correct spelling.

Short Answer Type Questions-I

(2 marks each)

Q. 1. Is sweet potato analogous or homologous to potato tuber ? Give reasons to support your answer.

A **[Delhi Set-I, Comptt. 2015]**

Ans. Analogous, sweet potato-root modification, potato tubers – stem modification. They are structurally different but both are functionally similar as they both store food. **1+1**

[CBSE Marking Scheme, 2015]

Q. 2. Explain with the help of an example the type of evolution homology is based on ?

A **[Delhi Set-II, Comptt. 2015]**

Ans. Homology is based on divergent evolution. These have similar anatomical structure but perform different function.

Example : Thorns of *Bougainvillea* and tendrils of *Cucurbita*/Forelimbs of human and horse (any other appropriate example).

[CBSE Marking Scheme, 2015] 1+1=2

Detailed Answer :

Homology is based on divergent evolution. It indicates the common ancestry. The homologous organs, though perform different functions but have the same fundamental structure. During development these organs follow the same basic plan of organization but however in adult condition they get modified to perform different function in response to adaptation according to different environmental conditions *e.g.* the forelimbs of man, whale and bat. They have same structural plan but have different functions.

Q. 3. What is chance mutation ? Explain this phenomenon using application of D.D.T. as an example.

A **[Delhi Set-III, Comptt. 2015]**

Ans. DDT is an insecticide-kills most of the insects but some become resistant varieties in much less time scale of just month or years. It is a chance event in nature-so chance mutation. **4×½=2**

[CBSE Marking Scheme, 2015]

Q. 4. State the evolutionary relationship giving reasons between the thorn of *Bougainvillea* and tendril of cucurbit.

U **[Outside Delhi Set-I, Comptt. 2015]**

Ans. Divergent evolution/Homologous organs. Similar in origin but perform different function. **1+1=2**

[CBSE Marking Scheme, 2015]

Detailed Answer :

The thorn of *Bougainvillea* and tendril of cucurbits are homologous structures as both are similar in structure and origin but have different functions. Both of them arise from the axil of leaf and have anatomical similarity. Thorn provide protection and tendril gives support. Divergent evolutionary relationship has brought such similarity between them.

Q. 5. (i) Select the homologous structures from the combinations given below:

(a) Forelimbs of whale and bat

(b) Tuber of potato and sweet potato

(c) Thorns of *Bougainvillea* and tendrils of *Cucurbita*.

(ii) State the kind of evolution they represent

R **[Outside Delhi Set-I, 2015]**

Ans. (i) (a) Fore limbs of whale and bat and **(b)** Thorns of *Bougainvillaea* and tendrils of *Cucurbita* are homologous organs.

(ii) They represent divergent evolution as they have same fundamental structure, common ancestry but different functions. **1+1**

Q. 6. 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 *Cucurbita.*

(iv) Forelimbs of Bat and Whale.

R **[Outside Delhi Set-III, 2014]**

Ans. (i) & **(ii)** Analogous.

(iii) & **(iv)** Homologous. ½ × 4 = 2

[CBSE Marking Scheme, 2014]

Commonly Made Error

- Students get confused between *homologous* and *analogous* structures.

Answering Tip

- Homologous and Analogous organs should be discussed with respect to their origin and functions. Merely giving a list of these organs does not help in proper learning.

Q. 7. What do the forelimbs of whales, bats and cheetah with respect to evolution signify ? Provide one such example in plants.

R **[Foreign Set - I, II, 2017]**

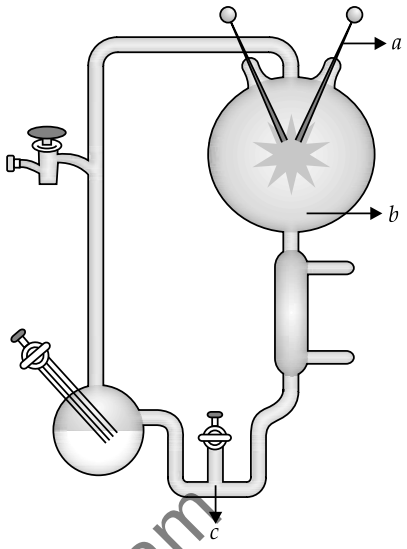
Ans. Homologous organs or divergent evolution. 1

Thorns of *Bougainvillea* and tendrils of *Cucurbita* / any other suitable correct example. 1

[CBSE Marking Scheme, 2017]

Q. 8. Name the scientist who had used the set-up shown below. Write the purpose of 'a' in the set-up and the conclusion the scientist arrived at.

R **[Delhi Set-I, Comptt. 2013]**



Ans. Name of the scientist is S.L. Miller.

Purpose of 'a' is to supply electric discharge as it is a substitute of thundering.

Conclusion : Life originates from pre-existing life. It proved the chemical evolution of life.

[CBSE Marking Scheme 2013] 2

Q. 9. The figure given in question no. 8 represents Miller's apparatus used for his experiment. Name the chemicals found in the samples drawn from 'c'. How did this experiment support evolution ?

[Outside Delhi Set-I, Comptt. 2013]

Ans. Chemicals found in the samples drawn from 'c' are sugar, proteins and amino acids.

It provided experimental evidences for the theory of chemical evolution of life. It proved that life originates from pre-existing life. **2**

Answering Tip

- Practice self-explanatory diagrams of Urey and Miller experiment with proper labelling, arrows and headings.

AI **Q. 10. Mention the contribution of S.L. Miller's experiments on Origin of Life.**

R **[Outside Delhi Set-II, 2013]**

Ans. S.L. Miller created an environment in a 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. **1 + 1 = 2**

Commonly Made Error

- Students fail to mention the composition of gaseous mixture in the flask.

Q. 11. Write the Oparin and Haldane's hypothesis about the origin of life on earth. How does meteorite analysis favour this hypothesis?

R **[Outside Delhi Set-III, 2013]**

Ans. Oparin–Haldane theory of chemical evolution states that life originated from pre-existing non-living organic molecules.

In 1953, S.L. Miller observed formation of amino acids from CH_4, H_2, NH_3 and water vapour at 800°C.

It states that life originated from pre-existing non-living organic molecules (*e.g.*, RNA, protein, etc.). When the meteorites were analysed, there were similar compounds which conclude that similar process is going on elsewhere in the space. **2**

Q. 12. List two main propositions of Oparin & Haldane.

R **[Outside Delhi Set-I, 2013]**

Ans. **(i)** Chemical evolution from inorganic molecules to organic molecules.

(ii) First life formed by assembly and interaction of organic molecules. **1 × 2 = 2**

Q. 13. What does the comparison between the eyes of octopus and those of mammals say about their ancestry and evolution ?

U **[Outside Delhi Set-I, Comptt. 2013]**

Ans. The eyes of octopus and those of mammals show convergent evolution. They are different in origin and structures which have evolved for the same function and hence have similarity. They are thus analogous structures and they do not share any common ancestry and are thus a result of convergent evolution. **2**

Q. 14. How do Darwin's finches illustrate adaptive radiation ? A **[CBSE SQP, 2013, 2012]**

Ans. Original stock of seed-eating finches migrated to different habitats (of Galapagos Islands), adapted to different feeding methods by altered beak structure and evolved into different types of finches. **2**

Answering Tip

- Understand the concept of adaptive radiation carefully.

Q. 15. Choose two pairs of homologous structures from the following and mention why they are so called?

(i) Heart of humans and monkeys

(ii) Eyes of octopus and mammals

(iii) Thorns of *Bougainvillaea* and tendrils of cucurbits

(iv) Flippers of penguins & dolphins.

[Delhi Set-I, Comptt. 2012]

Ans. **Following are homologous organs :**

(iii) Thorns of *Bougainvillaea* and tendrils of cucurbits.

(iv) Flippers of penguins and dolphins.

They are homologous organs because they are similar in origin and fundamental structural plan but due to their different need they have developed differently, hence different in functions. They indicate divergent evolution. **2**

Q. 16. Divergent evolution leads to homologous structures. Explain with the help of an example.

U **[Delhi Comptt. 2011]**

Ans. Development of different functional structures from a common ancestral form due to their migration to different habitats and adaptation to new requirements is called divergent or adaptive radiation.

For example : Darwin's finches of Galapagos Islands had common ancestors but now have different types of modified beaks according to their food habits. **2**

Q. 17. Select two pairs from the following which exhibit divergent evolution. Give reasons for your answers.

(i) Forelimbs of cheetah and mammals

(ii) Flippers of dolphins and penguins.

(iii) Wings of butterflies and birds.

(iv) Forelimbs of whale and mammals.

[Outside Delhi, Set-III, 2015]

Ans. **(i)** Forelimbs of cheetah and mammals.

(iv) Forelimbs of whales and mammals.

All these animals show similarities in pattern of bones of forelimb but they perform different functions. They have similar anatomical structure. Hence, the same structural organs in these animals have developed in different directions because of adaptations to their different requirements. This shows thus the divergent evolution and that the structures/ organs are homologous. **2**

AI **Q. 18. How does palaeontological evidence support the evolution of life on earth.**

U **[Delhi Set-I, Comptt., 2013]**

Ans. Fossils are the remains of life forms of the part preserved in the rock. The study of fossils is called paleontology. Rock sediments of different ages contain fossils of different types. Early rocks contain fossils of simple organisms while recent rocks contain fossils of complex organisms and some contain extinct organisms. Study of fossils in different sedimentary layers indicate the geological period in which they existed and accordingly also indicate the evolutionary changes in the organisms. Hence, new forms of life evolved at different geologic times in the history of earth. **2**

Q. 19. Write the technical term that describes each one of the following statements with reference to their evolution :

(i) Microbes developing resistance to antibiotics in a much lesser time scale.

(ii) Resemblance of varieties of placental mammals to corresponding marsupials in Australia.

U **[Delhi Set-II, Comptt. 2017]**

Ans. **(i)** Evolution by anthropogenic action i.e. by human activities.

(ii) Adaptive radiation (convergent evolution).

1 + 1 = 2

[CBSE Marking Scheme, 2017]

Short Answer Type Questions-II (3 marks each)

AI **Q. 1. Differentiate between homology and analogy. Give one example of each.**

U **[Outside Delhi Set-I, 2016]**

Ans.

Sr. No	Homology	Analogy
(i)	Organisms having the same structure developed along different directions due to adaptations / different functions.	Different structures having the same function (in different organisms).
(ii)	Result of divergent evolution.	Result of convergent evolution.
(iii)	Indicates common ancestry.	Does not indicate common ancestry.
(iv)	Anatomically same structures.	Anatomically different structures. **(Any two) 1+1=2**
	Example : Forelimbs of whale, bats, cheetah and human // Thorns of *Bougainvillea*, tendrils of cucurbits	**Example :** Wings of butterfly and birds // Sweet potato and potato **1**

[CBSE Marking Scheme, 2016] 3

Detailed Answer :

Sr. No.	Homology	Analogy
(i)	The organs, which have similar structure origin but different function are called homologous organs. The phenomenon is known as homology.	The organs which have same function but are different in their origin and structure are called analogous organs. The phenomenon is known as analogy.
(ii)	They are the result of divergent evolution and have common ancestry.	They are the result of convergent evolution and do not share any common ancestry.
(iii)	**Example :** Forelimbs of humans, dog, cheetah and flippers of whale.	**Example :** Wings of birds and wings of insects. **3**

Q. 2. Differentiate between divergent and convergent evolution. Give one example of each.

U **[Outside Delhi Set-II, 2016]**

Ans. Difference between divergent and convergent evolution :

Sr. No.	Divergent evolution	Convergent evolution
(i)	Same structure developed along different direction.	Different structures evolving for the same function.
(ii)	Due to adaptation to different needs.	Due to adaptation to meet similar needs. **1 + 1 = 2**
	Example : **(a)** Vertebrates heart & brain. **(b)** Thorn of *Bougainvillea* and tendrils of cucurbita. **(c)** Fore limbs of whales, bat, cheetah, humans. **(Any one example)**	**Example :** **(a)** Wing of bird & insects. **(b)** Potato & sweet potato. **(c)** Eye of Octopus & mammals. **(d)** Flippers of Penguins & dolphin. **(Any one example)**

[CBSE Marking Scheme, 2016] ½ × 2 = 1

Detailed Answer :

Difference between divergent and convergent evolution :

Sr. No.	Divergent evolution	Convergent evolution
(i)	Divergent evolution is the process by which related species become less similar in order to survive and adapt in different environmental condition.	Convergent evolution is the process by which unrelated species become more similar in order to survive and adapt in similar environmental condition.
(ii)	Here, the same structure evolves in different directions in different organisms.	Here, different structures evolve in the same direction in different organisms.
(iii)	**Example :** Forelimbs of whales, bats, cheetah and humans perform different functions.	**Example :** Wings of butterfly and of birds. Potato and sweet potato.

1+1+1

Q. 3. How do homologous organs represent divergent evolution ? Explain with the help of a suitable example A **[Outside Delhi Set-III, 2016]**

Ans. Organs with similar structure / same ancestry / anatomically same / same origin developed along different directions due to adaptation / different needs to perform different functions.

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 needs / to perform different functions.

(Any other correct example) 3

[CBSE Marking Scheme, 2016]

Detailed Answer :

Homologous organs are the organs having fundamental similarity in structure and origin but different function. They represent a case of divergent evolution. Divergent evolution is the process by which related species become less similar in order to survive and adapt in different environmental condition.

For example : human hand, Whale's flippers, Bat's wing and Cheetah's foot. All these perform different function but are constructed on the same plan. Thus, in these animals, the same structure developed along different directions due to adaptations to different needs. **3**

Q. 4. (a) Differentiate between analogous and homologous structures.

(b) Select and write analogous structures from the list given below:

(i) Wings of butterfly and birds

(ii) Vertebrate hearts.

(iii) Tendrils of Bougainvillea and Cucurbita

(iv) Tuber of sweet potato and potato.

U **[CBSE, Outside Delhi/Delhi, 2018]**

Ans. (a) Differences between analogous and homologous structures:

Analogous: Anatomically not similar though perform similar functions/ is a result of convergent evolution. **1**

Homologous: Anatomically similar (but perform different functions)/ is a result of divergent evolution. **1**

(b) Option **(i)** Wings of butterfly and birds. **(iv)** Tubers of sweet potato and potato

(Any one)1

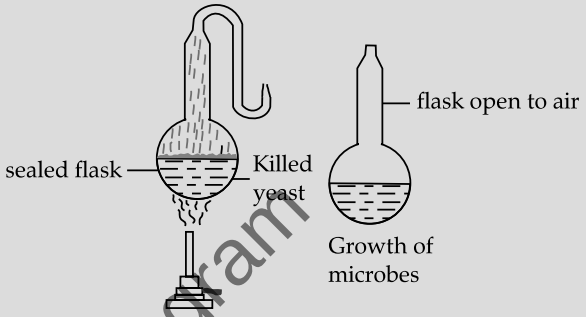
[CBSE Marking Scheme, 2018]

Q. 5. Describe the experiment that helped Louis Pasteur to dismiss the theory of spontaneous generation of life. R **[Delhi Set-I, 2016]**

Ans. Two pre sterilised flasks with killed yeast, one sealed, other open to air, differential growth of life in two flasks / life was found only in open flask. **1**

The following diagram can be considered in lieu of above explanation, life comes from pre-existing life (it came from air entering the flask) / proved the theory of biogenesis.

½ × 4 = 2



[CBSE Marking Scheme, 2016]

Detailed Answer :

Experiment of Louis Pasteur :

(i) He took two pre-sterilised flasks containing nutrient broth killed yeast.

(ii) One flask was left open and the other was sealed.

(iii) After sometime, the flask which was left open showed new live organisms while in air tight flask no new life originated.

(iv) Appearance of life even after sterilisation concluded that life in the flask arose from pre-existing life, thus it discarded the theory of spontaneous origin of life. **3**

Q. 6. "Post-industrialization the population of melanised moth increased in England at the expense of white-winged moths." Provide explanations. A **[Foreign Set-I, 2016]**

OR

How can evolution by natural selection be explained by melanised moths before and after industrialisation in England?

[Delhi Set-II, Comptt. 2016]

Ans. Pre-Industrialisation had more white winged moth against grey lichens on tree trunk, industrialisation led to deposition of soot and smoke on tree bark, making bark of trees dark, against the dark background. White moth could not survive because they could easily be spotted out and preyed upon by the predators, therefore the melanised moth could camouflage against dark bark and increased in number (through reproduction)/natural selection. **½×6=3**

[CBSE Marking Scheme, 2016]

Q. 7. (i) State Oparin-Haldane's hypothesis.
(ii) How does S.L. Miller's experiment supports it?

U **[Foreign Set-II, 2016]**

OR

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

[SQP, 2016 - 17]

Ans. (i) Oparin-Haldane's hypothesis was that life could have come from pre-existing non-living organic molecules and that formation of life was preceded by chemical evolution from inorganic to organic molecules and the first life was formed by the interaction of organic molecules. ½ + ½

(ii) S.L. Miller created condition similar to prehistoric earth with reducing environment, high energy radiations, high temperature, etc. in the laboratory. He created electric discharge in a closed flask, containing CH_4, H_2, NH_3 and water vapour at 800°C, observed the formation of amino acid (organic molecules), thus supporting that life originated from pre-existing non-living organic molecules.

½ + ½ = 1

For Diagram: Refer Topic 1/ Revision Notes/ Important Diagrams/ Fig 7.1

(All four content in flock tube should be mentioned otherwise no marks)

[CBSE Marking Scheme, 2016] 1

Answering Tip

- Carefully draw the diagram and label the parts carefully. Don't forget to mention all four content in flock tube. Each labeling carries a mark.

Q. 8. (i) What are fossils ? How are they an evidence for evolution?
(ii) "Anthropogenic action can lead to evolution." Explain with the help of an example.

R **[Foreign Set-III, 2016]**

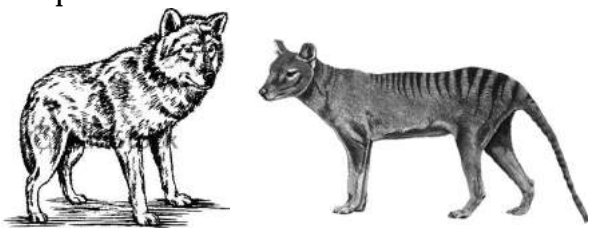
Ans. (i) Fossil-remains / impression of hard parts of life-forms existed in past, preserved in sedimentary rocks, volcanic ash, peat, etc. They are written documents of evolution.

Study of fossils in different sedimentary layers indicates the geological periods in which they existed and showed that life forms varied over time. This indicates that new forms of life have evolved at different geological times in the history of earth.

(ii) Anthropogenic action *i.e.* human activities has led to the evolution of a number of new species in a short time scale. This hastens the process of evolution. For example excess use of herbicides and pesticides in crop production has resulted in selection of resistant varieties of pests in a much lesser time scale / use of antibiotics or drugs, against microbes leads to resistant organism in lesser time scale. **3**

[CBSE Marking Scheme, 2016]

Q. 9. Refer to the figure given below and answer the questions that follow :



Wolf **Tasmanian Wolf**

(i) Explain the process by which Tasmanian wolf evolved.
(ii) Name the process that has resulted in evolution of wolf and another similar animal such as Tasmanian wolf.
(iii) Compare and contrast the two animals shown?

A **[SQP, 2017-18]**

Ans. (i) Adaptive radiation : The process of evolution of different species in a given geographical area starting from a point and radiating to other areas of geography (habitats).

(ii) Convergent evolution (Adaptive convergence): formation of functionally similar structures independently by unrelated organisms.

(iii) Wolf is a placental mammal whereas Tasmanian wolf is a marsupial mammal. **3**

[CBSE Marking Scheme, 2017]

Q. 10. (i) Name the different gases contained in the flask used as an experimental setup by S.L. Miller.
(ii) On the basis of composition of gases in this experiment, what was the condition in the flask ?
(iii) Write the conclusion drawn from this experiment.

A **[CBSE SQP – 2017, 18]**

Ans. (i) CH_4, NH_3, H_2O and H_2.

(ii) Anaerobic / Anoxygenic.

(iii) Life come from pre-existing non-living organic molecules and that formation of life was preceded by chemical evolution. **1+1+1**

[CBSE Marking Scheme, 2017]

Detailed Answer :

(i) Harold Urey and Stanley Miller made electric discharge in a closed flask containing CH_4, NH_3, H_2 and water vapour at 800° C.

(ii) They created a condition similar to that of primitive earth *i.e.* Anaerobic or anoxygenic.

(iii) Conclusion from the experiment is that life originated from pre-existing non-living organic molecules and that formation of life was preceded by chemical evolution.

AI **Q. 11. How did industrialization play a role in Natural selection of light and dark coloured moth in England ?**

U **[Delhi Set-I, Comptt. 2015]**

OR

Explain the increase in the numbers of melanic

(dark winged) moths in the urban areas of post-industrialization period in England.

[Outside Delhi Set-I, II, 2013]

OR

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

[Outside Delhi Set-II, 2012]

Ans. Industrial melanism is an example of natural selection. Before industrialisation, there were more white winged moth on trees than dark winged. ½

After industrialisation, due to industrial smoke and soot, tree trunks became dark because dark coloured moth survived by hiding among dark coloured bark and the light coloured moth were easily spotted and picked by predators. ½ + ½

Under this condition the white winged moths did not survive, due to predation. ½ + ½

Dark coloured moth survive / able to camouflage to survive. This supports the principle of natural selection and supports the fact that species that can better adapt are fit and survive and increase in population size. ½

Q. 12. What do you infer from the resemblance between flying squirrel and flying phalanges with reference to their evolution. A **[Delhi Set-I, Comptt. 2015]**

Ans. Evolution of marsupial mammals has resulted in flying phalanger, through adaptive radiation. ½+½

Evolution of placental mammals has led to the evolution of a flying squirrel (independently). **1**

The resemblance between the two, proves convergent evolution. ½+½

[CBSE Marking Scheme, 2015]

Q. 13. How does the study of fossils support evolution ? Explain. **[Outside Delhi Set-I, Comptt. 2015]**

U **[Delhi Set-I, Comptt. 2013]**

Ans. Fossils are remains / hard parts of life forms, found in sedimentary rocks, some of them appear similar to modern organisms / some represent extinct organisms, study of fossils in different sedimentary layers indicates the geological period in which they existed (provide palaeontological evidence). **1×3=3**

[CBSE Marking Scheme, 2015]

Detailed Answer :

Fossils are the dead remains of the hard parts of life of different forms and ages preserved in sedimentary rocks of different periods. Early rocks contain the fossils of simple forms of life while the recent rocks contain the fossils of complex forms of organisms. The study of fossils from different strata of rocks has helped the geologist to reconstruct the geological period in which they existed. This indicates that new forms of life originated at different geological times in the history of earth.

Q. 14. How do fossils help us in understanding the evolutionary history ? A **[Foreign Set - III, 2017]**

Ans. **(i)** Fossils in different sedimentary layers indicate the period in which they existed. **1**

(ii) They show that life forms varied over time. **1**

(iii) New forms of life have arisen at different times in the history of earth. **1**

[CBSE Marking Scheme, 2017]

Q. 15. 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. **[Foreign Set - III, 2017]**

Ans. Pasteur in his experiment took a flask containing sugar solution and added yeast to it, then boiled the contents of the flask so that yeast got killed. ½ + ½ + ½

In pre-sterilized sealed flask (open to air) life comes from pre existing life, new living organisms arose in presence of killed yeast. ½ + ½ + ½

[CBSE Marking Scheme, 2017]

Q. 16. Describe the experiment of S.L. Miller on the origin of life. Write the conclusion drawn at the end of the experiment. R **[Foreign Set - I, 2017]**

Ans. **Miller's experiment: For diagram-** Refer Topic 1/ Revision Notes/ Important Diagrams/ Fig 7.1

The set-up created conditions like that of primitive atmosphere, Electrical discharge with electrodes in closed flask, containing CH_4, NH_3, H_2, H_2O vapour, observed formation of amino acids. **½ × 4 = 2**

Conclusion : The first form of life arose through evolutionary forces from non-living molecules / abiogenesis. **3**

[CBSE Marking Scheme, 2017]

Answering Tip

- Always draw neat labelled diagram. Labeling lines should not cut each other.

Q. 17. 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.

A **[Outside Delhi Set - I, II, III - 2017 Comptt.]**

Ans. Analogous **1**

(i) Flippers of Penguins & Dolphins / Eye of octopus and mammals. ½

(Any other appropriate & correct example)

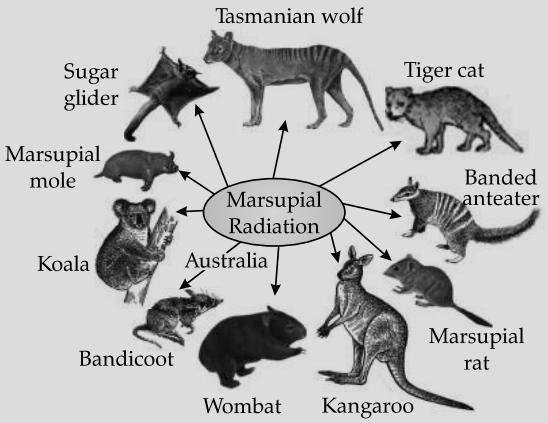
(ii) Sweet potato (root modification) and potato (stem modification). ½

They are anatomically dissimilar structure though they perform similar function, convergent evolution. ½ + ½

[CBSE Marking Scheme, 2017]

Q. 18. Explain adaptive radiation with the help of a suitable example. R **[Delhi Set-I, 2015]**

Ans. The process of evolution that starts from a single point and radiates in different directions is called adaptive radiation *e.g.* Australian marsupials have evolved from a single ancestor and placental mammals exhibit similarities with their corresponding marsupials such as placental wolves and Tasmanian wolves.



[CBSE Marking Scheme, 2015] 3

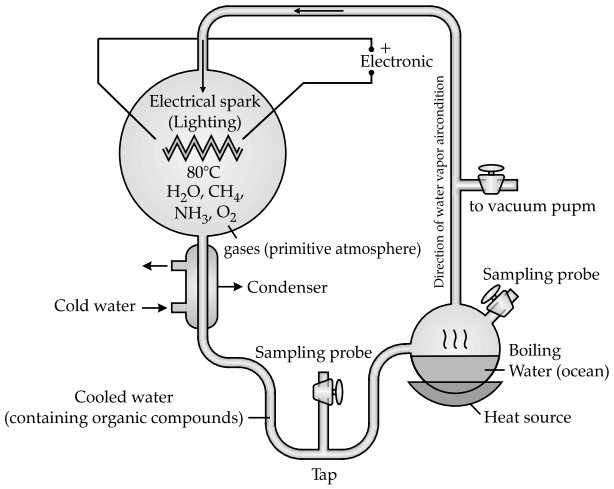
Detailed Answer :

Adaptive radiation is the process of evolution of different species in a given geographical area or starting habitat from a point spreading or radiating to other geographical areas or habitats *e.g.* members of marsupials, different from each other have evolved from a common ancestral stock and variety of placental mammals exhibit resemblance with corresponding marsupials. Adaptive radiation can be called as the convergent evolution as more than one adaptive radiations have taken place in different habitats of an isolated geographical area.

Commonly Made Error

- Students often define 'radiation' instead of 'adaptive radiation'. Some of them define adaptations without mentioning 'speciation from a common ancestor'.

Q. 19. A student was simulating Urey and Miller's experiment to prove the origin of life. The set up used by the student is given



(i) Find out the reasons why he could not get desired results?

(ii) What conclusion was drawn by Urey and Miller through this experiment ?

(iii) Compare the conclusion drawn with the theory of spontaneous generation.

A **[CBSE, SQP, 2015]**

Ans. **(i) He could not get desired results because :**

(a) O_2 was used instead of H_2.

(b) Temperature maintained was 80°C instead of 800°C. **1**

(ii) It was concluded that life could have come from pre-existing non-living organic molecules and their formation was preceded by chemical evolution. **1**

(iii) They 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 & Miller proved that life originated abiogenetically whereas theory of spontaneous generation emphasized that units of life called spores were transferred to different planets including earth.

[CBSE Marking Scheme, 2015] 1

Q. 20. (i) Explain adaptive radiation with the help of a suitable example.

(ii) Cite an example where more than one adaptive radiation have occurred in an isolated geographical area. Name the type of evolution your example depicts and state why it is so named.

U **[Outside Delhi Set-III, 2014]**

Ans. **(i)** Adaptive radiation is the process of evolution of different species in a given geographical area from a point and spreading or radiating to other geographical area or habitats. For example: Drawin's finches / black birds (on Galapagos islands) evolved from original seed eating features into insectivorous and vegetarian features in different habitat / islands. **½ × 3=1½**

(ii) Number of Australian marsupials and placental mammals, different from each other have evolved from an ancestral stock within Australian island continent. **½**

This is a type of convergent evolution, because more than one adaptive radiation occurred in isolated geographical area. **½ + ½=1**

[CBSE Marking Scheme, 2014]

Detailed Answer :

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

(a) All the varieties he conjectured, evolved on the island itself.

(b) 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.

(ii) E.g. Australian marsupials and placental mammals. Number of marsupials, different from each 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).

Convergent evolution : This is because, more than one adaptive radiation has occurred in isolated geographical area. **3**

AI **Q. 21. With the help of any two suitable examples explain the effect of anthropogenic actions on organic evolution.** A **[DDE, Delhi Set-I, 2013]**

Ans. New species evolve in a short time scale of months or years due to anthropogenic actions or human activities. This hastens the evolutionary process. For example,

(i) During post industrialisation period in England, the tree trunks were covered by dust, coal particles and thus became dark. On such trunks, white moths could be easily picked up leaving the dark-peppered moths.

(ii) Due to excessive use of antibiotics or herbicides, new resistant varieties of organisms appeared. These resistant varieties got selected over the non-resistant varieties. **3**

Q. 22. Write about the ancestry and evolution of bat, horse and human on the basis of a comparative study of their forelimbs. What are these limbs categorized as ? U **[Delhi Set-I, Comptt. 2013]**

Ans. The forelimbs of frog, lizard, pigeon, bat, whale and horse have the same basic structural plan as human hand. In each case, the forelimb consists of an upper arm, forearm, wrist, palm and fingers. The upper arm is made up of humerus, forearm is composed of radio-ulna, the wrist consists of carpals and the palm contains metacarpals and digits. The forelimbs of all these vertebrates are categorized as homologous organs because these are similar in structure and arrangements but are different in shape and function because they developed along different direction due to adaptation to different needs. **1 × 3 = 3**

Q. 23. State the theory of Biogenesis. How does Miller's experiment support this theory ?

U **[Delhi Set-I, 2012]**

OR

(i) Explain the theory of biogenesis.

(ii) How did Miller demonstrate experimentally the chemical evolution that happened three billion years ago ? **[Delhi Comptt. 2010]**

Ans. **Theory of Biogenesis :** A living organism arises from another living organism. **1**

Miller's experiment : An electric discharge was created in a closed flask containing CH_4, H_2, NH_3, and water vapour at 800° C, thus creating condition of early earth with reducing environment, high energy radiations and high temperature in the laboratory. This resulted in the formation of amino acids, supports chemical evolution of life. **1**

// Miller's experiment does not support theory of Biogenesis it supports chemical evolution of life. **1**

[CBSE Marking Scheme, 2010]

Detailed Answer :

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

Miller's experiment gave experimental evidence of chemical evolution.

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. **3**

Q. 24. What is adaptive radiation ? When an adaptive radiation be referred to as convergent evolution? Give an example ?. U **[Delhi Set-II, 2015]**

Ans. The process of evolution of different species from one species in a given geographical area starting from a point and radiating or spreading to other geographical areas or new habitats is called adaptive radiation. This is called as divergent evolution as this involves the formation of different functional forms of basic similar structures *e.g.* Darwin's finches and Australian marsupials. However when more than one adaptive radiation appeared to have taken place in different habitats of an isolated geographical area, the adaptive radiation can be referred to as convergent evolution. This involves the development of similar adaptive functional structures in unrelated groups of organisms *e.g.* Australian marsupials and placental mammals. **3**

Q. 25. Excessive and continuous use of pesticides lead in evolution of some new species of pests. Explain what must have led to this. What is this type of evolution called ?

A **[Outside Delhi Comptt. Set - I, II - 2017]**

Ans. Excessive use of pesticides has resulted in selection of resistant varieties in a much lesser time scale, as evolution is stochastic process based on chance events in nature and chance mutation in organism. **2**

Evolution by anthropogenic action. **1**

[CBSE Marking Scheme, 2017]

Q. 26. Name the scientist who influenced Darwin and how? E & A **[Delhi Set, 2016]**

Ans. Darwin was influenced by **Thomas Malthus** and his book ''An essay on the principles of population'' in which he discussed that there are 'positive checks' that control geometrically growing population. The work of Malthus on human population growth in fact influenced him. **3**

Long Answer Type Questions **(5 marks each)**

Q. 1. State the hypothesis proposed by Oparin and Haldane. How was it experimentally proved by S.L. Miller ? Explain.

A **[Delhi Comptt. 2017, Set - I, II, III]**

Ans. The first form of life could have come from pre-existing non living organic molecules (RNA, protein etc.), and that formation of life was preceded by chemical evolution or formation of diverse organic molecules from inorganic constituents, the condition on earth were high temperature (Volcanic storms), reducing atmosphere (containing CH_4, NH_3, etc.), Miller in his experiment created electric discharge in a closed flask containing CH_4, H_2, NH_3 and water vapour at 800° C, and observed the formation of amino acids / organic compounds, which supported chemical evolution. **½ × 10 = 5**

[CBSE Marking Scheme, 2017]

Detailed Answer :

Oparin and Haldane proposed the theory of chemical evolution of life. It states that, the first form of life was originated from non-living inorganic and organic molecules such as CH_4, NH_3, H_2O, sugar, proteins, nucleic acids, etc. Harold Urey and Stanley Miller conducted an experiment to prove this theory. They created a condition similar to that of primitive earth. They made electric discharge in a closed flask containing CH_4, NH_3, H_2 and water vapour at 800° C and observed the formation of amino acids, which supported chemical evolution.

AI **Q. 2. (i) List any four evidences of evolution.**

(ii) Explain any one of the evidences that helps to understand the concept of evolution.

U **[Delhi Set-1, Comptt. 2016]**

Ans. **(i)** Four evidences = Fossils / comparative anatomy/ homologous organs / Analogous organs/Biochemical evidences/embryological evidences. **(Any four) 2**

(ii) Any one evidence explained **1**
Definition / concept **1**
Example **1**
How it explains evolution.

[CBSE Marking Scheme, 2016]

Detailed Answer :

(i) Four Evidences of evolution
- **(a)** Paleontological evidences.
- **(b)** Morphological and anatomical evidences.
- **(c)** Biogeographical evidences.
- **(d)** Biochemical evidences.

(ii) Paleontological evidences
- **(a)** The study of fossils is known as paleontology.
- **(b)** Fossils are the remains of or impressions of life forms of the past preserved in sedimentary rocks or in other media like volcanic ash or peat etc.
- **(c)** Fossils are the written documents of evolution.
- **(d)** The study of fossils reveals the existence of life in the past and illustrates the course of evolution of plants and animals.
- **(e)** Rock sediments of different ages in the earth crust indicate the presence of fossils of different life forms.
- **(f)** A variety of fossils ranging complex to simple and modern to extinct organisms can be observed.
- **(g)** Study of fossils in different sedimentary layers indicate the geological period in which they existed and the geologic time is a chronological sequences or the history of evolution based on the study of fossils.
- **(h)** For example fossils of earliest life consisted only of prokaryotes. Later on eukaryotes developed. The differences found in the fossils of different periods are due to changes in form, structure habits of organisms due to evolution.
- **(i)** Fossil histories of some organisms has been studied and the best among them is that of modern horse. It has been found out that modern horse *Equus* and its relatives have evolved from eocene animal *Eohippus* as a result of number of changes in structure and habit which have occurred during the course of evolution.

Q. 3. (i) How does the study of fossils help to understand evolution.

(ii) How did S.L. Miller provide an experimental evidence in favour of Oparin and Haldane's hypothesis? Explain.

A **[Delhi Set-II, Comptt. 2016]**

Ans. (i) The fossils are the written documents of evolution. Study of fossils in different sedimentary layers indicates the geological period in which they existed and showed that life forms varied over time. This indicates that various forms of life have evolved at different geologic times and hence new forms of life similar to modern organisms have arisen at different times in history of earth and from the study of fossil record. Thus, it has been concluded that evolution has taken place from simple to complex in a gradual manner.

(ii) Oparin and Haldane gave the hypothesis of chemical evolution of life. They suggested that life could have come from pre-existing non-living organic molecules and that the formation of life was preceded by chemical evolution. Miller created electric discharge in a closed flask, containing methane, hydrogen, ammonia and water vapour at 800°C and thus created conditions similar to prehistoric earth in the laboratory. He observed formation of amino acids thus supporting that life originated from pre-existing, non-living organic molecules.

2½ + 2½ = 5

Q. 4. How did Darwin explain adaptive radiation ? Give another example of animals exhibiting adaptive radiation.

A **[Delhi Set-III, Comptt., 2016]**

Ans. The process of evolution of various species in certain geographical area beginning from a point and spreading or radiating to other geographical areas or habitats is remains as **adaptive radiation.** One of the best example of this phenomenon is that of Darwin's Finches.

Darwin observed many varieties of finches on the same island all of which have evolved on the island itself from original seed eating features. This has led to many other forms with altered beaks, 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 is called adaptive radiation. **½×8=4**

Another example = Australian Marsupials. **1**

[CBSE Marking Scheme, 2016]

Answering Tip

- If marking system says half marks per point, it would be good to answer the question in points, this will fetch you more marks. example, in this question you should cover your answer in 8 points.

Q. 5. (i) Explain the observations and the conclusion drawn by Darwin during his visit to Galapagos islands.

(ii) Write the two key concepts of Darwin's theory of natural selection.

U **[Outside Delhi Set-I, Comptt., 2016]**

Ans. (i) Small black birds-Darwin's finches-Many varieties of finches in the same island, which he conjectured evolved in the island itself, Seed eating-altered beaks arose-insectivorous. Thus, the process of evolution of different species in a given geographical area starting from a point and radiating to other areas of geographical habitats is Adaptive Radiation. **3**

(ii) Branching descent, struggle for existence, competition, survival of fittest. **(Any two) 2**

[CBSE Marking Scheme, 2016]

Detailed Answer :

(i) (a) During his visit to Galapagos islands Darwin observed a great diversity of small black birds called Darwin's Finches. He described Galapagos islands as the living laboratory of evolution. He observed that there were 13 species of finches differing from each other as well as from main land finches in their size, beaks and food habits. From these observations, Darwin concluded that from original seed eating birds many different varieties with altered beaks have evolved such as finches, vegetarian finches etc. He further concluded that after originating from common ancestral seed bearing stock the finches must have spread or radiated to different geographical areas or habitats and undergone adaptive changes in their beaks according to food habits to become vegetarian or insectivorous. This process of evolution of different species of Darwin's finches in a given geographical area starting from a point and radiating or spreading to other areas of geographical habitats is called adaptive radiation.

(ii) Two key concepts of Darwin's theory of natural selection

(a) Branching descent (adaptive radiation).

(b) Struggle for existence and competition and

(c) Survival of the fittest.

AI **Q. 6. (i) What was proposed by Oparin and Haldane on origin of life ? How did S.L. Miller's experiment support their proposal ?**

(ii) Which human chromosome has (1) maximum number of genes, and which one has (2) fewest genes ?

(iii) Write the scientific importance of single nucleotide polymorphism identified in human genome.

R **[Delhi Set-I, 2014]**

Ans. (i) Oparin and Haldane believed in the chemical evolution of life. They proposed that the first form of life could have come from pre - existing non-organic molecules. S.L. Miller created electric discharge in a closed flask containing CH_4, H_2, NH_3 and water vapour at 800° C, thus creating the condition of early earth with reducing environment, high energy radiation and high temperature. This resulted in the formation of amino acids.

Miller's experiment thus supports the chemical evolution of organic molecules from the inorganic ones, a condition being the basis requirement conducive to the formation of early life. **½×6=3**

(ii) Chromosome 1, Y **½+½=1**

(iii) It help to find chromosomal locations for disease, associated sequences and tracing human history. **½+½=1**

[CBSE Marking Scheme, 2014]

Q. 7. (i) Differentiate between analogy and homology giving one example each of plant and animal respectively.

(ii) How they are considered as an evidence of evolution. U **[Delhi Set-II, 2016]**

Ans. (i) Refer to Topic 1/ Q.1. (SAQ-II).

(ii) Analogy and homology of structures indicate the evidences of evolution from comparative study of morphology and anatomy of form, structure, relative position of different organs and their functions. Analogy indicates that similar environmental conditions and habitat result in the selection of similar adaptive features in different groups of organisms towards the similar function. This shows the evolution of similar functional structures from unrelated organs. This is the result of convergent evolution.

Homology includes the organs having similar structure origin and development, developed to have different forms so as to perform different functions in different groups of organisms. This phenomenon of producing functionally different forms from structurally similar organs is the result of divergent evolution. It indicates towards the common ancestry. **2½ + 2½ = 5**

Q. 8. 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 references to DDT. How does the theory of Hugo de Vries support this. R **[Foreign Set, 2012]**

Ans. The use of DDT for the first time resulted in the death of maximum number of mosquitoes but few survived. Later on it was found that mosquitoes continue to survive and reproduce even in the presence of DDT. It is because the sustained use of DDT made the mosquitoes resistant to DDT within a few years due to variation and change in gene frequencies in their population in relation to changes in environment within a time span of few years only. According to Hugo de Vries, the evolution is caused by a single step large mutation arising out suddenly in a population. **5**

TOPIC-2

Evolutionary Theories, It's Mechanism and Evolution of Man

Revision Notes

Theories of Biological Evolution

1. **Lamarckism (Theory of Inheritance of Acquired Characters)**
   - It was proposed by Lamarck in 1801 and was explained in his book *Philosophic Zoologique*.
   - It states that evolution of life forms occurred by use and disuse of organs. Continued use of an organ makes it larger, more elaborate and continued disuse of an organ causes its gradual decrease in size, degeneration and finally its elimination. The new character so acquired is passed on to next generation *e.g.*
     - **(a) Evolution by Use of Organs :** Long neck of giraffe is due to continuous elongation to forage leaves on tall trees. This acquired character was inherited by succeeding generations.
     - **(b) Evolution by Disuse :** Disappearance of limbs in snakes.
   - This theory was eliminated out because, it is proved that the characters are inherited only through somatic cells.
2. **Darwinism (Theory of Natural Selection)**
   - It was proposed by **Charles Darwin (1859) in his book "Origin of Species"**.
   - It is based on two key concepts namely,

   (a) Branching descent (Adaptive radiation) **(b)** Natural selection (Convergent evolution)

(a) Branching Descent
- It explains that all organisms are modified descendants of previous life forms.

(b) Natural Selection
- Consider a bacterial colony (say A) growing on a given medium.
- If the medium composition is changed, only a part of the population (say B) can survive under new conditions. This variant population outgrows the others and appears as new species *i.e.* B is better than A under new condition.
- Nature selects for fitness.
- The work of **Thomas Malthus** on principle of populations (1794) was influenced by **Darwin**.
- **Natural selection is based on the following facts :**

(a) Heritable minor variations.
(b) Over production by organisms.
(c) Limited natural resources.
(d) Struggle for existence for food and space.
(e) Survival of the fittest.

- Population size grows exponentially if everybody reproduces maximally (*e.g.*, bacterial population).
- In fact, population size is limited due to competition for resources (Struggle for existence).
- Only some survives (Survival of the fittest).
- Darwin said that the organisms with heritable variations make resource utilization better.
- They reproduce and leave more progeny.
- It leads to a change in population characteristics and new forms appear.

➢ **Mechanism of Evolution**
- Darwin ignored about origin of variation and mechanism of speciation.

➢ **Mutation Theory**
- **Hugo de Vries** (1901) proposed Mutation Theory of evolution in his book "Mutation theory".
- He conducted some experiments on *Oenothera lamarckiana* (evening primrose) and believed that evolution takes place through mutation and not by minor variation.
- Evolution for Darwin was gradual while for deVries it is a sudden / spontaneous process. He believed mutation caused speciation and hence called it **saltation** (single step large mutation).

➢ **Differences between Darwinian Variation & Mutation**

Darwinian Variation	Mutation
It shows minor variation.	It shows large variation.
It is slow and directional.	It is random, sudden and directionless.
It showed gradual evolution.	It showed discontinuous evolution and speciation by saltation.
It is caused by reshuffling of genes.	It is caused by change in the genetic material.

➢ **Hardy - Weinberg Principle**
- It says that allele frequencies in a population are stable and constant from generation to generation.
- The gene pool (total genes and their alleles in a population) remains constant. This is called genetic equilibrium (Hardy-Weinberg equilibrium).
- Sum total of all the allelic frequencies = 1.*e.g.*, In a diploid, p and q are the frequencies of alleles A & a respectively.
- The frequency of AA = p^2 (*i.e.* the probability of an allele A with frequency p is the product of the probabilities, *i.e.* p^2)
- The frequency of aa = q^2
- The frequency of Aa = 2pq
- Hence $p^2 + 2pq + q^2 = 1$ [binomial expansion of $(p+q)^2$]
- Change of frequency of alleles in a population causes disturbance in genetic equilibrium. This is due to evolution.

➢ **Factors Affecting Hardy-Weinberg Equilibrium :** There are fine basic processes which may bring about the change in Hardy Weinberg equilibrium and bring about the variations at the genetic level as follows :

(a) Gene Migration
- Gene flow from one population to another.
- Here, gene frequencies change in both populations.
- There would be a gene flow if migration happens multiple times.

(b) Genetic Drift
- The accidental gene flow causing change in frequency.
- Sometimes, the change in frequency is so different in the new sample of population that they become a different species.
- The original drifted population becomes founders and the effect is called founder effect.

(c) Mutation
- Mutations result in formation of new phenotypes.
- Over few generations, this leads to speciation.

(d) Genetic Recombination
- It is the reshuffling of gene combinations during crossing over resulting in genetic variation.

(e) Natural Selection : It is the major factor which adds variations in the population, change the gene frequencies in the gene pool resulting in the formation new gene pool. These are of three types namely, Stabilizing selection, Directional selection and Disruptive selection.

(i) Stabilizing Selection : Here, more individuals acquire average character value and variation is reduced.

(ii) Directional Selection : Here, individuals of one extreme are more favoured.

(iii) Disruptive Selection : Individuals of both the extremes are favoured. It produces two peaks that may lead to the development of two different populations.

➢ **Account on Evolution**

(a) Proterozoic Era - 2000 Million Years Ago (Mya)

- First cellular forms of life.
- Some of the cells had the ability to release O_2 as the light reaction in photosynthesis.
- Single celled organisms → Multicellular organisms.

(b) Paleozoic Era

- **500 mya :** Invertebrates.
- **400-600 mya :** First land organisms (plants).
- **400 mya :** Arthropods invaded the land.
- **350 mya :** Jawless fish. Fish with stout and strong fins could move on land and go back to water.
- **320 mya :** Sea weeds and few plants.
- **Amphibians to reptiles :** They lay thick-shelled eggs which do not dry up in sun unlike those of amphibians.
- In the next 200 million years reptiles dominated on earth. Giant ferns (Pteridophytes) were present but they all fell to form coal deposits slowly.

(c) Mesozoic Era

- **200 mya :** Some of the land reptiles went back into water to evolve into fish-like reptiles (*e.g.,* Ichthyosaurs).
- The land reptiles were dinosaurs.
- They include

(i) *Tyrannosaurus rex :* Largest dinosaur (20 feet in height, huge fearsome dagger-like teeth).

(ii) Triceratops

(iii) Pteranodon

(iv) Stegosaurus

(v) Brachiosaurus

(d) Cenozoic Era

- 65 mya : Dinosaurs suddenly disappeared.
- First mammals (shrew-like) : Their fossils are small sized.
- In South America, there were mammals resembling horse, hippopotamus, bear, rabbit etc.
- Due to continental drift, when South America joined North America, these animals were over ridden by North American fauna.
- Due to continental drift, Australian marsupials survived because of lack of competition from any other mammals.

➢ **Origin and Evolution of Man (Human ancestry)**

(i) ***Dryopithecus* & *Ramapithecus* (15 mya)**

(a) Hairy.

(b) Walked like gorillas and chimpanzee.

(c) ***Dryopithecus :*** ape-like.

(d) ***Ramapithecus :*** man-like.

(e) Fossils of man-like bones found in Ethiopia and Tanzania.

(f) Man-like primates (3-4 mya) : Height up to 4 feet.

(ii) ***Australopithecus* (2 mya)**

- In East African grasslands.
- Hunted with stone weapons.
- Ate fruits.

(iii) ***Homo habilis***

- First human-like being (hominid).
- Brain capacity : 650-800 cc.
- Did not eat meat.

(iv) ***Homo erectus* (1.5 mya)**

- Large brain (900 cc) : Ate meat.

(v) Neanderthal man : 40,000 - 1 lakh yrs ago :

- Brain 1400 cc.
- Lived in East and Central Asia.
- Used hides to protect their body.
- Buried their dead.

(vi) ***Homo sapiens*** **(Modern man) :** Evolution took place during 10,000 to 75,000 years ago.

- Prehistoric cave art developed about 18,000 years ago.
- Agriculture and settlements : 10,000 years ago.

Very Short Answer Type Questions (1 mark each)

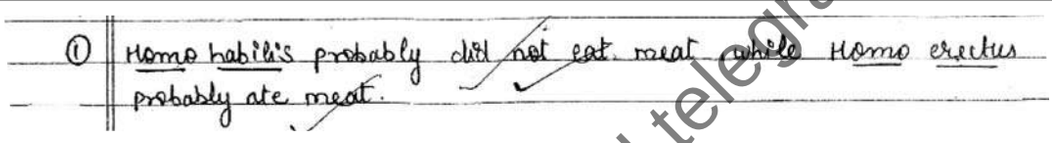
Q. 1. Write the probable differences in eating habits of *Homo habilis* and *Homo erectus*.

U **[Outside Delhi Set-I, 2016]**

Ans. *Homo habilis* did not eat meat, were vegetarian while *Homo erectus* were probably meat eaters. **1**

[CBSE Marking Scheme, 2016]

OR



[Topper's Answer, 2016]

Answering Tip

- Do a comparative analysis of the fossils of human ancestors mentioning posture, height, cranial capacity, feeding habits etc.

Q. 2. What role does an individual organism play as per Darwin's theory of natural selection ?

A **[Delhi - 2017, Set-I]**

Ans. Individual with reproductive fitness passes on the useful gene to the next generation. **1**

[CBSE Marking Scheme, 2017]

Q. 3. 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 A **[Delhi - 2017, Set - III]**

Ans. (i) Pre-historic cave art.

(ii) Agriculture / Human Settlement. **½ + ½ = 1**

Commonly Made Error

- Many students fail to write the correct logical sequence.

AI **Q. 4. According to De-Vries what is saltation?**

R **[Delhi Set-I, 2016]**

OR

What is 'Saltation' according to De Vries?

[Delhi Set-I Comptt. 2014]

Ans. Saltation is a single step large mutation which brings major change as speciation. **1**

Q. 5. Name the common ancestor of the great apes and man. R **[Outside Delhi Set-I, 2014]**

Ans. *Dryopithecus/Ramapithecus.* **1**

[CBSE Marking Scheme, 2014]

Commonly Made Error

- Students often write incorrect spellings of ancestors.

Q. 6. Write the basis of origin of variations in organisms as described by Hugo de Vries.

U **[Outside Delhi Set-III, Comptt., 2013]**

Ans. Saltations (Mutation), large differences arising out all of a sudden in a population. **1**

Q. 7. 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 ?

A **[CBSE SQP, 2013]**

Ans. The formula to calculate allele frequency is :

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

Commonly Made Error

- Many students write incorrect equation. In some cases, "=1" is not written.

Q. 8. State the significance of coelacanth in evolution.

A **[Delhi Set-I, 2012]**

Ans. ***Coelacanth*** is a special type of fish called lobfin caught in S. Africa in 1938. It is significant in evolution because it is a missing link between fishes and the amphibians. They evolved into the first amphibians that lived on both land & water.

These were the ancestors of modern day frogs and salamanders. The amphibians further evolved into reptiles. **1**

Q. 9. List the two characteristics of mutation that help in explaining evolution.

U **[Outside Delhi Set-I, II, III, 2011]**

Ans. **(i)** Mutation are random and inheritable.

(ii) Same type of mutations may occur in a number of individuals of same species. **1**

Q. 10. Write the names of the following:

(a) A 1.5 mya primate that was ape-like.

(b) A 2 mya primate that lived in East African grasslands. R **[Outside Delhi/Delhi, 2018]**

Ans. **(a)** *Dryopithecus.* ½

(b) *Australopithecines / Australopithecus / Homo habilis.* ½

[CBSE Marking Scheme, 2018]

Q. 11. Name the common ancestor of great apes and man.

R **[Outside Delhi, Set-2011]**

Ans. *Dryopithecus africanus.* 1

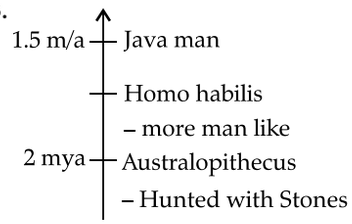
Q. 12. Rearrange the following in increasing order of evolution.

Gnetales, Ferns, Zosterophyllum, Ginkgo.

E & A **[Outside Delhi Set-I, Comptt., 2014]**

Ans. *Zosterophyllum* → Ferns → *Ginkgo* → Gnetales. **1**

Q. 13.



Study the ladder of human evolution given above and answer the following questions.

[Delhi Set, Comptt. 2010]

(i) Where did *Australopithecus* evolve?

(ii) Write scientific name of Java man.

Ans. **(i)** East Africa.

(ii) *Homo erectus.* **½ + ½ = 1**

Short Answer Type Questions-I **(2 marks each)**

AI **Q. 1. Name the first human like hominid. Mention his food habit and brain capacity.**

R **[Outside Delhi Set-III, Comptt. 2015]**

Ans. *Homo habilis* were first human like hominid. They probably did not eat meat/vegetarian, and their brain capacities were between 650-800 cc. **2**

[CBSE Marking Scheme, 2015]

Commonly Made Error

- Students often write *cranial capacity* as "large" and "small", without giving the exact values.

Answering Tip

- Precise and specific features of the fossils of human ancestors should be learned by the students. Students should be able to differentiate between general and specific features.

Q. 2. Mention the evolutionary significance of the following organisms : R **[Delhi - 2017, Set - I]**

(i) Shrews

(ii) Lobefins

(iii) *Homo habilis*

(iv) *Homo erectus*

Ans. **(i)** First mammals ½

(ii) First amphibians (lived both on land and in water) / fish with stout and strong fins which could move on land and go back to water. ½

(iii) First human like being / hominid / brain capacity from 650 - 800 cc / did not eat meat. ½

(iv) Large brain around 900 cc / eat meat. ½

[CBSE Marking Scheme, 2017]

Q. 3. Describe the mechanism of evolution as explained by Hugo de Vries.

U **[Outside Delhi Set-I, Comptt., 2012]**

Ans. While working on evening primrose, Hugo de Vries put forward the idea of **mutation,** which he described as the large change arising out all of a sudden in a population. It is believed that evolution is not due to minor heritable continuous variations as proposed by Darwin but this is due to mutation which cause evolution. According to Darwin, the evolution is a gradual and slow process but de-Vries believed that it is due to saltation, single step large change called mutation and is a discontinuous process. It brings about speciation. **2**

Commonly Made Error

- Students sometimes do not describe the mechanism of evolution. They miss to mention the keyword mutation (saltation).

Short Answer Type Questions-II (3 marks each)

AI **Q. 1. Compare and contrast the theories of evolution proposed by Darwin and Hugo De Vries.**

U **[CBSE SQP, 2018]**

Ans.

S.No.	Drawin's Theory of Natural Selection	De Vries Theory of Mutation
1.	Minor variations cause evolution.	Mutation are random and directionless.
2.	Darwinian variations are small and directional.	Mutations are random and directionless.
3.	Evolution is gradual.	Sudden mutations cause evolution.

1+1+1

U **[CBSE Marking Scheme, 2018]**

Answering Tip

- Learn the differences between theories of evolution proposed by Darwin and Hugo De Vries in tabular form for better retention and understanding.

Q. 2. What does Hardy-Weinberg principle of equilibrium indicate? List any two factors that could alter the alteration. What would such an alteration lead to ?

U **[Outside Delhi Set-I, Comptt. 2015]**

Ans. (i) Allele frequencies are stable and constant from generation to generation / the gene pool (total genes and their alleles in a population) remains a constant / sum total of all allelic frequencies is one. **1**

Hence, $p^2 + 2pq + q^2 = 1$ (where p and q represent the frequencies of gene A and allele a).

Factors : Gene migration, gene flow, genetic drift, mutation, genetic recombination, natural selection. ½+½

(ii) Such an alteration causes variations at the genetic level and thus leads to evolution.

[Any two] 1

[CBSE Marking Scheme, 2015]

Commonly Made Error

- Hardy Weinberg principle was not explained by many candidates. Only the equation was given. In some cases, "=1" was not written.

Answering Tip

- Understand Hardy Weinberg principle in detail. Also, understand the factors which disturb the Hardy Weinberg equation.

Q. 3. Explain the interpretation of Charles Darwin when he observed a variety of small black birds on Galapagos Island.

U **[Delhi Set-III, 2015]**

Ans. Charles Darwin observed an amazing variety of small black birds called Darwin's finches in the same island. All the varieties evolved on the island itself from ancestral stock and have radiated to different habitats where they have undergone adaptive changes. Darwin interpreted the formation of a number of divergent species from a common ancestral stock with new species adapting different habitats as adaptive radiation resulting into the divergent evolution.

According to Darwin this evolution was also based on available resources of food and space and on this basis therefore by observing their characteristics on the Galapagos islands, he proposed his famous theory known as the 'theory of natural selection'. **The main postulates of this theory are as follows :**

(i) All organisms possess an enormous power of fertility.

(ii) There is a struggle for the existence within a species as well as between two different species for food, space and resources.

(iii) Nature will favour the survival of the fittest.

(iv) Darwin believed that variations ultimately lead to the formation of new species.

[CBSE Marking Scheme, 2015] 3

Q. 4. What does the following equation represent ? Explain.

$p^2 + 2pq + q^2 = 1$ U **[Outside Delhi Set-I, 2015]**

OR

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

[Delhi - 2017, Set - I]

Ans. The equation $p^2 + q^2 + 2pq = 1$ represents the genotypic frequencies of a population, when it is in Hardy-Weinberg equilibrium.

According to this law, the frequency of occurrence of alleles of a gene in a population remains constant through generations unless disturbances, such as mutation and non-random mating are introduced.

Individual frequencies are represented as p and q such as in diploid where p and q represent the frequency of allele A and a respectively. The sum total of allelic frequencies is 1.

The frequency of genotypes, AA is p^2, that of aa is q^2 and that of Aa is $2pq$.

Hence $p2 + 2pq + q^2 = 1$ which is expansion of binomial expression $(p + q)^2$. When frequency measured differs from expected values the difference indicates the extent of evolutionary change.

[CBSE Marking Scheme, 2015] 3

Commonly Made Error

- Students are unable to explain the equation. They write vague answers.

AI **Q. 5. Describe the three different ways by which Natural selection can affect the frequency of a heritable traits in population.**

U **[Foreign 2014, Outside Delhi Comptt. 2011]**

Ans. **(i)** Stabilization, in which more individual acquire average character value *i.e.*, medium sized individuals. ½ + ½

(ii) Directional, more individuals acquire value other than the average character value. ½ + ½

(iii) Disruptive, more individuals acquire peripheral character value at both ends of distribution curve. Consequently the original population is disrupted into two or more separate groups that later evolved into new species. ½ + ½

[CBSE Marking Scheme, 2014]

Detailed Answer :

Natural selection can affect the frequency of a heritable trait in a population in the following ways:

(i) It can lead to stabilization (in which more individual acquire mean character value *i.e.* medium-sized individuals).

(ii) It may result in directional change (more individuals acquire value other than the mean character value).

(iii) It may result in disruption (more individuals acquire peripheral character value at both ends of the distribution curve). **3**

Answering Tip

- Compare the directional, disruptive and stabilizing selection with diagram. Lay stress on operative terms.

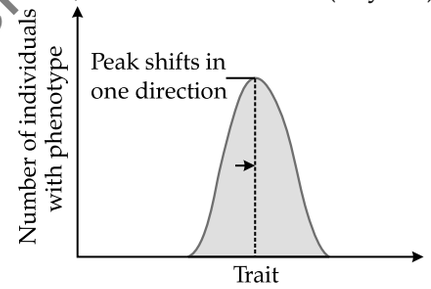
Q. 6. (i) State Hardy-Weinberg principle. Name any two factors which affect it.

(ii) Draw a graph to show that natural selection leads to directional change. U **[CBSE SQP, 2012]**

Ans. **(i)** Hardy-Weinberg principle states that the total genes and their alleles in a population remains constant *i.e.* allelic frequencies in a population are stable and constant from generation to generation.

Gene flow, genetic drift, mutation, genetic recombination, natural selection. **(Any two) 2**

(ii)



1

Q. 7. Write in what context did Darwin use that terms 'fitness', 'survival' and 'selection' while elaborating the mechanism of evolution.

A **[Delhi Comptt. 2017, Set - I, II, III]**

Ans. Fitness refers to reproductive fitness (will leave more progeny) - more survival and hence selected by nature - natural selection **1 × 3=3**

Q. 8. What is is disturbance in Hardy-Wenberg genetic equilibrium indicative of ? Explain how it is caused.

U **[Outside Delhi Set - II, 2017]**

Ans.

According to Hardy - Weinberg genetic equilibrium, gene pool remains constant and stable. ~~Even of~~ The allelic frequencies remain stable and constant generation and generation for sexually reproducing organisms.

Any disturbance in Hardy - Weinberg genetic equilibrium is indicative of the action of evolutionary forces i.e., evolution in play.

Disturbance to Hardy - Weinberg genetic equilibrium is caused due to mutation, genetic recombination, natural selection, gene flow or gene migration, genetic drift.

i) Mutation causes heritable change in phenotype and genotype of organisms, thereby changing allelic frequencies.
ii) Recombination occurs due to crossing over in Pachytene stage of Meiosis I. It results in variations
iii) Natural selection operates in 3 ways:
i) Stabilising :- The average phenotype is favoured and selected
ii) Directional :- Any one of the extreme characters is favoured
iii) Disruptive :- Two extreme characters are favoured.
All these cause change in allelic frequencies.
iv) Gene flow :- the migration of a group of individuals (emmigration and immigration) leads to changes in the allelic frequencies in the old and new population
v) Genetic drift :- When gene flow occurs due to chance events like natural calamities, it is known as genetic drift.
When a group of individuals move into a new population, the allelic frequencies are different in the new one such that they become a new species. This is Founder Effect and the original drifted population is known as Founderss.

[Topper's Answer, 2017]

Q. 9. Fitness is the end result of the ability to adapt and get selected by nature. Explain with suitable example.
E & A **[Delhi Set-I, 2012]**

Ans. Industrial Melanism : Before industrialisation started in England it was observed, there were more white - winged peppered moth on trees than dark winged moth but after industrialisation, there were more dark - winged moths in the same area, predators spot a moth against a contrasting background, post industrialisation the tree trunk became dark due to industrial smoke and soot, Under this condition the white- winged moth did not survive due to predators, but the dark-winged moth managed to survive.
[CBSE Marking Scheme, 2012] 3

Note : Any other example explained under the following heads in the text book - fitness, selection and adaptation.

Detailed Answer :

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 melanism : It is a case of natural selection. In England, it was observed before industrialisation that white-winged moth were more than dark-winged moths. But the situation became reversed after industrialisation. It was found that predators would spot and pick a moth against a contrasting background. During pre-industrialisation, the tree trunks were covered with white lichens and on white-background dark coloured moth could be picked up.

During post industrialisation, the tree trunks were covered by dark, dust, coal particles and became dark on which white moth could easily be picked up. Thus, it was found that industrial melanism supports evolution by natural selection. **3**

Commonly Made Error

- Most of the students are unable to explain industrial *melanism.*
- They forget to mention the different varieties of peppered moths.
- They forget to mention about Natural Selection.

Answering Tip

- Discuss Industrial Melanism while understanding Natural Selection. Learn this topic with respect to different coloured moths, effect of industrialisation and natural selection of black moths.

AI Q. 10. 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. R **[Delhi Set-I, 2011]**

Ans. Branching descent : Different species descending from the common ancestor - get adapted in different habitats. ½
E.g. Darwin finches - varieties of finches arose from grain eaters / Australian marsupials - evolved from common marsupial. ½ + ½ = **1**
Natural selection : A process in which heritable variations enable better survival of a species to reproduce in large number. ½
e.g. White moth surviving before the industrial revolution and black moth surviving after industrial revolution / Long necked giraffe survived / DDT resistant mosquito survive. **1**
[CBSE Marking Scheme, 2011]

Commonly Made Error

- Students often forget to mention about the term 'common ancestor' in the script. Some students do mention the example of Darwin's Finches, but forget to explain it.

Q. 11. (i) How does the Hardy - Weinberg's expression ($p^2 + 2pq + q^2 = 1$) explain that genetic equilibrium is maintained in a population ?
(ii) List any two factors that can disturb the genetic equilibrium. A **[Outside Delhi Set-2010]**

Ans. (i) The gene pool *i.e.* the total genes and their alleles in a population tend to remain constant, this is called genetic equilibrium. Sum total of all allelic frequencies is 1. Individual frequencies can be named *p*, *q*, etc. In a diploid, *p* and *q* represent the frequency of allele A and allele a. The frequency of AA individuals in a population is simply p^2. This is simply stated in another way *i.e.*, 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 of aa is q^2, of Aa $2pq$. Hence, $p^2 + 2pq + q^2 = 1$. When frequency measured, differs from expected values, the difference (direction) indicates the extent of evolutionary change. Disturbance in genetic equilibrium or Hardy - Weinberg equilibrium *i.e.* change of frequency of alleles in a population would then be interpreted as resulting in evolution. ½ × 4=**2**
(ii) Gene migration / gene flow / gene drift / mutation / genetic recombination / natural selection.
(Any two) [CBSE Marking Scheme, 2014] 1

Q. 12. How can Hardy-Weinberg equilibrium be affected? Explain giving three reasons.
U **[Comptt Set- 1,2,3, 2018]**

Ans. (i) Gene migration / gene flow : When migration of a section of population occurs to another place and gene frequencies change in the original as well as in the new population.
(ii) Genetic drift : If the same change occurs by chance / new genes / alleles are added to the new population and these are lost from the old population.
(iii) Mutation : Pre existing advantageous mutations when selected will result in new phenotypes.
(iv) Genetic recombination : Variation in characteristics will be there because of genetic recombination during meiosis and also due to random fusion of gametes.
(v) Natural selection : Heritable variations enabling better survival enabled organisms to reproduce and leave greater number of progeny. ***(Any three)*** **1 × 3**
[CBSE Marking Scheme, 2018]

Q. 13. With the help of an algebraic equation, how did Hardy-Weinberg explain that in a given population the frequency of occurrence of alleles of a gene is supposed to remain the same through generations ?
R **[Outside Delhi/Delhi, 2018]**

Ans. In a population of diploid organisms
If frequency of allele A = p and frequency of allele a = q ½
Genotype frequency under random mating are
AA = p^2 (for the AA homozygotes)
aa = q^2 (for the aa homozygotes)
Aa = 2pq (for the Aa heterozygotes) ½
(In absence of selection, mutation, genetic drift or other forces, allelic frequency p and q are constant through generation).
Therefore, $p^2 + 2pq + q^2 = 1$ **1[2 marks]**
[CBSE Marking Scheme, 2018]

Detailed Answer:
The Hardy-Weinberg model enables us to compare a population's actual genetic structure over time with the genetic structure we would except if the population were in Hardy-Weinberg equilibrium (*i.e,* not evolving). If genotype frequencies differ from those we would except under equilibrium, we can assume that one or more of the model's assumptions are being violated and attempt to determine which one(s).
Hardy and Weinberg assigned the letter *p* to the frequency of the dominant allele A and the letter *q* to the frequency of the recessive allele a.
Since the sum of all the alleles must equal 100%, then $p + q = 1$. They then reasoned that all the random possible combinations of the members of a population would be equal $(p + q)^2$ or $p^2 + 2pq + q^2$.
The overall equation for the Hardy-Weinberg equilibrium is expressed in this way: $p^2 + 2pq + q^2 = 1$ [binomial expansion of $(p + q)^2$].

Q. 14. When does a species become founders to cause founder effect ? E & A **[Foreign Set, 2010]**
OR
How does a population become founders' of a new species. [Outside Delhi Set-I, Comptt., 2012]

Ans. When a few members or a small group of members from a certain population invades a new geographical region, they may have a different type of or changed allele frequencies from that of

the original drifted population, they become the founders of new species and the effect is called as the founder's effects.

Q. 15. (i) Rearrange the following in an ascending order of evolutionary tree : reptiles, salamander, lobfins, frogs.

(ii) Name two reproductive characters that probably make reptiles more successful than amphibians.

E & A **[Delhi Set. Comptt., 2009]**

Ans. (i) Lobefins, frogs, salamanders and reptile.

(ii) Two reproductive characters that made reptiles more successful than amphibians are :

(a) Reptiles lay eggs on land.

(b) Reptiles lay thick shelled egg which do not get dry up in sun shine unlike those of amphibians. **3**

Commonly Made Error

- Many students got confused and could not rearrange the organisms in ascending order.

AI **Q. 16. Name the ancestors of man based on the features given below—**

(i) Human like, meat eater with 900 cc brain, lived in Java.

(ii) More human with brain size 1400 cc, lived in central Asia, used hides & buried their dead.

(iii) Human like, vegetarian, with brain capacity between 650 cc & 800 cc.

(iv) Man like primate, that existed about 15 mya. Fossils found in Tanzania.

R **[Outside Delhi, Set-III, Comptt., 2013]**

Ans. (i) *Homo erectus*

(ii) *Homo sapiens neanderthalensis*

(iii) *Homo habilis*

(iv) *Australopithecus africans/Ramapithecus*

Long Answer Type Questions

(5 marks each)

Q. 1. (i) How did Darwin explain adaptive radiation ? Give another example exhibiting adaptive radiation.

(ii) Name the scientist who influenced Darwin and how ? A **[Delhi Set-III, 2016]**

Ans. Darwin explained the phenomenon of adaptive radiation on the basis of his investigation on fauna of Galapogas islands. Finches of Galapogas island offer the best example of adaptive radiation.

(i) During his journey, Darwin went to Galapogas island and observed that there were many varieties of finches in the same island. They varied from normal seed-eating ones to those that ate insects.

Another example of adaptive radiation is evolution of the Australian marsupials from a single ancestor. **2**

(ii) Work of Thomas Malthus influenced Darwin. He gave an idea about population growth and food availability. He said that present growth of human population is more than what food and other resources can sustain. This means that many people would die of starvation to level out the population. His views gave the Darwin the idea about "survival of fittest". **3**

Q. 2. (i) Explain Darwinian theory of evolution with the help of one suitable example. State the two key concepts of the theory.

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

U **[Delhi Set-I, 2014]**

Ans. (i) Darwinian theory of evolution :

(a) According to Darwin, evolution took place by natural selection.

(b) The number of life forms depends upon the life span of the organisms and their ability to multiply.

(c) Another aspect of natural selection is the survival of the fittest, in which nature selects the individuals that are most fit to adapt to their environment.

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

An example of such selection is the antibiotic resistance in bacteria. When a bacterial population was grown on an agar plate containing antibiotic penicillin, the colonies that were sensitive to penicillin died, whereas one or a few bacterial colonies that were resistant to penicillin survived.

This is because these bacteria had undergone chance mutation, which resulted in the evolution of a gene that made them resistant to penicillin drug. Hence the resistant bacteria multiplied quickly compared with the non-resistant (sensitive) bacteria, thereby increasing their number. Hence, the advantage of an organism over the other helps in the struggle for existence.

The two key concepts of the theory are :

(1) Branching descent : According to this concept, various species have come into existence from a common ancestor.

(2) Natural selection : According to this concept, nature selects the individuals that are most fit to adapt to their environment.

(ii) Characteristics of Neanderthal man :

(a) They possess a brain capacity of 1300 – 1600 cc.

(b) They were short but very strong with outward-curved thigh bones.

(c) They used hides to protect their body. They buried the dead. **5**

[CBSE Marking Scheme, 2014]

Commonly Made Error

- Students get confused between Darwinian and Lamarckism theory of evolution. Some students explained long neck of giraffe as example of Darwinian theory.

Answering Tips

- The concept of Lamarckism and Darwinian theory should be clearly discussed with example for proper understanding.
- Emphasize on technical terms like natural selection, branching descent, etc.

Q. 3. (i) How did Darwin explain adaptive radiation by taking an example of finches ?

(ii) How did Darwin's view on evolution differ from that of de-Vries ?

R **[Outside Delhi Comptt. 2017, Set - II]**

Ans. (i) Darwin conjectured that the Darwin's finches evolved on the island itself. ½

There were seed-eating finches and other finches with altered beaks arose allowing different types of food eating habits like insectivorous and vegetarian finches. ½

This process of evolution of different species in a given geographical area starting from a point and radiating to other areas of (geographical) habitats is called adaptive radiation. **1**

(ii)

Darwin	De Vries
Minor Variation (heritable) cause evolution.	Mutation caused evolution.
Variations are small and directional.	Mutation are random and directionless.
Evolution is gradual.	Single step large mutation / saltation causes speciation.

2 + 3 = 5

[CBSE Marking Scheme, 2017]

AI **Q. 4. (i) How do the observations made during moth collection in pre and post-industrialized era in England support evolution by Natural Selection ?**

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

U **[Delhi - 2017, Set - I]**

OR

Taking an example of white-winged moths and dark-winged moths of England in pre and post industrialised era, explain evolution by natural selection. [Outside Delhi Comptt. 2017, Set - I]

Ans. (i) (a) Before industrialisation white coloured lichen covered the trees in which white winged moths camouflaged themselves from predators.

(b) More white winged moths existed on trees than dark winged or melanised moths.

(c) After industrialisation there were more dark winged moths in the same area *i.e.,* proportion was reversed,

(d) Predators would spot a moth easily against a contrasting background.

(e) During post industrialisation tree trunks became dark due to industrial smoke and soot.

(f) White winged moth did not survive due to detection by predators whereas dark winged survived. **½ × 6 = 3**

(ii) 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 become insectivorous and vegetarian finches. **½ × 4 = 2**

[CBSE, Marking Scheme, 2017]

Detailed Answer:

(i) Before industrialization, white winged moths were more in number as compared to dark winged moths. It is because of less pollution.

The trunk of trees were covered with white coloured thick growth of lichens. Hence light coloured moth were not spotted by the predator and their number increased.

After industrialisation, the tree trunks become dark due to increased industrial pollution. So, now white winged moths could be detected easily and their number got decreased due to easy capture by the predator.

So, nature selected only those moths which were better suited.

(ii) The phenomenon well represented by Darwin's finches other than natural selection is adaptive radiation.

Adaptive radiation is an evolutionary process in which an ancestral species give rise to new species adapted to new habitats and new ways of life. Darwin finches evolved in same Island from original seed-eating finches. The alternation in beaks enable some of them to become insectivorous and some vegetarian.

Q. 5. (i) Describe Hardy – Weinberg Principle.

(ii) List any four factors which affect genetic equilibrium.

(iii) Describe founder effect. R **[Foreign 2014]**

Ans. (i) Allele frequencies in a population are stable and constant / gene pool, total genes and their alleles in a population remain constant from generation to generation and maintain genetic equilibrium. ½

(ii) Factors affecting genetic equilibrium are —

(a) Gene migration / gene flow.

(b) Genetic drift.

(c) Mutation.

(d) Genetic recombination.

(e) Natural selection. **(*Any four*) ½ × 4 = 2**

(iii) (a) Change in allele frequency.

(b) New genes develop, old genes are lost.

(c) Migration.

(d) Drift.

(e) New species. **(*Any four*) ½ × 4 = 2**

When section of population gets separated due to migration or genetic drift, gene frequencies changes, sometimes this change in allele frequency is different in the new population so that they becomes new species, this is called founder effect. ½

[CBSE Marking Scheme, 2014]

AI **Q. 6. (i) Name the primates that lived about 15 million years ago. List their characteristic features.**

(ii) (a) Where was the first man-like animal found ?

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

(c) When did modern *Homo sapiens* appear on this planet ? R **[Delhi Set-I, 2011]**

Ans. (i) *Dryopithecus, Ramapithecus.* **½ + ½ = 1**

They were hairy.

Dryopithecus is ape like Gorillas and Chimpanzees.

Ramapithecus more man like.

(*Any two*) ½ + ½ = 1

(ii) (a) Ethiopia / Tanzania / Eastern Africa. ½

(b) Order of appearance from earliest to the latest = *Homo habilis*, *Homo erectus*, Neanderthals. ½

Cranial capacity = *Homo habilis* = 650 – 800 cc, *Homo erectus* = 900 cc, Neanderthals = 1400 cc.

½ × 3 = 1½

(c) During ice age / 75000 – 10000 years ago. ½

[CBSE Marking Scheme, 2011]

Commonly Made Error

- Most of the students write the invalid points. Most students instead of mentioning the approximate height in feet, write just tall height.
- Accurate dimension for cranial capacity is not mentioned by few students.

Answering Tip

- Discuss only the characteristic features of human ancestors. Do a comparative analysis of the fossils of human ancestors mentioning posture, height, cranial capacity, feeding habits etc.

Q. 7. How does the process of natural selection affect Hardy–Weinberg equilibrium ? Explain. List the other four factors that disturb the equilibrium.

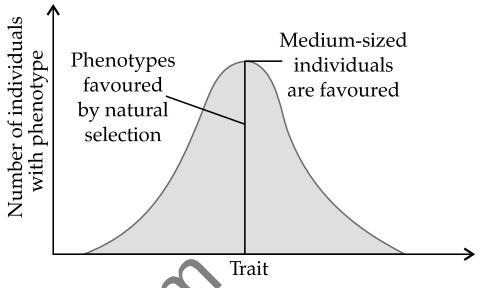
A **[Outside Delhi Set-III, 2013]**

OR

(i) Write Hardy–Weinberg principle.

(ii) Explain the three different ways the natural selection can affect the frequency of a heritable trait in a population shown in the graph given below.

A **[Delhi Set-I, II, III, 2010]**



Ans. (i) Hardy–Weinberg's principle says that allele frequencies in a population are stable and constant from generation to generation. The gene pool remains constant. This is called genetic equilibrium. Sum total of all the allelic frequencies is 1. Individual frequencies *e.g.* can be named p, q etc. Natural selection disturbs the allelic frequencies. Through natural selection either the frequency of p increases or the frequency of q it disturbs the natural frequency. In a diploid, p and q represent the frequency of allele A and allele a. The frequency of AA individuals in a population is simply p^2. This is simply stated in another ways *i.e.* the probability that an allele A with a frequency of p appear on both the chromosomes of a diploid individual is the product of the probabilities.

Hence, $p^2 + 2pq + p^2 = 1$.

The factors that affect the Hardy–weinberg's equilibrium are : Migration, Gene flow, Genetic drift, mutation and genetic recombination.

(ii) Variation due to mutation or recombination during gametogenesis or due to gene flow or genetic drift results in changed frequency of genes and alleles in future generation. Natural selection can lead to **stabilization** (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). **3 + 2 = 5**

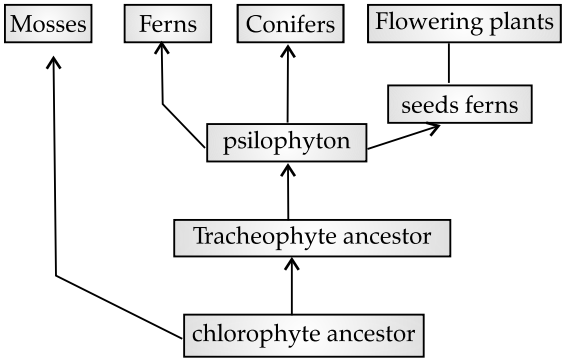
Commonly Made Error

- Students write incorrect explanation for stabilization, directional and disruption. Some students write correct explanation but draw incorrect diagram.

Answering Tip

- Directional, disruptive and stabilizing selection must be learned with comparison.

Q. 8. Study the schematic representation of evolutionary history of plant forms given below and mention.



(i) The plant form ferns and conifers are most related to

(ii) The nearest ancestors of flowering plants.

(iii) The most primitive group of flowering plants.

(iv) Common ancestry of psilophyton provides to.

(v) Common ancestors of psilophyton and seed ferns.

(vi) Common ancestors of mosses and tracheophytes.

E & A **[Delhi Set-I, Comptt., 2012]**

Ans. **(i)** Psilophyton.
(ii) Seed ferns.
(iii) Chlorophyte ancestor.
(iv) Ferns, conifers & seed ferns.
(v) Tracheophyte ancestor.
(vi) Chlorophyte ancestor. **1 × 5 = 5**

Commonly Made Error

- Spelling error is commonly seen.

Know the Terms

- **Abiogenesis :** It is the natural process by which life has arisen from non-living matter, such as simple organic compounds.
- **Biogeny :** Origin of first life.
- **Biopoiesis :** Process by which living organisms are thought to develop from non-living matter, and the basis of a theory on the origin of life on Earth..
- **Protobiogenesis :** Biochemical origin of life.
- **Chemogeny :** Origin and development of different types of organic molecules.
- **Cognogeny :** Development of different forms of life.
- **Eobiont :** Chemical precursor to a living organism.
- **Nebula :** Condensed mass of dust and gas.
- **Artificial Selection :** It is the process carried out by man to select better plants and animals.
- **Bio-geography :** The study of patterns of distribution of plants and animals in different parts of earth.
- **Gene Pool :** Sum total of all the genes in a population.
- **Panspermia :** Units of life in the forms of so called spores, which were transferred to earth from outer space (as believed by some scientists).
- **Saltation :** Single step large mutations.
- **Speciation :** It is the formation of new species from the pre-existing ones.
- **Organic (Biological) Evolution** : Changes in the characteristics/features of organisms or groups of such populations over a number of generations.

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