Long Answer Questions (PYQ)

[5 Marks]

Q.1.

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

Ans.

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

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

Ans.

Salient features of theory of Hugo de Vries:

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

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

Q.3.

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

Ans.

a. During his journey Darwin went to Galapagos Islands. There he observed an amazing diversity of creatures. Of particular interest were small black birds, later called Darwin's Finches which amazed him. He realised that there were many varieties of finches in the same island. All the varieties, he conjectured, evolved on the island itself. From the original seed-eating features, many other forms with altered beaks arose, enabling them to become insectivorous and vegetarian finches. This process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats) is called adaptive radiation. Darwin's finches represent one of the best examples of this phenomenon. Another example is Australian marsupials.
b. Thomas Malthus influenced Darwin.
   According to Malthus, population size grows exponentially (due to maximum reproduction). However, the population size remains limited due to limited natural resources which leads to competition.

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

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

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

Q.5.

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

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

Ans.

(a)

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

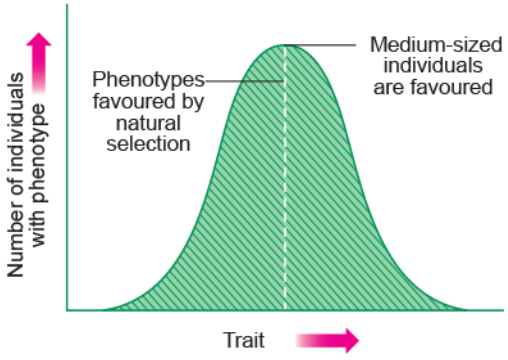
(b) Natural selection is based on following factual observations:

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

Q.6.

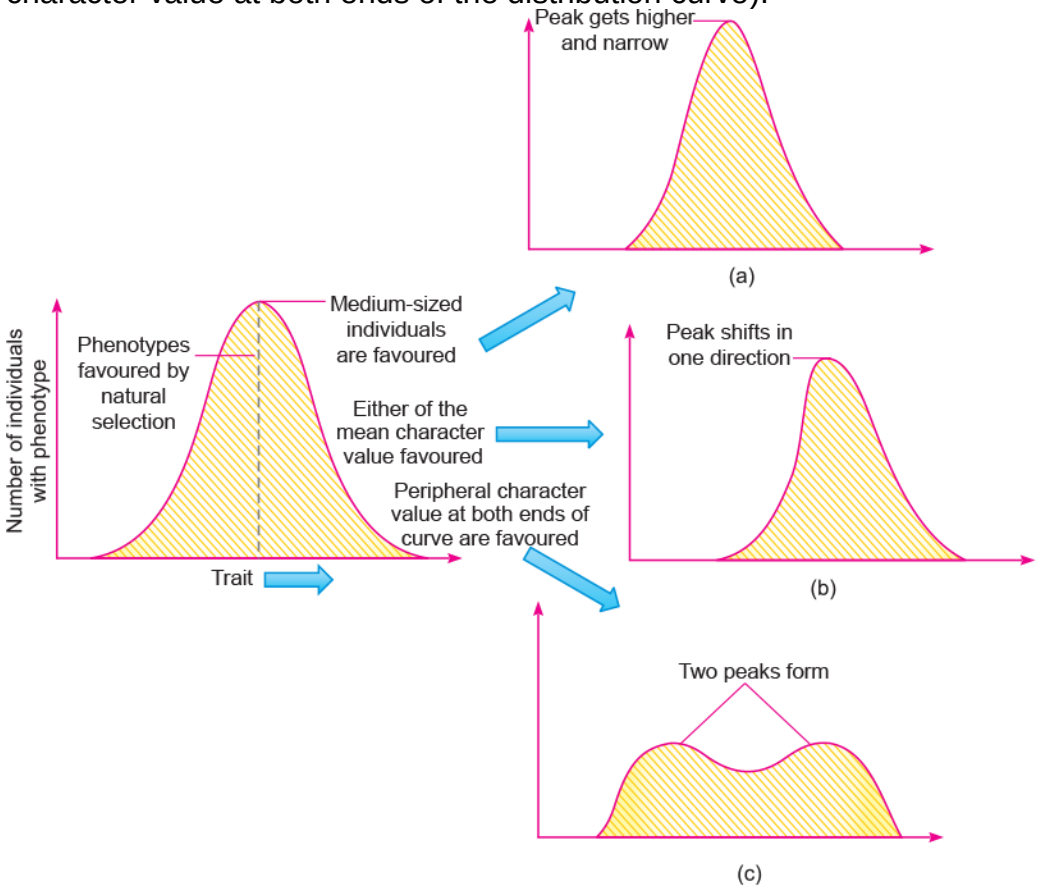
a. Write the Hardy–Weinberg principle.

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



Ans.

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



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

Q.7.

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

Ans.

a. Refer to Basic Concepts Point 8.

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

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

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

Ans.

Factors Affecting Hardy–Weinberg Equilibrium

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

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

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

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

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

Q.9.

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

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

Ans.

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

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

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

Q.10.

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

b.

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

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

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

Ans.

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

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

ii. *Ramapithecus* was more man-like.

iii. *Dryopithecus* was more ape-like.

b.

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

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

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

Q.11. Answer the following questions.

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

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

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

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

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

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

Q.12. Answer the following questions.

Q. Explain "founder effect".

Ans. Sometimes the change in allele frequency is so different in the new sample of population that they become a different species. The original drifted population becomes founder and the effect is called founder effect.

Q. State Oparin and Haldane Hypothesis.

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

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

Ans.

Experimental evidence of chemical evolution/Miller's experiment

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

Q.13. Answer the following questions.

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

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

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

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

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

Q.14. Answer the following questions.

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

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

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

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

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

Q.15. Answer the following questions.

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

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

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

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

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

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

Q.16. Answer the following questions.

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

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

i. Branching descent
ii. Natural selection

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

Ans. Characteristics of Neanderthal man:

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

Q.17. Answer the following questions.

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

Ans. Industrial melanism:

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

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

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

Q.18. Answer the following questions.

Q. Describe Hardy-Weinberg Principle.

Ans.

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

Q. List any four factors which affect genetic equilibrium.

Ans.

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

Q. Describe Founder effect.

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

Q.19. Amswer the following questions.

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

Ans. The various causes of variation are :

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

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

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

a. **Stabilisation:** Larger number of individuals acquire mean character value so peak gets higher and narrower.
b. **Directional change:** Large number of individuals acquire value other than mean character value so peak shifts in one direction.
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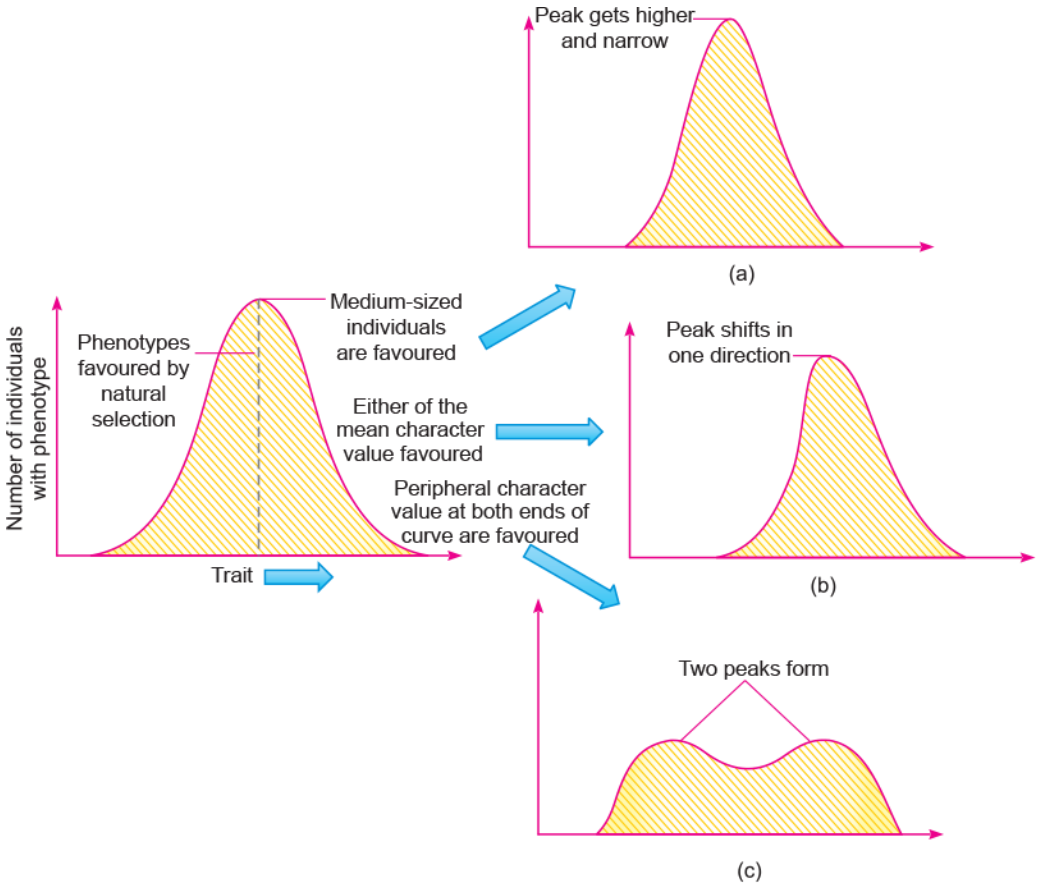

Diagrammatic representation of the operation of natural selection on different traits:(a) Stabilising (b) Directional and (c) Disruptive

Long Answer Questions (OIQ)

[5 Marks]

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

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

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

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

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

Ans.

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

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

Ans. Evolution of Man

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

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

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

Ans. Morphological and comparative anatomical evidences

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