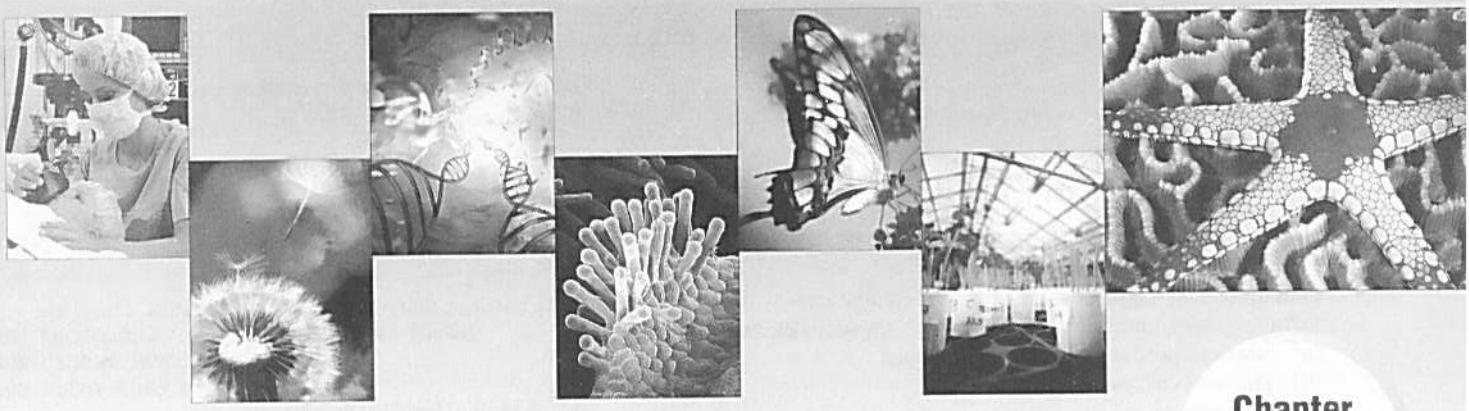


Chapter

7.3

Evolution

Origin of Universe and Earth

Philosophers and scientists have been busy to solve the riddle as to how the universe and our earth were formed and how and when 'life' originated on earth. The branch of life science for the study of 'Origin of life' and evolution of different forms of life on earth was called Bioevolution or Evolutionary Biology by Mayer, (1970).

The study of universe or cosmos is called Cosmology. Our earth belongs to the Solar system having nine stars called planets constantly rotating around a common Sun. On the basis of the order of the distance from the sun these planets include Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto while moon is a satellite of earth. The universe is made up of matter and energy and it was formed about 10 to 13 billion years ago as a red hot, dense, rotating gaseous cloud of cosmic dust called Ylem or primaeval matter. The Ylem consisted of particles of matter (like neutron, proton and electron) and antiparticles of antimatter. Scientists like **Lemaitre** (1931), **Gamow** (1948), **Dicke** (1964) etc. supported the **Big-Bang Hypothesis** which explains that collision between these particles and antiparticles caused a tremendous explosion to form atoms of hydrogen. Cosmic evolution began with the fusion of hydrogen atoms with progressively heavy atoms of different elements. Stellar systems and stars were formed by spreading of original gaseous cloud into the space and divided into smaller and larger masses. Most of the stars are masses of red hot gases even today.

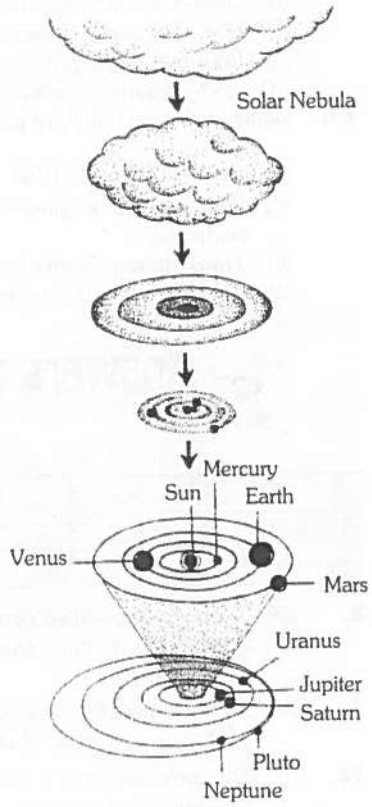


Fig : 7.3-1 Universe showing origin of earth

Kant (1755) and **Laplace** (1796) supported **Nebular Hypothesis** which explains our solar system to have evolved about 4.5 to 5 billion years ago from a rotating red-hot gaseous cloud containing millions of free atoms of different varieties. First of all sun was formed when this cloud condensed, next the planets were thrown off from the sun and later on, in turn satellites were thrown off by planets. However, Nebular hypothesis was rejected by astronomers of present century like Weizsacker (1944), Alfen (1950) and Hoyle (1955).

According to them the sun was originally surrounded by a disc of rotating gas. Later many rotating concentric whorls were formed by break up of the disc and by gravitation and rotation particles of each whorl collected and condensed to form a planet. Our earth was formed about 4.6 billion years ago as a red hot gaseous cloud of free atoms with temperature of 5000° to 6000°C.

Structure of present earth : The earth is orange like in shape. Its pole to pole diameter is 12640 km and equatorial diameter is 12783 km. It is about 15 crore km away from sun and about 484000 km away from moon. Due to tremendous temperature gases existed in atomic form; but gradually they cooled down in hundreds and millions of years into molten core. According to density other elements got stratified. Earth contains the central solid core, the middle mantle, shell and outer crust. The earth rotates at its polar axis in one day and it rotates around the sun in $365\frac{1}{2}$ days or one year.

Origin of Life

Life is the part and parcel of the universe and both are very intimately associated with each other. We know that "Life is the most unique, complex organisation of molecules, expressing itself through chemical reactions which lead to growth, development, responsiveness, adaptation and reproduction" that matter has achieved in our universe. Origin of life is a unique event in the history of universe.

(i) **Ancient theories of origin of life :** Various theories have been put forward to explain the phenomenon of origin of life. A few of them were only speculations while others were based on scientific grounds. These theories are –

(a) **Theory of special creation :** According to a Spanish Priest Father **Saurez** (1548 – 1617 B.C.), the whole universe was created in six days by the God. First day Earth and heaven, second day sky, third day dry land and vegetation, fourth day Sun, Moon and other planets, fifth day fishes and birds, and sixth day human beings and other animals were created by God. This theory was based on some supernatural power.

(b) **Theory of spontaneous generation or Abiogenesis :** This theory postulates that life originated from non-living matter spontaneously from time to time. This theory was supported by Plato, Aristotle, Anaximander, John Ray, Needham, Van Helmont, *etc.*, upto the end of seventeen century. Huxley (1870) criticised this theory and propounded the theory "life originated from preexisting life only."

❑ Abiogenesis means origin of life from non-living organisms.

(c) **Biogenesis :** Scientists like Redi (1668), Spallanzani (1767), Louis Pasteur (1866–1862) provided experimental support for the Biogenesis concept of Huxley.

Francesco Redi (1668) showed that maggots could not be created from meat. Actually, the smell of meat attracts flies which lay eggs on the flesh. These eggs hatched into flies.

Spallanzani (1767) showed that even primitive, unicellular organisms cannot arise from non-living matter.

Louis Pasteur (1860-62) obtained air samples in the flasks of broth (yeast and sugar solution) whose drawn-out necks were sealed cooling these contained a partial vaccum. Where a sample was required, the flask was opened. Air was drawn in and the flask was resealed. Flasks were incubated. These flasks which were opened in the streets became turbid while those exposed to dust-free air rarely contained bacteria.

Louis Pasteur also, used swan-necked flasks whose long, curved necks permitted exchange of air between outside and inside of the flask, but dust and bacteria were trapped along the wall of the neck. On tilting the flask, the bacteria got washed down into the broth, so that the latter became cloudy due to bacterial growth.

(d) **Cosmozoic or Extraterrestrial or Interplanetary or Panspermiatic Theory :** Richeter (1865), Preyer (1880), Arrhenius (1908), Hoyle (1950) and Bondi (1952) believed in eternity of life. According to Arrhenius life was transferred from "cosmozoa" (life of outer space) to different planets small units called 'spores'. The spores were covered by a thick protective covering. When the spores got favourable conditions and temperature, the spore coat was dissolved and gave birth to initial living organisms. This theory does not explain as to how the life originated in space and how the life originated in spores remain impenetrable by ultraviolet and gama rays.

(e) **Theory of Catastropism or Theory of sudden creation from inorganic material : Cuvier** (1769-1832) believed in catastrophism. According to him, the catastrophy destroys the whole life on earth, and after that, new life originates called it as Mechanistic theory.

(ii) **Modern Theory / Oparin Haldane Theory / Chemical Theory / Naturalistic Theory / Materialistic Theory : Haldane,** a British scientist, stated that in the early atmosphere of gas mixture probably carbon dioxide, ammonia and water vapours were predominantly present. When ultraviolet rays reacted on them, organic molecules were formed. Gradually, quantity of these oceans which later gave rise to amino acids, proteins, carbohydrates, nucleic acids, *etc.*

Oparin's Modern Theory : Oparin (1924) proposed that "life could have originated from non-living organic molecules." He believed in Biochemical origin of life. Haldane (1929) also stated similar views. Oparin greatly expanded his ideas and presented them as a book "The origin of life" in 1936.

According to this theory, the Earth originated about 4,500 million years ago. When the earth was cooling down, it had a reduced atmosphere. In this primitive atmosphere nitrogen, hydrogen, ammonia, methane, carbon mono-oxide and water were present. Energy was available in the form of electric discharges by lightening and ultraviolet rays. As soon as the earth crust was formed, it was very much folded. Torrential rains poured over the earth for centuries and were deposited in deep places.

The atmospheric compounds, inorganic salts and minerals also came in deep places oceans, these molecules gave rise to a variety of compounds and finally to the self-duplicating molecules. Ultimately these molecules were enclosed in membranes derived from lipids and proteins, along with water and chemical compounds, giving rise to cell like units. Again random combinations may have led to the formation of chlorophyll–containing organisms which could produce their own food (autotrophs) by a process called photosynthesis. These organisms had a better chance to live because they synthesise starch from carbon dioxide and water in the presence of sunlight. Starch could be used as further source of energy. During photosynthesis, oxygen was produced. The oxygen was used by other organisms for respiration. Also oxygen, when acted upon by ultraviolet rays, formed ozone layer through which ultraviolet rays cannot pass. This layer is formed about 25 km. from earth's surface. After the formation of ozone layer, organisms could come to the surface of the ocean and could survive even on land, if thrown out of oceans. The Oparins's and Haldane's theory of origin of life is most accepted these days as it is supported by Miller's experiment duly supported by David Buhal, Melvin Kelvin's experiment *etc.*

❑ O_2 is absent in the primordial atmospheres at the time of origin of life.

Miller's Experiment : An American scientist (Biologist) Stanley Miller (1953) performed an experiment under support of Oparin's theory of origin of life. He believed that basic compounds which are essential for life can be synthesised in the laboratory by creation in the laboratory, on a small scale, the conditions which must have existed at the time of origin of life on earth.

Miller took a flask and filled it with methane, ammonia and hydrogen in proportion of 2:1:2 respectively at 0°C. This proportion of gases probably existed in the environment at the time of origin of life. This flask was connected with a smaller flask, that was filled with water, with the help of glass tubes. In the bigger flask, two electrodes of tungsten were fitted. Then a current of

60,000 volts was passed, through gases contained in bigger flask for seven days. At the end of seven days, when the vapours condensed, a red substance was found in the U-tube. When this red substance was analyzed, it was found to contain amino acids, Glycine, aspartic acid, alanine and nitrogenous bases which are found in the nucleus of a cell.

❑ An experiment to prove that organic compounds were the basis of life, was performed by miller.

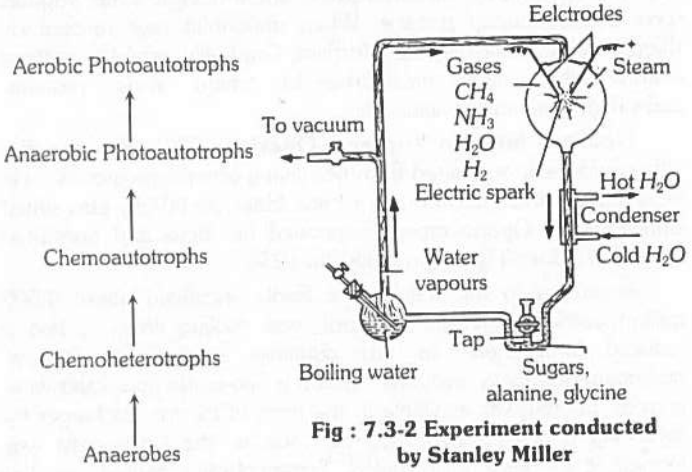


Fig : 7.3-2 Experiment conducted by Stanley Miller

From the above theory we conclude that life first originated in water. Therefore, water still continues to be an essential constituent of life.

The entire process of the origin of life, as proposed by Oparin, can be summarised as under :

(a) **The Chemical Evolution**

(1) **Step 1 : Formation of simple molecules** : The reactions between simple atoms like carbon, hydrogen oxygen and nitrogen in the primitive atmosphere led to the formation of simple compounds like water, ammonia and methane. But since the earth was very hot, all these substances remained in the form of vapours in the atmosphere. Gradually, as the earth started cooling down, the dense clouds began raining on the earth. But the liquid was still very hot. Therefore, as the liquid water touched the earth's surface, it again got vaporized to be returned to the atmosphere. This process continued for millions of years. As a result of these heavy downpours, the earth's surface got filled with water to form rivers and oceans. Ammonia and methane got dissolved in the oceanic water. The mineral elements, which were dissolved in rivers, were also carried into the oceans when rivers joined it.

The scientists have found that simple unicellular organisms (resembling modern cyanobacteria) were present on this earth about 3600 million years ago. It is believed, therefore, that life must have originated on this earth about 4600 to 3600 million years ago.

It must be clear that the earth's atmosphere at that time was quite different from as it exists today. The earth's atmosphere at that time was reducing, not oxidizing (as it is today). The primitive atmosphere of earth had hydrogen, nitrogen, water vapours, carbon dioxide, methane and ammonia abundance. Oxygen was not available in free state in sufficient quantities.

(2) **Step 2 : Formation of simple organic compounds :** Continuous rains provided opportunities for different types of molecules to collide with each other and react. Methane is an active compound, and it reacted with other compounds to form organic compounds like ethane, butane, propane, ethyl alcohol. From such organic compounds which were formed in the ocean and which played a role in the origin of life include –

(i) **Sugars, glycerol and fatty acids :** These were formed by the combination of carbon, hydrogen and oxygen.

(ii) **Amino acids :** These were formed by the combination of carbon, hydrogen, oxygen and nitrogen.

(iii) **Pyrimidines and Purines :** These were formed by the combination of carbon, hydrogen and nitrogen.

These compounds were formed at the time when sunlight could not reach earth because of dense clouds in the sky. Under such circumstances, the energy required for the synthesis of above–mentioned chemical substances must have been obtained from the cosmic rays and lightening in the sky. Haldane proposed that these simple organic compounds gradually accumulated in the water bodies and finally a 'hot thin soup' or 'prebiotic soup' or broth was formed. This set the stage for the chemical reactions.

(3) **Step 3 : Formation of complex organic compounds :** The simple organic compounds combined in different ratios to form complex organic compounds like polysaccharides, fats and proteins.

(i) Simple sugars combined in different ratios to form polysaccharides like starch, cellulose, glycogen *etc.* The formation of such compounds had been very important for the origin of life because cell walls are made up of cellulose and energy–giving molecules are stored in the form of starch and glycogen.

(ii) The reaction between glycerol and fatty acids yielded fats.

(iii) Different types of combinations between a variety of amino acids yielded different types of proteins. The formation of protein was a very important step in the origin of life because proteins are not only structural components of cell organelles, but many proteins, called enzymes, work as catalysts for biochemical reactions.

In fact, the present day organisms synthesise their complex molecules from simple organic substances with the help of enzymes only. However, enzymes themselves are proteins. Therefore, first of all protein must have been synthesized without the help of any enzyme.

(4) **Step 4 : Formation of nucleic acids and nucleoproteins :** The reaction between methane, ammonia and water resulted in the formation of purines and pyrimidines. Some of the purines and pyrimidines combined with sugar and phosphorus to form nucleotides. Many molecules of nucleotides combined to form nucleic acids–DNA and RNA. The formation of nucleic acid in the oceanic water was a big step in the direction of origin of life. Nucleic acids combined with the proteins to form nucleoproteins. Some of the nucleoproteins developed the capability to synthesise molecules similar to themselves, from organic and inorganic substance present in the ocean. In other words, the capability to reproduce had evolved. As a result of continuos reproduction, the number of nucleoproteins went on increasing. Since, organic substance were required for this, the organic substances started being depleted resulting in competition

between the nucleoproteins. Physical and chemical changes sometimes led to the changes in the competition of nucleoproteins, and new types of nucleoproteins came into existence by mutations. Those new nucleoproteins which were successful in the competition, increased in number.

(b) **Organic Evolution (Biological Evolution)**

(1) **Step 5 : Formation of Coacervates :** Oparin believed that the formation of protein was a very important step towards the origin of life. The **Zwitterionic** nature of the protein molecules enabled these colloidal structures to maintain their identity inspite of being surrounded by water molecules–forming a type of emulsion. The coalescence of these colloidal structures led to the formation of structures called coacervates. These coacervates had the ability to exchange substances with the surrounding water and accumulating required substances within them.

❒ Under certain conditions scientists have obtained cell like structures. These are known as coacervates.

Sydney F. Fox's experiment : Sydney F. Fox of Florida University, obtained some complex molecules by heating upto 90°C a dry mixture of many amino acids found in living organisms. The molecules so obtained very much resembled the proteins. He heated these molecules in water and allowed the mixture to cool down. In the fluid so obtained, he could observe minute structures resembling the cells. He called them microspheres. The microspheres are surrounded by membranes, and these also reproduce vegetatively just like yeast. Surprisingly the biochemical processes like breakdown of glucose also occur their. However, electron microscopic examination of these does not reveal any cellular structure. On keeping in distilled water, these become turgid, but these get shrunk if immersed in salt solution. Oparin's coacervates and Fox's microspheres are infact, similar structures or Protocells or Protobionts or Eobionts.

(2) **Step 6 : Formation of Primitive living system :** A primitive cell membrane was formed by the arrangement of lipid molecules between the surface of coacervates and external watery medium. This provided stability to the coacervates. It is believed that a primitive cell was formed when–

(A) **Nucleic acids** having the property of self-duplication entered the coacervates.

(B) **Rearrangement** of molecules occurred inside the coacervate surrounded by lipid molecules.

(3) **Step 7 : Formation of first cell :** Evidences available so far indicate that the cells of the earliest organisms did not contain either nucleus or cell organelles. The molecules of nucleic acid were surrounded by a colloidal mixture (may be called protoplasm) of proteins and organic compounds. This, in turn, was surrounded by a thin protein-lipid membrane. Water and soluble substances would pass through this membrane. Some proteins achieved the ablity to act as enzyme. Such cells which lacked nuclei were called prokaryotic cells. In 1966, some fossils have been discovered from 300 million years old rocks. These fossils are of prokaryotic organisms. Earliest organism is chemoheterotrophs.

(4) **Step 8 : Origin of autotrophism :** In the primitive organisms, the process of metabolism began because all the substances required for reduction were available in water. Of course, oxygen was not available which was required for oxidation of substances to yield energy. Thus the first living organisms were anaerobes and heterotrophs. The primitive cells respired anaerobically i.e., these used to obtain energy by fermenting the organic compounds obtained form the water, with the help of enzymes due to fast nutrition, growth and multiplication, their number in the ocean increased greatly. As a result, scarcity of organic substances developed in the ocean. A struggle started between the cells for obtaining nutrition.

At such a time, some of these organisms developed the capability of synthesizing organic substances. Such organisms began synthesizing energy– giving substances (carbohydrates) from simple inorganic substances abundantly available in the environment. In this way, evolution of autotrophs from heterotrophs took place.

This was the beginning of autotrophic nutrition. However, it was quite different from the photosynthesis which is carried out by green plants, because it utilized energy obtained by anaerobic respiration (not solar energy). Therefore, such type of nutrition is also called chemoautotrophic nutrition. Such type of nutrition is observed even today in the sulphur bacteria.

$$6CO_2 + 12H_2S \xrightarrow[\text{Chemical energy}]{\text{Fermentation}} C_6H_{12}O_{11} + 6H_2O + 12S$$

At the same time, from different chemicals present in the oceanic water evolved porphyrins which where like modern chlorophyll led to the evolution of present chlorophyll, so that these cells started utilizing H_2O instead of H_2S for photosynthesis. Thus they performed anoxygenic photosynthesis.

$$6CO_2 + 12H_2S \xrightarrow[\text{Energy}]{\text{Solar}} C_6H_{12}O_6 + 6H_2O + 12S$$

Till then, oxygen was not freely available in the atmosphere. However, gradually molecular changes in the bacteriocholorophyll led to the evolution of present chlorophyll, so that these cells started utilizing H_2O instead of H_2S for photosynthesis. Thus they performed oxygenic photosynthesis using water as hydrogen donar.

$$6CO_2 + 12H_2O \xrightarrow[\text{Energy}]{\text{Solar}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

In this way, the prokaryotic cells which were chemoautotrophs, became photo autotrophic. These cells resembled modern cyanobacteria. In 1968, the forms of such types of cells have been recovered from 320 million years old rocks. These have been given the name *Archaeospheroides barbertonensis*. Due to the absence of well-defined nuclei in them, these have been included under the kingdom 'Monera'. Thus, release of O_2 in the atmosphere and its free availability was the result of photosynthesis. This was a revolutionary change which greatly affected the course of organic evolution.

(5) **Step 9 : Origin of Eukaryotic cells :** As a result of photosynthesis, oxygen was released in the atmosphere which started reacting with methane and ammonia in the atmosphere. Its reaction with methane yielded CO_2 and H_2O. On the other hand, reaction between oxygen and ammonia resulted in the formation of CO_2 and nitrogen. In the course of these changes, Ozone (O_3)

gas was formed from oxygen; the ozone spread in the form of an envelope surrounding the earth, the distance between the ozone layer and the earth's surface being approximately 15 miles. Thus free oxygen changed the reducing atmosphere into oxidizing atmosphere. As free oxygen became available on the earth, gradual changes took place in cell structure also. Membrane bound organelles *i.e.*, mitochondria, chloroplasts, golgi bodies, lysosomes evolved. Most of the organisms on the earth today are eukaryotic. Gradual changes in the earth's atmosphere led to gradual changes in the eukaryotic cells also. Instead of living separately, the cells started living together in the form of colonies. Simultaneously, multinucleation of multicellular structures forming tissues. Different types of tissue combined to form special organs. From the organs, organ systems and ultimately complex bodies of organisms were formed.

❑ Organic evolution would have not been taken place if individuals in a population did not show genetic variation.

❑ Synthetic theory is the most accepted theory of organic evolution.

❑ The greatest evolutionary change enabling the land vertebrates to be completely free from water, was the development of shelled eggs and internal fertilization.

❑ The material for organic evolution is mutation.

Evidence of Organic Evolution

The following are the evidences in favour of Organic Evolution :

(i) **Evidences from Classification :** All the known living animals and plants have been classified into various species, genera, families, order, classes, phyla and kingdoms. The classification of a particular animal is attempted only after its extensive study. It is seen that every living being is related with other living being. The relations may be very close or may be quite apart. On their relationship, they are put under various orders, classes, phyla *etc.* On the superficial examination one can hardly believe that they are interrelated. But after their careful study they can be arranged in definite order, Protozoa (acellular) being at the base while Chordata at the top. No doubt, there is some sort of gap between chordates and non-chordates today but who knows that this gap may be filled some day by some further discoveries. Moreover, the present-day types represent only the terminal twigs of a vast phylogenetic tree and for establishing relationship we should focus our attention on the main trunk. The animals can be classified as described above in a systematic order.

(ii) **Evidences from Comparative Morphology and Anatomy :** In all the living animals, the basic substance of life is Protoplasm. If the species had been created separately, then there should be no relationship in the various organs and systems of animals. But on the contrary, we see that large number of animals although unlike in appearance show most of the systems and organs made on the same plan. The resemblance are very close in the members of the same group. For example –

(a) **Analogy and Homology :** While examining the various structures in the bodies of different animals, one may come across certain organs of same origin but of different functions. For example, the forelimbs of salamandar, crocodile, bird, bat, whale, and man, all have the same origin and essential structures but different functions to perform. Such structures are called homologous. On the other hand, the wings of insect, pterodactyle, bird and bat perform the same function, though they have different origin and entirely different structures. Such structures are termed analogous.

The homologous structures give us the answer that how the two different types of animals or organs have the same origin and functions to perform; this shows that they have changed themselves according to their different needs.

❑ Analogous organs are those, which are functionally similar.

❑ Homologous organs explains divergent evolution.

❑ Similarity developed in distantly related groups as an adaptation to the same function is called convergent evolution.

❑ The wings of an insect and a bat exhibit analogy.

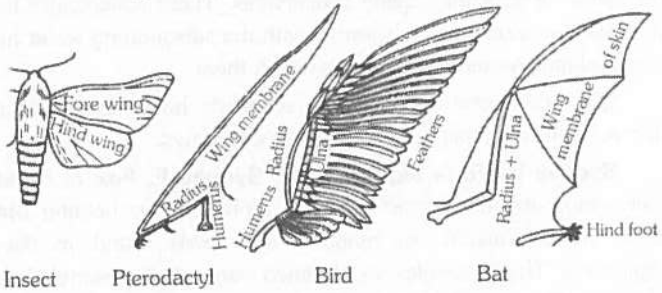


Fig. 7.3-3 : Analogy in the wings

(b) **Vestigeal organs :** There are present in the body of animals certain structures which have no function and are very much reduced. These structures are quite developed and functional in allied animals. Such useless organs are termed as vestigeal and are of frequent occurrence. In human body alone, there are as many as ninety such organs. For example, vermiform appendix is vestigeal in man but functional in rodents, horse and other herbivorous animals.

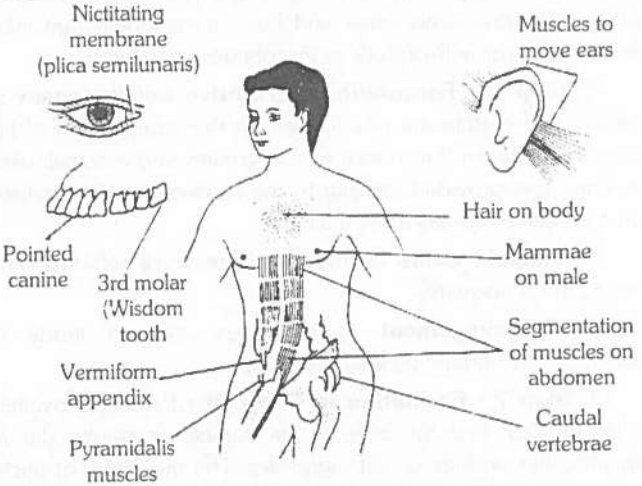


Fig. 7.3-4 : Different vestigeal organs in man

❑ Hind limbs is a vestigeal organ of python.

❑ Muscles of ear pinna is vestigeal organ of man.

❑ Wisdom teeth is vestigeal organ of man.

(c) **Atavism :** Atavism or reversion is the sudden reappearance of some ancestral features which was either vestigeal or altogether absent in parents. Such as Large canines, thick body hairs, short temporary tails, ability to move pinnae.

(d) **Connecting links :**Intermediate or intergrading forms between two groups of organisms :

Table : 7.3-1

Organism	Connecting link between
Viruses	Living and nonliving
Euglena (Protozoa)	Plants and animals
Proterospongia (Protozoa)	Protozoa and Porifera
Peripatus (Arthropoda)	Annelida and Arthropoda
Neopilina (Mollusca)	Annelida and Mollusca
Balanoglossus (Chordata)	Nonchordata and Chordata
Dipnoi (Lungfish)	Pisces and Amphibia
Archaeopteryx (Aves)	Reptiles and Birds
Prototheria (Mammalia)	Reptiles and Mammals

Missing links : These are the fossil forms, transitional between two present day groups (taxa) of organisms.

E.g., Stegocephalous - between fishes and amphibians

Archaeopteryx – between reptiles and birds

Archaeornis - between reptiles and birds

Inostracevia - between reptiles and mammals

Manchurosaurus - between reptiles and mammals

Table : 7.3-2

Era	Age million years	Period	Epoch	Dominated Fauna
Coenozoic (Age of Modern life)	0.1	Quaternary	Recent (Holocene)	Modern man, mammals, birds, fishes, insects.
	2.5		Pleistocene	Extinction of great mammals. Primitive man common. Evolution of human society & culture.
	7	Tertiary	Pliocene	Evolution of primitive man–like forms from man like apes. Formation of modern mammals.
			Miocene	Mammals at peak. Evolution of man–like apes.
	38	Oligocene	Rise of monkey, apes and monocots	
	54	Eocene	Diversification of placental mammals birds, origin of horse	
	65	Palaeocene	Origin of primates, placental mammals, angiosperm forests	
Mesozoic (Era of Medieval life)	135	Cretaceous	Extinction of dinosaurs and toothed birds. Rise of first modern birds Angiosperm appeared.	
	195	Jurassic (Age of Giant Reptiles)	Origin of advanced lizards, crocodiles, alligators, marsupials toothed birds. Dinosaurs became large. Reptiles dominant.	
	240	Triassic	Origin of dinosaurs & primitive mammals (egg–laying mammals). Extinction of primitive amphibians.	
Paleozoic (Era of Ancient life)	285	Permian	Extinction of many marine invertebrates like trilobites. Rise of modern insects. Evolution of mammals like reptiles.	
	375	Carboniferous (Age of Amphibians)	Origin of reptiles and winged insects. First seed plants.	
	420	Devonian (Age of fishes)	Origin of first land vertebrates (amphibians) Fishes abundant. Origin of gymnosperms.	
	450	Silurian	Origin of jawed fishes and wingless insects.	
	520	Ordovician (Age of invertebrates)	Origin of chordates with first jaw– less fishes (origin of vertebrates). Invertebrates abundant.	
	570	Cambrian	All invertebrate phyla established. Trilobites (swimming crustaceans which do not exist today) dominant	
Pre-Cambriam	2300 3600 3800	Proterozoic (Era of early life)	Origin of marine metazoans including sponges, cnidarians, annelids, molluscs and arthropods. Scanty fossils. Origin of prokaryotes (Monera) and Eukaryotes (Protista).	
	4200	Archaezoic	Origin of life.	
	4200 – 4600	Azoic	No life?	

(iii) **Evidences from Physiology/Biochemistry :** Various types of chemical tests exhibit many basic similarities in physiological and chemical properties that show a physiological relationship among animals.

Take the example of thyroxin hormones, which are similar in all vertebrates. The thyroid of human beings can be very easily replaced by the thyroid of cattle without any ill effects and so on.

Evidences from Serology : This is a method by which the reactions of blood serum is observed. From the blood are also extracted the crystals of Oxyhaemoglobin. The structure differs in different vertebrates, but in a definite order. The reaction is nearly identical in man and anthropoid monkeys, but slightly less identical with other mammals.

(iv) **Evidence from Embryology :** Van Baer (Father of modern embryology) put forward :

Germ layer theory : Various body structures arises from the same germ layers in different species of animals.

Baer's Law : It revealed the fact about the sequence of development of structures in organisms (*i.e.*, less general features → more general features → more special features).

Muller and Haeckel in year 1864 reinterpreted the Baer's law in light of evolutionary theory as Biogenetic law. According to this law 'structure of ancient origin develop earlier than structure of newer origin' or 'development of structures in an organism follow the same sequence as they evolved in his ancestors' or Ontogeny (life history of an individual) repeats phylogeny (evolutionary history of race).

(v) **Evidences from Palaeontology :** The study of fossils and their interpretation forms one of the great evidences of evolution. An Italian scientist, **Leonardo da Vinci,** was the first person to recognize their importance and said they were either remains of organisms of their impressions on some sort of clay or rock.

A number of fossils have been discovered from time to time. Some of these fossils are very prefect in their state of preservation. For example, the fossils *Archaeopteryx* shows the characters of reptile on the one hand, and the characters of birds on the other hand, meaning that the birds have evolved from reptiles, the *Archaeopteryx* being a connecting link.

In the same way all the evolutionary stages of horse, elephant, camel and man *etc.*, can be constructed. The earliest horse was known as *Eohippus.* It was eleven inches in height and made its appearance in Eocene time from some unknown five-toed ancestor. The Eohippus, after various evolutionary stages, transformed itself into the present-day horse *Equus,* which shown many dissimilarities from its great grand, grand ancestor. The various stages in its evolutionary life had been preserved as fossils. The same is the case with camel, elephant and man, *etc.* So this science of paleontology helps in a great deal in understanding the process of evolution.

- ❑ Wallace gave a theory very similar to that of Darwin.
- ❑ In Cenozoic era mammals and birds were evolved.
- ❑ There was no life in Azoic era.
- ❑ Fossils are remains of organisms present in the rocks.
- ❑ Ruling reptiles were dominant during Mesozoic era.

Fossils :

(a) Direct evidences of organic evolution are provided by fossils (L. *fossil*, dug up).

(b) The science of discovering and studying fossil record is called Palaeontology (Gr. *palaeo*, ancient; logy, study of).

(c) Fossils are remnants, models and impressions of extinct organisms.

(d) Fossils are found preserved in earth's sedimentary rocks.

(e) Fossil may be an entire organism buried in sediment or snow, small part of ancient organism or impression of ancient leaf or stem.

(f) Fossilization occurs where organisms are buried and preserved by natural processes.

Age of fossils

(a) The age of the fossils or rocks can be determined by 'Clock of the rock method' or 'Radioactive clock'.

(b) 'Clock of the rock' method is based on conversion of unstable radioactive nuclei into stable nuclei over a fixed period.

(c) Radioactive clock method was introduced by Boltwood in 1907.

(d) The common radioactive elements which lose their radioactivity and change into their non-radioactive isotopes at a fixed rate are :

Potassium ^{40}	→	Argon ^{40}
Carbon ^{14}	→	Nitrogen ^{14}
Uranium ^{238}	→	Lead ^{207}
Rubidium ^{87}	→	Strontium ^{87}
Thorium ^{232}	→	Lead ^{206}

Living fossils : Living fossils are the organisms which underwent little change during long geological periods e.g.,

Peripatus	–	Primitive arthropod
Limulus (king crab)	–	Arthropod
Neopilina	–	Mollusca
Lingula	–	Mollusca
Latimaria	–	Coelocanth fish
Sphenodon (tuatara)	–	Reptilia
Didephis	–	Opossum
Plastasterias	–	Echinodermata
Echidna and platypus	–	Mammalia

(vi) **Evidences from geographic distribution :** If the study of horizontal distribution of animals on the face of this earth is made, it would be seen that animals are not evenly distributed. Two identical places with the same climate and vegetation may not have same sort of animal fauna **Alfred Russel Wallace** (1823-1913) divided the whole world into six major biogeographical regions or realms. Nearctic – Northern America, Palaearctic –N. Africa, N. Asia, Europe, Neotropical – Central and S. America, Oriental –Asia (South of himalayas *i.e.*, India, Ceylon, Malayasia, Indonesia, Philippines), Ethiopian – S. Africa, Australian –Australia, New Zealand. For example, *Elephants* and *Rhinoceros* occur in India and Africa only and not in Brazil, although the climatic conditions are alike. Again, members widely separated areas. For example, lung fishes are found in South America, Australia, Africa and nowhere else.

The explanation of this uneven distribution is quite obvious, and can be explained on the basis of organic evolution. A particular species, after arising from one place, migrates to other far off places. While doing so, it has to come across various climatic changes for which it tries to modify it self. In this way, the new species are added. After its dispersal, if some barriers arise, the species becomes confined to that particular region and is isolated from the parent species. This provides a very interesting theory on the mechanism of organic evolution.

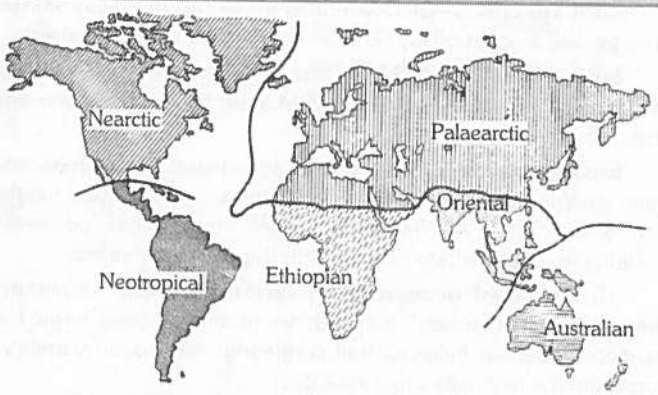


Fig : 7.3-5 The biogeographical realms of the world

Charles Darwin during his voyage around the world studied the fauna and flora of Galapagos islands (off the west coast of south America). Galapagos islands are called 'a living laboratory of evolution'. Darwin studied 20 related varieties of the bird belonging to family Geospizidae different in shape and size of beak. These birds are now called 'Darwin's finches'.

(vii) **Evidences from Genetics : Johann Gregor Mendel** in 1866 published his work on experimental breeding. He bred two individuals differing in certain well-defined characters, and observed the ratio in which various contrasting parental characters appeared in successive generations. Since then, selective breeding has started in the case of domestic animals and plants to obtain the evidences of organic evolution. These furnish the direct evidences of evolution.

Conclusion : According to the above description, we have seen certain evidences in favour of organic evolution. Although the evidences are indirect, merely interpretations based on certain phenomenon, certain organs, systems and other facts but they throw enough light to show us that the present day forms of life have originated from simpler forms in millions and millions of years. The process was continuous gradual, and accompanied by trial and error.

Theories of Organic Evolution

(i) **Lamarckism :** Lamarck (1744 –1829) was one of the most brilliant stars on the horizon of the history of evolution. Though he was a man of great intellect yet he had to cut a sorry figure because of poverty, and secondly, as he could not get the approval of the famous and influential **Cuvier.** His work was recognized only few years after his death.

He was the first naturalist to put forward a general theory of evolution in his famous book. *Philosophic Zoologique* published in 1809. His evolutionary theory may be summarised in the form of following laws:

(a) **The internal forces of life tend to increase the size of an organism :** Lamarck believed that there is some kind of internal force which is constantly working in living beings. It tries to make the animal bigger in size.

(b) **The necessity in animals to produce new structures :** According to this law, each organ and structure is the product of some continuous necessity in the animals, to develop it. He believed that it was not due to the direct influence of the environment, but acted through the nervous system, the process being very slow. The plants, he said, were directly influenced by their environmental conditions.

(c) **The effect of use and disuse :** Lamarck thought that the continuous use of a particular organ or structure tends to increase its size and its development. On the other hand, disuse results in disappearance of that structure, the process being slow and gradual. He supported this by a number of well-known examples. The long neck of giraffe was the result of continuous stretching to obtain food from the trees (long neck was acquired due to excessive use). The wings of certain birds *Ratitae* were not used for long, as there were no formidable enemies and food was available in abundance. So they did not fly and consequently lost the power of flight. Their wings became rudimentary (flightless condition acquired due to the disuse of wings).

(d) **Inheritance of acquired characters :** Lamarck stated that all the characters, which are acquired in one's own lifetime are inherited by offsprings.

Criticism : The greatest draw-back in the Lamarck's work was that it was too theoretical and there were no proofs to support it. His ideas were theoretically sound but practically they had no standing. He met a severe criticism from various workers –

(1) The most serious blow came from Weismann who put his theory of continuity of germplasm which states that the inheritance is the sole concern of germ cells. Characters introduced in the germ cells will only be inherited and not those which are present in somatic cells.

(2) If the acquired characters were to be inherited, as Lamarck said, the world would have been full of cripples, blinds and deformed persons, as most of these characters are acquired.

(3) Some workers have practically proved that mutations are not inherited by offspring's even if practiced for generations.

Lamarck's second and third laws show much truth in them; but they are not the sole cause of evolution. The laws of heredity of Weisman are practically opposed to the fourth law of Lamarck. Nevertheless, there came a number of workers who supported Lamarck and modified his laws. They were known as Neo-Lamarckian and the names of a few of them are : Cope, Haeckel, German savant, Gadow and Spencer.

(ii) **Germplasm theory :** Germplasm theory was given by Weisman. Later on, Weismann also admitted that the germplasm may become modified to a certain extent by some environmental factors.

❑ Key point to Lamarck's view about organic evolution is that every offspring inherits characters acquired by the parental generation.

❑ Law of "Inheritance of acquired characters" is presented by Lamarck.

❑ Lamarck's theory was most severely criticized by cuvier who greeted it by calling it "Nouvelle Folie."

Table : 7.3-3 Difference between Lamarckism and Neo–Lamarckism

Lamarckism	Neo–Lamarckism
It is the original theory given by Lamarck.	It is a modification of the original theory of Lamarck in order to make it more suitable to modern knowledge.
The theory lays stress on internal force, appetency and use and disuse of organs.	Neo–Lamarckism does not give any importance to these factors.
It believes that changes in environment brings about a conscious reaction in animals.	The theory stresses on the direct effect of changed environment on the organisms.
According to Lamarckism the acquired characters passes on to the next generation.	Normally only those modifications are transferred to next generation which influence germ cells or where somatic cells give rise to germ cells.

(iii) **Darwinism :** Charles Robert Darwin was undoubtedly the first naturalist who put the idea of organic evolution on sound footing. His statements and theories were based upon practical experiences and large number of proofs which he collected directly from the nature. He devoted his whole life for the purpose of finding out proofs in support of the theory of organic evolution.

Table : 7.3-4 The natural selection theory may be summarized by a chart devised by wallace

	Facts	Inference
A	1. Enoromous fertility 2. Limited food and space	Struggle for existence
B	1. Struggle for existence 2. Variations	Survival of fittest or natural selection
C	1. Survival of fittest 2. Continuous environmental changes	Origin of new species

❑ Charles Darwin wrote Origin of species.

❑ Darwin was appointed up on a world survey ship of British government H.M.S. Beagle.

His main ideas about the evolution are given below –

(a) **Over-production of offsprings :** The power of reproduction is enormous in the living beings. The single *Paramecium* (Protozoa) divides about 600 times in a years. If all the progeny survive their total amount would exceed that of earth in a few months. Again if all the eggs of a lobster were to produce young ones, in about ten years time the sea would be full of lobsters and there will be hardly any space for other animals. Darwin gave one more interesting example of elephants. An elephant lives for about a hundred years and starts reproducing at the age of thirty. If each female produce six young ones, in 750 years, about 1,90,00,000 would be alive.

(b) **Limited supply of food and shelter :** The amount of food and shelter is limited in a particular area. It is sufficient only for a definite number of individuals.

(c) **Struggle for existence :** It is a common experience, that even with the enormous rate of reproduction, the number of species mostly remains stationary. The nature has provided a number of checks over their population. There is limited food, breeding places, shelter, presence of predators and parasites, *etc.*

There is always going on a struggle for existence among various agencies. The struggle for existence may be–

Inter-specific : When two different groups of animal species are opposed to each other, *i.e.*, lion and deer or birds and insects.

Intra- specific : When there is struggle between the members of the same species, as all of them have same wants and requirements.

Environmental : It is the struggle between the animals and their environment (*i.e.*, climate, vegetation, open spaces, jungles and water, *etc.*,) A change in climate may affect adversely, resulting in the extinction of some and the survival of others.

(d) **Universal occurence of variations :** The "departures form the original pattern" and changes in animals were termed as variations. Darwin believed that continuous and useful variations constitute the raw material of evolution.

(e) **Survival of the fittest or Natural selection :** In struggle for existence, only those organisms survive which possess the most useful variations. This has been called 'Natural selection' by Darwin and 'Survival of fittest' by Spencer.

(f) **Inheritance :** The useful variations are inherited by the progeny.

(g) **Origin of new species :** Favourable variations accumulate over generations to ultimately form a complete new species.

❑ To explain inheritance of characters from one generation to another Darwin proposed 'Theory of Pangenesis'. According to this theory each somatic cell produce pangene. All the pangenes from body cells accumulate in gametes and transfer characters to next generation.

Most of the biologists agree with the Darwin's theory as the best explanation of organic evolution. But there are a number of objections to this theory.

❑ By performing the replica plating experiment, Lederberg supported the "Natural Selection Theory".

Objections

(1) Darwin's theory does not explain that the effects of 'use and disuse' of organs are inherited.

(2) He considered the minute fluctuating variations as the cause of natural selection, but most of the variations are non-heritable.

(3) He did not distinguish between germinal and somatic variations. His theory of Pangenesis has no basis at all.

(4) He believed that variations occur in all directions haphazardly. But now it is established that the variations occur only on definite lines of change.

(5) Darwin called mutations as 'SPORTS' but being unaware about genetics he couldn't explain these.

(6) Darwin's theory explains survival of the fittest but not about arrival of the fittest.

(7) It does not explain how natural selection could make use of certain adaptive characters in their initial stages, *i.e.*, what would be the use of electric organs, electric fishes, until they have enough of power to produce a shock.

(8) It does not explain the over-specialised and vestigeal organs. Overspecialization of certain characters proved harmful such as Antlers of Irish elk, teeth of Swedolon, heavy armour of dinosaure.

(9) According to him, only useful characters are inheritable but on the contrary certain useless and non-adaptive characters are also passed on.

(10) Geologists and astronomers think that the time required for producing organic world is much more than the actual age of the earth today.

In the light of these criticism and objections various workers after him modified his theory. Most of the work was done after the rediscovery of Mendel's work in 1900. This modified theory of Darwin is known as **Neo- Darwinism.**

Examples of Natural selection

(1) **Industrial melanism :** Industrial melanism is a phenomenon where the moths living in the industrial areas, develop black colour (melanin pigments) to match the body to soot-covered background, on the bark of trees.

The industrial melanism is observed and worked out by a number of evolutionists like Fisher, Ford and Kettlewell.

Industrial melanism was observed in a peppered moth *Biston betularia* living, Manchester, in an industrial city of Great Britain and it is the example of 'evolution taking place before the eyes'.

The change of the lighter coloured variety of peppered moth, *Biston betularia (typica)*, to its darker variety (*carbonaria*) is due to mutation of a single Mendelian gene for survival in smoke-laden industrial environment.

The peppered moths exist in two forms, namely melanic forms and non-melanic forms. The melanic forms are black in colour because they contain melanin pigments. The melanic forms are also called carbonaria. The non-melanic forms are light coloured. The light colour is due to the absence of melanin pigments and are called *Biston betularia typica*.

(2) **Resistance to DDT :** The resistance is a character controlled by genes. The resistant flies arise as a result of the application of DDT. They reproduce more and more resistant flies. Thus the resistant populations are evolved as a selective advantage against insecticides.

(3) **Resistance of bacterium to drugs : L.L. Cavalli** and **G.A. Maccacro** (1952) experimentally proved that the colon bacteria *Escherichia coli* develop resistance to the antibiotic chloramphenicol 250 times as great as that tolerated by normal bacteria by exposing the bacteria to increased concentration of the drug.

Table : 7.3-5 Difference between Darwinism and Neo–Darwinism

Darwinism (Natural Selection)	Neo–Darwinism
It is the original theory given by Charles Darwin (1859) to explain the origin of new species.	Neo–Darwinism is a modification of the original theory of Darwin to remove its short–comings in light of genetic researches.
According to this theory accumulation of continuous variations causes changes in individuals to form new species.	Instead of continuous variations, mutations and genetic variations are believed to help form new species.
It believes in the selection of individuals on the basis of accumulation of variation.	Variations accumulate in the gene pool and not in the individuals.
Darwinism does not believe in isolation.	Neo–Darwinism incorporates reproductive isolation as an essential component of evolution.
It can explain the origin of new characters.	The theory can explain the occurrence of unchanged forms over millions of years.
Darwinism cannot explain the persistence of certain forms in the unchanged condition.	Normally only those modification are transferred to next generation which influence germ cells or where somatic cells give rise to germ cells.

(iv) **Mutation theory**

(a) **Hugo de Vries** (1901), a Dutch Botanist, pioneered the theory of mutations to explain the mechanism of evolution.

(b) The plant on which de Vries had experimented was *Oenothera lamarckiana* (Evening primrose).

(c) The mutation observed by de Vries in *Oenothera* essentially was chromosomal number variant.

(d) Mutations are discontinuous variations, called 'sports' by Darwin and 'saltatory variations' by **Bateson.**

(e) Mutations are generally harmful and recessive.

(f) Role of mutations in evolution is genetic variations.

(g) Mutations are due to changes in chromosomes, genes or DNA.

(h) To be a successful event for evolution, a mutation must occur in germplasm DNA.

(i) Mutations are the changes which may or may not be inherited.

(j) Germinal mutation is a change that is inherited.

(k) Hereditary variations in plants have been produced by use of X-rays.

(l) Frequency of a mutated gene in a population is expected to increase if that gene is selected by nature.

(m) The possibilities of hereditary and evolutionary changes are greater in species that reproduce by sexual means.

(n) Organic evolution would not have taken place if individuals in a population did not show gene variations.

(v) **Variations :** Dissimilarities between members of the same species are called variations. Tendency to differ helps organisms in their adaptations for different environmental conditions. Heritable variations are responsible for changes in a species to form new species. Variations are thus important in evolution.

Variations are progressive factors in evolution. Members of the same species exhibit variations by structural, physiological or psychological dissimilarities.

Types of variations : Variations are classified in three sets.

(1) **Germinal and somatic variations :** Germinal variations arise in germplasm of the organism. They occur in the gene pattern and are inheritable. These variation reach the zygote through gametes and hence are inherited from generation to generation. For example colour of eyes or hair occur since birth whereas characters of height and body built develop later in life. Germinal variations are also called blastogenic.

Somatic variations are produced due to environmental factors. They develop in somatic cells or somatoplasm and are also called acquired variations. These are non-heritable. Darkness of skin due to working in the sun, development of intelligence by better education, achievements of a musician, muscular body of an athlete, bored nose and pinna in ladies, are some examples of acquired variations. Somatic or acquired variations are not important in evolution.

(2) **Continuous and discontinuous variations :** Continuous variations are small and graded variations which are found in the members of same species. Darwin called them as fluctuating variations and realised their importance in evolution. Darwin considered all fluctuating variations inheritable from one generation to other to form new species. They were considered important factor for natural selection. For example children of the same class and age show continuous variations in their height and intelligence but they will be much different from children of other classes.

Discontinuous variations arise suddenly and they are distinctly visible in the group. These ungraded variations deviate so much from the average character that they are seen in new form among members of the same species. There are no grades or intermediate stages in such variations. Darwin called these variations as sports while Hugo de Vries called these as mutations. These discontinuous variations are stable and inheritable. Polydactyly or more than five digits in hands or feet in man, occurrence of four horns instead of two in goat etc. are mutations.

(3) **Determinate and Indeterminate variations :** Determinate variations arise in a definite direction and time and are due to adaptations. These are found continuously and progressively in organic evolution and are affected by strong gene combination from generation to generation. Leaf eating moth *Diabrotica soror* is a good example of this variation. In this moth many different colours are found other than main colour.

Indeterminate variations do not arise under any special condition and can arise suddenly in any direction. These can develop to any extent.

Causes of variations

(a) Environmental conditions

(b) Inherent tendency to vary

(c) Dual parentage

(d) Nuclear reorganization

(e) Change in the gene pattern

(vi) **Synthetic theory**

(a) **Dobzhansky** (1937) in his book 'Genetics and Origin of Species' provided the initial basis of synthetic theory.

(b) 'Modern synthetic theory of evolution' was designated by **Huxley** in 1942.

(c) Some of the important workers who have contributed to the modern synthetic theory are : Th. Dobzhansky, R.A. Fisher, J.B.S. Haldane, Sewall Wright, Ernst Mayr and G.L. Stebbins.

(d) According to synthetic theory there are five basic factors involved in the process of organic evolution. These are :

(1) Gene mutations

(2) Changes in chromosome structure and number

(3) Genetic recombinations

(4) Natural selection and

(5) Reproductive isolation.

(e) While the first three factors are responsible for providing genetic variability, the last two are responsible for giving direction to the evolutionary processes.

(f) Besides the five factors outlined above, there are two accessory processes, namely migration of individuals from one population to another and hybridization between races, species and even related genera, which contribute to the evolution.

(g) The most accepted and recent theory of organic evolution is the synthetic theory.

(vii) **Hardy-weinberg equilibrium**

(a) Mutations introduce new genes into a species resulting a change in gene frequencies.

(b) **G.H. Hardy**, an English mathematician, and **Wilhelm Weinberg**, a German physician, in 1908 established a simple mathematical relationship to the study of gene frequencies.

(c) If certain conditions existed, gene frequencies would remain constant.

(d) The conditions necessary for gene frequencies to remain constant are :

(1) Mating must be completely random.

(2) Mutations must not occur.

(3) Migrations of individual organisms into and out of the population must not occur.

(4) The population must be very large.

(5) All genes must have an equal chance of being passed to the next generation.

(e) According to Hardy-Weinberg concept, the gene frequencies will remain constant if all above five conditions are met.

(f) The distribution of genotypes could be described by the relationship $A^2 + 2Aa + a^2 = 1$, where A^2 represents the frequency of the homozygous dominant genotype, $2Aa$ represents the frequency of the heterozygous recessive genotype and a^2 represents the frequency of the homozygous recessive genotype.

(g) Constant gene frequencies over several generations indicate that natural selection and evolution are not taking place.

(h) Changing gene frequencies would indicate that evolution is in progress.

Human Evolution

During the course of evolution different animal species evolved special organs for a successful life like wings in insects, birds and bats for flying, claws for holding, burrowing and climbing in rats and squirrels and fins or paddles in aquatic life for swimming. Similarly, most significant event in human evolution has been evolution of brain which enabled him to become most superior member of animal kingdom. The large and more complex brain evolved greater ability of thinking, logical power and capacity of taking decisions depending on the situation.

Present human species is named as *Homo sapiens sapiens* (*Sapient* = wise). **T. H. Huxley** (1863) in his book 'Man's Place in Nature' made first attempt to explain scientific grounds of upbringing of man. **Charles Darwin** (1871) in his book 'The Descent of Man' gave his ideas about ancestry of man.

(i) **Systematic position of man in animal kingdom**

Phylum	:	Chordata
Subphylum	:	Vertebrata
Class	:	Mammalia
Order	:	Primates
Suborder	:	Anthropoidea
Superfamily	:	Hominoidea
Family	:	Hominidae
Genus	:	*Homo*
Species	:	*sapiens*

(ii) **Place of descent of man :** Available fossils give the evidence that most of the fossils of prehuman ancestors including monkeys and apes have been recovered from Africa, Asia and Europe. However, descent of man is supposed to have occurred in Asia due to following reasons – (i) Civilization of Asia is oldest. (ii) Asia is the land of origin of all domesticated animals and crop plants. (iii) Migration of many animal species has taken place in Asia. (iv) Fossils of many ancestors of man have been found in Java and China which are part of Asia. (v) Climate of Asia was favourable at that time for the evolution of man.

(iii) **Time of descent of man :** Although time of descent of man is a controversial subject but fossil evidence indicates that time of evolution of man is from Miocene epoch to the beginning of Pliocene epoch of Tertiary period in Coenozoic era. It can be estimated that ancestral man evolved from man like apes about 1 crore 32 lakh years ago.

Summary of the main features associated with human phylogeny are given as under

Genus	Age of appearance (mya)*	Skull and brain capacity/cm³	Teeth	Diet	Posture	Significance
Dryopithecus (earliest fossil ape)	25 (Miocene)	Large muzzle	Large canines, incisors; square molars	Soft fruit, leaves	Knuckle walker	Earliest fossil ape, persisted until 10 million years ago
Ramapithecus	15 (Miocene)	Deeper jaw	Small canines, flattened molars, thicker enamel	Seeds, nuts	Partially upright	Earliest hominid ground-dwelling in savannah
Australopithecus afarensis (Lucy)	4.0 (Pliocene)	Large jaws ; 450-600 cc	Small canines and incisors	Herbivorous	Fully erect	Still at home in trees but savannah dwellers
A.africanus	2.5	Ventral foramen; 450 cc	Small canines	Carnivorous	Fully erect	Small game hunter, many variant forms
Homo habilis	2.0 (pleis-tocene)	Lighter jaw; 700 cc	Small canines	Carnivorous	Fully erect	Earliest stone tools, began hunting for meat, major increase in brain size foreshadowing social attributes
Homo erectus (Jawa man)	1.5	Thick, low forehead, brow ridges; 950 cc	Small canines	Omnivorous	5-6 feet tall	Beginning of cultural evolution, stone tools, cooperative hunting in bands, rudimentary language, used fire.
Homo sapiens (Swanscombe)	0.25	Heavy jaw; 1200 cc	Small canines	Omnivorous	5-6 feet tall cave-dweller	
Neanderthal	0.08	Face long and narrow, brow ridges, enlarged nasal cavity; 1500 cc	Heavier than modern teeth, wisdom teeth	Omnivorous	5-6 feet tall	Buried their dead, and flint flake tools

* Mya = Million years ago.

(iv) **Evolutionary characteristics of man :** The modern man possesses following special features, which have been acquired during the course of evolution –

(a) Bipedal locomotion.
(b) Large brain and cranial cavity.
(c) Grasping hands and feet.
(d) Erect posture.
(e) Stereoscopic (binocular) vision.
(f) Sensitivity
(g) Social organisation.
(h) Expression by speech.

Morphological changes that have occurred in man during the process of evolution are

(a) Increase in brain size and intelligence.
(b) Attainment of erect posture.
(c) Flattening of face.
(d) Shortening of body hair and reduction in their number.
(e) Elevation and narrowing of nose.
(f) Increase in height.
(g) Reduction of brow ridges.
(h) Rounding and enlargement of cranium.
(i) The bowl like form of pelvic girdle and broad ilia to support the viscera.
(j) Formation of chin.

The vertebrates of class mammalia as well as other primates have common ancestory with monkeys and apes. Mammals evolved from primitive reptiles in early Jurassic period (about 210 million years ago).

Humans belong to family hominidae in which *Homo sapiens* is the only living species. The evolutionary history of man has been built up on the basis of study of fossils and molecular homology.

The earliest hominid stock included fossils of *Ramapithecus* and *Sivapithecus* unearthed from Africa and Asia. Several species belonging to genus *Homo* can be recognised from fossil record. Human evolution took place in Africa and Asia.

A common ancestory for great apes and man has been deduced on the basis of similarities in DNA content, chromosome number and banding pattern of chromosomes.

(v) **Early human ancestors :** The fossils *Ramapithecus* and *Sivapithecus* which lived in Africa and Asia (about 1015 million years ago) are believed to be the forerunners of Hominids. These were first man–like primates. The first fossil of *Ramapithecus* was a fragment of upper jaw recovered from the Shivalik Hills of India. Ramapithecus and Sivapithecus must have a short face, small brain case, thickly enameled large teeth and they must have been used to walk on their knuckles.

(a) ***Australopithecus*** (the first man–ape) **:** Its fossils were described by **Raymond Dart** in 1925 from South Africa. These were intermediate between Ramapithecus and genus Homo.

Australopithecines are considered to be ancestral to all hominids of genus Homo.

Australopithecines must have been small statured averaging about four feet. They walked nearly or completely straight. The vertebral column had a distinct lumbar curve with pelvis broad and basin–like. The teeth were larger than those of modern man. though jaws and teeth were larger than those of modern man. Their face was prognathous and a chin was absent. The bulge of occipital region was small. Eyebrow ridges projected over the eyes.

Their brain capacity ranged from 450–600 *ml i.e.*, slightly larger than that of modern adult Chimpanzee. Thus, Australopithecine's represented man with an ape–brain.

❑ Ramapithecus has been known from shivalik hills in India.
❑ Australopithecus stood erect.
❑ G. E. Lewis discovered fossils of Ramapithecus.
❑ Australopithecus have 500 *c.c.* cranial capacity.

(b) ***Homo erectus*** **(The forerunner of Modern Humans) :** In the Middle Pleistocene period, Australopithecines were succeeded by large brained form which were described under the name *Pithecanthropus* or Java man. Its first fossils were obtained by **Dubois** (1891). These were named *Pithecanthropus erectus* (erect ape–man). Similar fossils were found in a cave near Peking, China, and were named *Sinanthropus* pekinenis.

Mayer (1950) has replaced these names by *Homo erectus–*

(1) **Java Man (*Homo erectus erectus* = *Pithecanthropus erectus*) :** Its fossils occurred in the Pleistocene deposits about 500,000 years ago. Its cranial cavity was about 940 *c.c*; (intermediate between that of Australopithecus (600–700 c.c.) and modern man (1400–1600 c.c.) It was more than five feet tall with skeleton much like ours. Its forehead was low and slanting. The face was prognathous, and jaws were massive with huge teeth. The chin was absent and bony eye. He might have learnt the use and construction of tools and knew how to lit fire.

❑ Fire was first used for protection and cooking by Java man.

(2) **Peking man (*Homo erectus pekinensis* = *Pithecanthropus pekinensis–Sinanthropus pekinensis*) :** These perhaps lived 500,000–2,00,000 years ago. It was very similar to **Java man** with heavy bony eyebrow ridges, low slanting forehead and chinless face. However, their cranial cavity was much larger as compared to Java man ranging from 850–1200 ml. and averaging 1075 c.c.

❑ The skull of pithecanthropus was found in Java.
❑ The fossils of sinanthropus pekinensis have been discovered in pleistocene epoch.

(3) ***Homo sapiens*** **(Late Pleistocene Man) :** *Homo erectus* were succeeded by early *Homo sapiens*, which were described under different names *Homo neanderthalensis, Homo heildelbergensis, etc.* But, since they are grouped under *Homo sapiens.*

The fossils of primitive man were found in Europe, Asia and Africa. These are Heildelberg man, Neanderthal man, Solo man and Rhodesian man.

Heidelberg man : Their jaw is large and heavy and lacks a chin. Teeth are like those of modern man. Heidelberg is regarded as an ancestor to Neanderthal man and contemporary to *Homo erectus.*

Neanderthal man : Their fossils were found in the Neanderthal valley in Germany. Previously, it was named as *H. sapiens neanderthalensis.* These arose some 1,50,000 years ago and flourished in Europe, Asia and North Africa. These were similar to us below the neck, and were heavily built with outwardly curved thigh bones.

The skull bones were thick, forehead was low and slanting and the eyebrow ridges were heavy. The jaw was deep with no chin. The cranial capacity was about 1450 c.c. (almost equal to the modern man). But its lower and posterior portions were larger than the upper and anterior parts. It was quite intelligent to use and construct tools. It buried its dead and could perform ceremonies as well as constructed hut–like dwelling structures.

❑ Neanderthal man lives in cave.

Solo man (*Homo solonensis*) : Fossils were discovered from the banks of solo river. They had heavy eyebrow ridges but forehead was receding type. Brain capacity was 1300 *cc.*

Rhodesian man (*Homo Rhodesiensis*) : Fossils of Rhodesian men were found in Rhodesia in the large limestone cave. Their skull had a cranial cavity about 1300 c.c. with receding forehead and ridge was protruded out.

Period	Million yrs. ago	Cultural stage	Australoids	Caucasoids	Mongoloids	Negroids	Races of man
Recent Holocene	1,400 BC 3,000 BC 5,000 BC 10,000 BC	Iron age Bronze age Neolithic Mesolithic					
	20,000						*Homo sapiens sapiens* (Modern man)
Late	40,000	Upper paleolithic					Cro-magnon
							Neanderthal
	250,000	Middle paleolithic					*Homo sapiens* (True man)
Plestocene Middle	500,000	Lower paleolithic					*Pithecanthropus* (Java man) *Sinanthropus* (Peking man) *Homo erectus* (early true man)
Early	800,000 2,000,000	Pre paleolithic					*Homo habilis* (Handy man) *A. africanus* *A. robustus* *Zinjanthropus* *Australopithecus* (ape man)
Pliocene	14,000,000						*Gigantopithecus* (ancestor to modern gorilla)
Miocene	25,000,000	Pliopithecus (ancestor to modern gibbons)					*Ramapithecus* (subman) Ancestors of great ape *Dryopithecus* or proconsul (preman)
Oligocene	38,000,000	To old world monkeys					*Aegyptopithecus* *Ancestors of gibbon* *Propliopithecus* *Old world monkeys* *Parapithecus* *Oligopithecus*

Cro–Magnon Man (Homo sapiens fossils) : These lived during last 30,000 years or more in Europe. These succeeded Neanderthals and became extinct about 10,000 years ago in the last glacial period.

These were about 180 cm. in height with a large skull, broad face, rounded forehead, narrow nose and a **prominent chin.** They lacked eyebrow ridges. The cranial cavity was about 1660 c.c. These were cave dwelling and hunters. They made tools from stones and ornaments from ivory.

- ❑ Cro–Magnon had perfectly orthognathus face.
- ❑ Cro–Magnon is the most recent ancestor of "*Homo sapiens*".
- ❑ Cro–Magnon man was expert in making tools, weapons, paintings etc.
- ❑ Cranial capacity of modern man is 1350–5000 cm^3.

Modern Man (*Homo sapiens–sapiens*) : After last glacial period *i,e.,* about 10,000 years ago, *Homo sapiens–sapiens* appeared and began to spread all over the globe. He learned to cultivate plants and domesticate animals of economic importance. These were the first settlers who started living a settled life.

Tips & Tricks

- ✍ When the contents of intestine of ancient animals are preserved, it is known as coprolite.
- ✍ Palynofossils are tiny microscopic spores, pollen and other vegetal remains of the past.
- ✍ Analogous organs are also called homoplastic organs.
- ✍ The Pedigree of man is not complete like that of horse.
- ✍ Old World refers to the Eastern Hemisphere.
- ✍ Tarsiers are found in forests of Phillippines and East Indies. They are insectivorous mouse-sized animals with enormous eyes suitable for nocturnal life.
- ✍ The Gibbon is the smallest of the apes (5.5 – 11 kg) and the Gorilla, the largest of the apes (180 kg).
- ✍ Neo–Darwinism gains strength from a number of evidences like industrial melanism, origin of DDT–resistant mosquitoes, geographical distribution of sickle–cell anaemia etc.
- ✍ Artificial selection is the phenomenon in which man interbreeds the genetically different individuals and selects the genetically improved domesticated animals and plants.
- ✍ J. Lederberg and E. Lederberg provided experimental evidence for 'selection' in bacteria. By using replica plating technique, they demonstrated the process of 'selection' of antibiotic–resistant strains of bacteria.
- ✍ Speciation is the formation of new species. It may occur by gradual drifting apart of two or more species which later on cease to interbreed. Species formed may be allopatric or sympatric. Rapid speciation occurs by polyploidy.

Ordinary Thinking

Objective Questions

Origin of Life

1. Stanley Miller proposed origin of life by **[NCERT; J & K CET 2005]**

(a) Chemical synthesis
(b) Abiogenesis
(c) Biogenesis
(d) None of these

2. Hot dilute soup was given by **[MP PMT 2007]**

(a) Oparin (b) Haldane
(c) Urey (d) None of these

3. Which of the following statements is incorrect **[CPMT 2010]**

(a) J.B.S. Haldane-law of continuity of germplasm
(b) Louis Pasteur-germ theory of disease and immunology
(c) de Vries-mutation theory
(d) Lemaitre-big bang theory

4. Which one of the following experiments suggests that simplest living organisms could not have originated spontaneously from non-living matter **[CBSE PMT 2005]**

(a) Larvae could appear in decaying organic matter
(b) Microbes did not appear in stored meat
(c) Microbes appeared from unsterilized organic matter
(d) Meat was not spoiled, when heated and kept sealed in a vessel

5. Which of the following was most likely to have been absent in free form in the primordial atmosphere at the time of origin of life **[NCERT; CPMT 1998; KCET 1998, 2006; MP PMT 1999; CBSE PMT 2004; BVP 2004; BCECE 2005; WB JEE 2012]**

Or

Miller performed experiment to prove abiogenic molecular evolution of life. Which molecule was not present in Miller's experiment **[CPMT 2010]**

(a) O_2 (b) CH_4
(c) H_2 (d) NH_3

6. Nucleoprotein gave most probably the first sign of

(a) Life (b) Amino acids
(c) Soil (d) Sugar

7. The complex organic compounds that may have first evolved in the direction of origin of life on earth, may have been **[NCERT]**

(a) Proteins and amino acids
(b) Proteins and nucleic acids
(c) Urea and nucleic acids
(d) Urea and amino acids

8. In his classic experiment on the formation of amino acids, Stanley Miller passed an electric discharge in a mixture of **[CPMT 2001, 02, 09; MP PMT 2003; KCET 2004; Kerala PMT 2006; J & K CET 2008; AMU (Med.) 2012]**

Or

Stanley Miller had put the oparin-Haldane theory to test in 1953 by creating in the laboratory, the probable condition of the primitive earth. In the experiment, simple amino acids were synthesized from which of the following mixture as observed after 18 days **[NCERT]**

(a) Steam, CH_4, H_2 and NH_3
(b) CH_4, CO_2, O_2 and H_2
(c) NH_3, O_2, H_2 and steam
(d) CH_4, H_2, N_2 and steam

9. The scientist related with the over throw or the "Theory of spontaneous generation" and experiments with swan-necked flasks is **[KCET 1996, 2001; Kerala PMT 2003]**

(a) Von Helmont (b) Louis Pasteur
(c) Miller (d) Haeckel

10. According to spontaneous generation theory, the sequence of origin of life may be considered as

(a) Amino acid– protein–chlorophyll
(b) Chlorophyll–starch–glycogen
(c) Nucleic acid– amino acid – chlorophyll
(d) Chlorophyll – nucleic acid – amino acid

11. The idea of spontaneous generation was first refuted by **[DPMT 2003; Kerala CET 2003]**

(a) L. Pasteur (b) L. Spallanzani
(c) F. Redi (d) S.L. Miller

12. The idea of Natural Selection as the fundamental process of evolutionary changes was reached **[KCET 2007]**

(a) By Alfred Russel Wallace in 1901
(b) Independently by Charles Darwin and Alfred Russel Wallace in 1859
(c) Independently by Charles Darwin and Alfred Russel Wallace in 1900
(d) By Charles Darwin in 1866

13. Which one of the following is incorrect about the characteristics of protobionts (coacervates and microspheres) as envisaged in the abiogenic origin of life) **[NCERT; CBSE PMT 2008]**

(a) They were partially isolated from the surroundings
(b) They could maintain an internal environment
(c) They were able to reproduce
(d) They could separate combinations of molecules from the surrounding

14. Abiogenesis means **[NCERT; BHU 2001; CPMT 2002; J & K CET 2002; RPMT 2005; DUMET 2009]**

(a) Origin of life from non-living organisms
(b) Origin of life from living organisms
(c) Origin of viruses and microbes
(d) None of these

15. About how long ago was the earth formed **[NCERT; CPMT 1999; DUMET 2010]**
(a) 4.6 billion years ago (b) 10 billion years ago
(c) 3.0 billion years ago (d) 20 billion years ago

16. Type of nutrition in the primitive cells
Or
It is believed that the organisms first inhabited earth's surface were **[NCERT]**
(a) Heterotrophic or holozoic
(b) Heterophytic or holophytic
(c) Saprophytic
(d) Saprozoic

17. Louis Pasteur's view on the origin of life is that
(a) Life originated within six days
(b) Life originated spontaneously from the living organisms only
(c) Life originated spontaneously from the non-living substances
(d) Life came from other planet

18. First cell produced on earth is **[NCERT; Manipal 2005]**
(a) Protobiont (b) Protozoa
(c) Metazoa (d) None of these

19. Select the correct statement from the following **[CBSE PMT 2007]**
(a) Darwinian variations are small and directionless
(b) Fitness is the end result of the ability to adapt and gets selected by nature
(c) All mammals except whales and camels have seven cervical vertebrae
(d) Mutations are random and directional

20. The organism which appeared first on earth is known as
(a) Eubiont (b) Probiont
(c) Eobiont (d) True biont

21. The concept of chemical evolution is based on **[CBSE PMT 2007]**
(a) Crystallization of chemicals
(b) Interaction of water, air and clay under intense heat
(c) Effect of solar radiation on chemicals
(d) Possible origin of life by combination of chemicals under suitable environmental conditions

22. Which one of the following amino-acids was not found to be synthesized in Miller's experiment **[NCERT;CBSE PMT 2006]**
(a) Glutamic acid (b) Alanine
(c) Glycine (d) Aspartic acid

23. There is no life on moon because there is no **[NCERT]**
(a) Carbon (b) Nitrogen
(c) Water (d) Silicates

24. According to available evidence life evolved through the process of **[Odisha JEE 2010]**
(a) Abiogenesis (b) Biogenesis
(c) Special creation (d) Spontaneous generation

25. In the early earth, water and CO_2 were produced by the combination of O_2 with **[Kerala PMT 2010]**
(a) Ammonia and methane
(b) Hydrogen
(c) Organic matter
(d) Sulphates and nitrates
(e) Hydrogen sulphide

26. The prebiotic atmosphere of the earth was of a reducing nature. It was transformed into an oxidizing atmosphere of present day due to the emergence of **[KCET 2012]**
(a) Cyanobacteria (b) Angiosperms
(c) Photosynthetic bacteria (d) Eukaryotic algae

27. Formation of which complex molecules was noticed by Urey and Miller when they subjected substances like NH_3, CH_4, H_2O etc. to electric discharge **[CBSE PMT 1993; BHU 2004]**
(a) Aquaregia (b) H_2SO_4
(c) HCN (d) Amino acids

28. The idea that life originates from pre-existing life is referred as **[J & K CET 2005]**
(a) Biogenesis theory (b) Special creation theroy
(c) Abiogenesis theory (d) Extraterrestrial theory

29. '*Origin of life*' was written by **[MP PMT 1997]**
(a) Darwin (b) Oparin
(c) Gray (d) Smith

30. Coacervates are **[DPMT 2007]**
(a) Protobionts having polysaccharide + protein + H_2O
(b) Protein aggregate
(c) Protein and lipid aggregates
(d) None of these

31. The most vital process for the existence of life on earth is **[KCET 1994]**
(a) Communication in animals
(b) Photosynthesis by plants
(c) Reproduction in plants and animals
(d) Respiration in animals

32. The four elements that make up 99% of all elements found in a living system are **[CBSE PMT 1994; BHU 2008]**
(a) *H, O, C, N* (b) *C, H, O, S*
(c) *C, H, O, P* (d) *C, N, O, P*

33. Which one of the following is the correct sequence of chemical substances produced during the origin of life on the earth **[NCERT; CBSE PMT 1996; AIEEE Pharmacy 2004]**
(a) Water, amino acid, nucleic acid and enzyme
(b) Glucose, amino acid, nucleic acid and protein
(c) Amino acid, ammonium phosphate and nucleic acid
(d) Ammonia, amino acid, protein and nucleic acid

34. Which is responsible for origin of life **[KCET 2011]**
(a) Spontaneous generation (b) Special creation
(c) Catastrophy (d) Chemosynthesis

35. Life originated in **[NCERT; MP PMT 2009]**
(a) Precambrian era (b) Proterozoic era
(c) Mesozoic era (d) Caenozoic era

36. Origin of life took place in/on **[MP PMT 1997]**
(a) Water (b) Air
(c) Mountains (d) Land

37. The presence of salts (*NaCl* and others) in animal body fluid gives an inference that life originated in the **[NCERT; MP PMT 1998, 99]**
(a) Salt solutions (b) Rain water
(c) Primitive ocean (d) None of the above

38. According to one of the most accepted theory the earth atmosphere before any life had originated consisted of H_2O, H_2, NH_2 and **[RPMT 2005]**

(a) CH_4 (b) O_2

(c) N_2 (d) None of these

39. Under certain conditions scientists have obtained cell-like structures. These are known as **[MP PMT 1999; Pb. PMT 2000]**

(a) Microbes (b) Protists

(c) Coacervates (d) Prebiotic soup

40. Chemical theory of origin of life was given by **[NCERT; CPMT 1999; JIPMER 2001]**

Or

Who proposed that the first form of life could have come from pri-existing non living organic molecules **[Kerala PMT 2011]**

(a) Stanley Miller (b) Oparin and Haldane

(c) Louis Pasteur (d) Spallanzani

41. The abiogenesis occurred about how many billion years ago **[Pb. PMT 1999; CPMT 2000; KCET 2000; DPMT 2004]**

(a) 1.2 billion (b) 1.5 billion

(c) 2.5 billion (d) 3.5 billion

42. Theory of special creation was given by **[Pb. PMT 2000]**

(a) Weismann (b) Helmont

(c) Manpertuis (d) Father Saurez

43. The spark-discharge apparatus to test chemical evolution of life was designed by **[KCET 2001; CPMT 2003]**

Or

The first experiment on chemical evolution and origin of life was carried out by **[NCERT]**

(a) Oparin and Haldane (b) Miller and Urey

(c) Jacob and Monad (d) Dixon and Jolley

44. Coacervates are **[NCERT; Kerala CET 2003]**

(a) Colloid droplets (b) Contain nucleoprotein

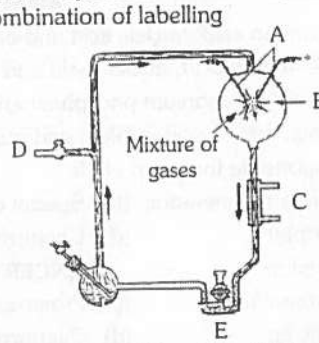
(c) Both (a) and (b) (d) Protobiont

45. Theory of catastropism was supported by **[DPMT 2006]**

(a) Louis Pasteur (b) A.I. Oparin

(c) Cuvier (d) Haldane

46. The diagram represents Miller's experiment. Choose the correct combination of labelling **[Kerala CET 2004]**



(a) A-electrodes, B- $NH_3 + H_2 + H_2O + CH_4$, C-cold water, D-vacuum, E-U trap

(b) A-electrodes, B- $NH_4 + H_2 + CO_2 + CH_3$, C-hot water, D-vacuum, E-U trap

(c) A-electrodes, B- $NH_3 + H_2O$, C-hot water, D-tap, E-U trap

(d) A-electrodes, B- $NH_3 + H_2 + H_2O + CH_4$, C-steam, D-vacuum, E-U trap

47. Coacervates were experimentally produced by **[NCERT; KCET 2004]**

(a) Urey and Miller (b) Jacob and Monod

(c) Fischer and Huxley (d) Sidney Fox and Oparin

48. Synthesis of amino acids to prove that amino acids were formed in primitive ocean was experimentaly proved by **[CPMT 1995; AFMC 2006]**

Or

Who performed an experiment to prove that organic compounds were the basis of life **[NCERT; MP PMT 1994]**

(a) Sydeny Fox (b) Oparin

(c) Haldane (d) Stanley Miller

49. Big bang theory was proposed by **[BVP 2001]**

(a) Kant (b) Lemaitre

(c) K. Bahadur (d) Weismann

50. Gases found in primitive atmospheres are **[MP PMT 2007]**

(a) CH_4, NH_3, H_2, H_2O (Vapour form)

(b) CH_4, NH_3, CO_2, H_2O

(c) CH_4, H_2O, CO_2

(d) CH_4, O_2, CO_2

Organic Evolution and Speciation

1. The most accepted and recent theory of organic evolution **[NCERT]**

(a) Natural selection theory (b) Phase theory

(c) Synthetic theory (d) Mutation theory

2. A population will not exist in Hardy-Weinberg equilibrium if **[AIPMT (Cancelled) 2015]**

(a) There are no mutations (b) There is no migration

(c) The population is large (d) Individuals mate selectively

3. The greatest evolutionary change enabling the land vertebrates to be completely free from water, was the development of **[NCERT; CMC Vellore 1993; MP PMT 1996]**

(a) Four legs

(b) Lungs

(c) Shelled eggs and internal fertilization

(d) Four chambered heart

4. Haeckal's theory of recapitulation (Biogenetic law) means that **[CMC Vellore 1993; CPMT 1993, 2003; MP PMT 1996, 2003]**

(a) All organisms start as an egg

(b) Life history of an animal reflects its evolutionary history

(c) Progeny of an organism resembles its parents

(d) Body parts once lost are regenerated

5. Evolution of different species in a given area starting from a point and spreading to other geographical areas is known as **[CBSE PMT (Pre.) 2012]**

(a) Adaptive radiation (b) Natural selection

(c) Migration (d) Divergent evolution

6. There was no life in **[NCERT; BHU 1999; AFMC 1999; CPMT 2002; RPMT 2005]**

(a) Azoic era (b) Mesozoic era

(c) Palaeozoic era (d) Cenozoic era

7. Occurrence of endemic pecies in South America and Australia is due to **[AIIMS 2010]**
   (a) Extinction of these species from other regions
   (b) Continental separation
   (c) Absence of terrestrial route to these places
   (d) Retrogressive evolution

8. The origin of mammal like reptiles occurred in **[NCERT; AMU (Med.) 2012]**
   (a) Triassic period (b) Permian period
   (c) Jurassic period (d) Tertiary period

9. Another term for adaptive evolution is **[MP PMT 2010]**
   (a) Clinal change (b) Microevolution
   (c) Macro-evolution (d) Speciation

10. The first life on earth came in water and evidences indicate that life orginated in one of the following eras **[MP PMT 2010]**
    (a) Palaeozoic (b) Mesozoic
    (c) Cenozoic (d) Proterozoic

11. Mutations which normally happen randomly are considered one of the raw materials for evolution because they **[Odisha JEE 2008]**
    (a) Are stable
    (b) Contribute to new variation in organism
    (c) Cause death of organism
    (d) None of these

12. Which epoch is of human civilization
    (a) Pliocene (b) Holocene
    (c) Palaeocene (d) Pleistocene

13. Which one of these was a flying dinosaur **[Kerala PMT 2012]**
    (a) Triceratops (b) Tyrannosaurus
    (c) Stegosaurus (d) Brachiosaurus
    (e) Pteranodon

14. Now unit of evolution is called **[Odisha JEE 2008; J & K CET 2012]**
    (a) Population (b) Genus
    (c) Order (d) Species

15. The major cause of evolution of genes and protein is **[DUMET 2010]**
    (a) Point mutation
    (b) Chromosomal aberration
    (c) Sexual reproduction
    (d) Gene duplication and divergence

16. Recapitulation theory (Biogenetic law) explains "*Ontogeny repeats Phylogeny*". It was given by **[MP PMT 1994, 95, 2004; CPMT 1995, 2002, 09; RPMT 1995; KCET 2004; Pb PMT 2004; BHU 2005, 12; Odisha JEE 2011; AMU (Med.) 2012]**
    (a) Lamarck (b) Haeckel
    (c) Darwin (d) Robert Hooke

17. Goldschmidt has classified evolution into micro, macro, and mega evolution. Which one of the following is referred to as micro-evolution **[MP PMT 2001]**
    (a) Evolution at variety level
    (b) Evolution at sub species level
    (c) Evolution at species and genus level
    (d) Evolution at family level

18. The pioneers in the field of 'organic evolution' are **[NCERT; KCET 2001]**
    (a) Karl landsteiner, Hugo de Vries, Malthus
    (b) Darwin, Hugo de Vries, Lamarck, Huxley
    (c) Lamarck, Karl landsteiner, Malthus, deVries
    (d) Darwin, Lamarck, Karl landsteiner, deVries

19. A common means of sympatric speciation is **[DUMET 2010]**
    (a) Polyploidy
    (b) Temporal segregation of breeding season
    (c) Spatial segregation of mating sites
    (d) Imposition of geographic barrier

20. A star fish with six arms may be a case of
    (a) Variation (b) Evolution
    (c) Autotomy (d) Mutation

21. Which of the following variations are temporary and have nothing to do with the last or next generation **[BHU 2004]**
    (a) Hereditary variations (b) Discontinuous variations
    (c) Environmental variations (d) None of these

22. Sibling species are also known as
    (a) Sub-species (b) Genus
    (c) Subline species (d) Biological races

23. Closely related species varying different in trait expresses **[Odisha JEE 2008]**
    (a) Convergent evolution (b) Divergent evolution
    (c) Parallel evolution (d) None of these

24. Which one of the following is not important for evolution **[VITEEE 2008]**
    (a) Mutation (b) Recombination
    (c) Genetic drift (d) Somatic variation

25. The basic unit of animal population which is communal interbreeding, in a species is known as
    (a) Cline (b) Sub-species
    (c) Sibling species (d) Deme

26. One of the important consequences of geographical isolation is **[CBSE PMT 2007; J & K CET 2008]**
    (a) No change in the isolated fauna
    (b) Preventing Speciation
    (c) Speciation through reproductive isolation
    (d) Random creation of new species

27. Which is not a pre-zygotic isolation mechanism **[VITEEE 2008]**
    (a) Geographical isolation (b) Ecological isolation
    (c) Seasonal isolation (d) Hybrid sterility

28. An evolutionary process giving rise to new species adapted to new habitats and ways of life is called **[VITEEE 2008; AMU (Med.) 2010, 12]**
    (a) Adaptive radiation (b) Atavism
    (c) Reversion (d) Genetic drift

29. Evolution means **[NCERT; MP PMT 1996]**
    (a) History of race
    (b) Development of race
    (c) History and development of race with variations
    (d) Progressive development of the race

30. Inclusive fitness theory is proposed by **[DPMT 2006]**
    (a) Darwin (b) Lamarck
    (c) Weismann (d) Hamilton

31. The principle that gives the geneticists a tool to determine when evolution is occurring is **[VITEEE 2008]**
(a) Chemiosmotic theory
(b) Hardy-Weinberg principle
(c) Malthusian principle
(d) Cloning theory

32. The Hardy-Weinberg principle cannot operate if **[KCET 2012]**
(a) The population is very large
(b) Frequent mutations occur in the population
(c) The population has no chance of interaction with other populations
(d) Free interbreeding occurs among all members of the population

33. Which one of the following is not a living fossil **[CBSE PMT 2006]**

Or

Missing link in evolution is **[CPMT 2005]**
(a) *Archaeopteryx* (b) *Peripatus*
(c) King crab (d) Sphenodon

34. Inorganic evolution means
(a) Formation of molecules
(b) Formation of cell
(c) Evolution of new species
(d) Same as organic evolution

35. Most modern breeds of the domestic dog have evolved as a result of **[CPMT 1993]**
(a) Natural selection (b) Artificial selection
(c) Sexual selection (d) Reproductive isolation

36. Read the following statements and choose the correct option
A. Increase in melanized moths after industrialization in Great Britain is a proof for natural selection
B. When more individuals of a population acquire a mean character value, it is called disruption
C. Changes in allelic frequency in a population will lead to Hardy Weinberg equilibrium
D. Genetic drift changes the existing gene or allelic frequency in future generations **[Kerala PMT 2012]**
(a) B alone is correct
(b) D alone is correct
(c) A and D alone are correct
(d) A and C alone are correct
(e) B and D alone are correct

37. A mutation from the wild to a new type is called
(a) Reverse mutation (b) Frame–shift mutation
(c) Gibberish mutation (d) Forward mutation

38. Ultimate source of organic variation is the process which provide raw materials for evolution is **[CPMT 2009]**

Or

The concept of sudden genetic change which breeds true in a species is represented as **[MP PMT 1996]**
(a) Sexual reproduction (b) Meiosis
(c) Mutation (d) Independent assortment

39. 'Genetic species concept' was given by **[BVP 2003]**
(a) Lamarck (b) Lotsy
(c) Ernst Mayr (d) Linnaeus

40. Which era is dubbed as the age of prokaryotic microbes **[CBSE PMT 1995; MP PMT 2012]**
(a) Phanerozoic (b) Proterozoic
(c) Precambrian (d) Archean

41. The presence of gill slits in the embryos of all vertebrates supports the theory of **[CBSE PMT 1995]**
(a) Recapitulation (b) Organic evolution
(c) Metamorphosis (d) Biogenesis

42. Which one of the following pairs is correctly matched **[CBSE PMT 1995]**
(a) Streamlined body –Aquatic adaptation
(b) Excessive perspiration–Xeric adaptation
(c) Parasitism–Intra-specific relationship
(d) Uricotelism–Aquatic habitat

43. As per modern synthetic theory organic evolution depends upon **[NCERT; MP PMT 1998, 2003]**
(a) Mutation, reproductive isolation and natural selection
(b) Gene recombination and natural selection
(c) Mutation and natural selection
(d) All of these

44. H.J. Muller was awarded Nobel Prize for **[CBSE PMT 1996]**
(a) Discovering that ionising radiations can cause mutation
(b) Gene mapping in *Drosophila*
(c) Reduction in nuclear weapons
(d) Discovered that chemicals can cause gene mutation

45. Evolution in which the animals of two different gene ecology show too much similarity with one another, as a result of adaptation is termed as **[CBSE PMT 1996, 2007; NEET 2013]**

Or

Similarity developed in distantly related groups as an adaptation to the same function is called **[MP PMT 1994]**
(a) Parallel evolution (b) Retrogressive evolution
(c) Progressive evolution (d) Convergent evolution

46. Biological species concept emphasizes on **[DPMT 2003; MHCET 2003]**
(a) Geographical isolation (b) Reproductive isolation
(c) Physiological isolation (d) None of these

47. Mutations are mainly responsible for controlling **[MP PMT 1996; CBSE PMT 1997]**
(a) Increasing population rate
(b) Maintaining genetic continuity
(c) Variation in organisms
(d) Extinction of organisms

48. The alien species introduced into Lake Victoria that was responsible for the extinction of cichlid fishes is **[Kerala PMT 2010]**
(a) African catfish (b) Water hyacinth
(c) Carrot grass (d) Nile perch
(e) Murrels

49. Single step large mutation leading to speciation is also called **[Kerala PMT 2010]**
(a) Founder effect (b) Saltation
(c) Branching descent (d) Natural selection
(e) Adaptive radiation

50. Geographic and reproductive isolation are most closely associated with **[NCERT; Kerala PMT 2004]**

Or

The origin of species from pre-existing species is **[J & K CET 2002]**

(a) Speciation (b) Extinction
(c) Over production (d) Competition
(e) Succession

51. A species is produced by loss or disappearance of a few characters found in parents it is termed as **[MP PMT 1997]**

(a) Progressive species (b) Retrogressive species
(c) Successive species (d) Digressive species

52. Which one of the following scientists is not related with organic evolution **[NCERT; MP PMT 1998]**

(a) Erasmus Darwin (b) Charles Darwin
(c) Darlington (d) T.R. Malthus

53. According to the theory of mutation by Hugo de Vries **[CPMT 2009]**

(a) Only small mutation takes part in variation
(b) Only large mutation takes part in variation
(c) Both small and large mutation cause variation in species
(d) None of the above

54. Which is basis of evolution **[NCERT; DPMT 2003; BVP 2004; Odisha JEE 2008]**

(a) Cell (b) Individual
(c) Population (d) Species

55. The example of recapitulation theory is **[EAMCET 1998]**

(a) Embryonic membranes of reptiles
(b) Tadpole larva of frog
(c) Placenta of mammals
(d) Canine teeth of dog

56. The importance of random accumulation of small genetic changes sufficient to explain evolution **[Pune CET 1998]**

(a) Haeckel (b) Mayr
(c) Darwin (d) Lamarck

57. The principle of organic evolution envisages **[Pune CET 1998]**

(a) No change in complexity
(b) Decreasing complexity
(c) Increasing complexity
(d) Drastic changes

58. Radiations with successful adaptations in case of insects is a result of **[Pune CET 1998]**

(a) Genetic divergence (b) Micro-evolution
(c) Macro-evolution (d) Mega-evolution

59. Finding of miller's experiment on origin of life has provided evidence for the **[Odisha JEE 2002]**

(a) Theory of special creation
(b) Theory of organic evolution
(c) Theory of biogenesis
(d) Theory of abiogenesis

60. What is evolution **[NCERT; CPMT 1998]**

(a) Development of DNA from nucleotides
(b) Development of organism through time
(c) Development of a cell from chemicals
(d) None of these

61. Abiogenetic theory of origin states **[Pb. PMT 2004]**

(a) Spontaneous generation
(b) Organic evolution due to chemical reaction
(c) Origin of life due to pre-existing organisms
(d) Origin of life from blue green algae

62. Evolutionary convergence is characterized by **[CBSE PMT 1997]**

(a) Development of characteristics by random mating
(b) Replacement of common characteristics in different group
(c) Development of dissimilar characteristics in closely related groups
(d) Development of a common set of characteristics in group of different ancestry

63. Which of the following is related with reproductive isolation **[BHU 1999]**

(a) Genetic isolation (b) Temporal isolation
(c) Behavioural isolation (d) All of these

64. The existence of marsupials in Australia and New Zealand prove **[KCET 1999]**

(a) Genetic drift (b) Geological period
(c) Continental drift (d) Both (b) and (c)

65. The life begins above which level **[RPMT 1999]**

(a) Molecule (b) Amino acid
(c) Mixture (d) Compound

66. In Hardy-Weinberg equation, the frequency of heterozygous individual is represented by **[NEET (Phase-II) 2016]**

(a) $q2$ (b) $p2$
(c) 2pq (d) pq

Evidences of Evolution

1. The first seed plants appeared during **[MP PMT 2010]**

(a) Silurian era (b) Devonian era
(c) Carboniferous era (d) Cretaceous era

2. The wings of a bird and the wings of an insect are **[AIPMT 2015]**

(a) Analogous structures and represent convergent evolution
(b) Phylogenetic structures and represent divergent evolution
(c) Homologous structures and represent convergent evolution
(d) Homologous structures and represent divergent evolution

3. Homologous organs explain

(a) Convergent evolution (b) Divergent evolution
(c) Pedogenesis (d) Prodagility

4. Below are listed some pairs of characters. The homologous pair is **[AIIMS 2010]**

(a) Forelimbs of dog and camel
(b) Insect wing and bat wing
(c) Feathers of birds and fins of fish
(d) Lens of vertebrate and arthropod

5. Which is a vestigeal organ of python **[AIIMS 2009]**

(a) Nose (b) Hind limbs
(c) Scales (d) Teeth

6. The formation of two species from one ancestral species is known as **[KCET 2015]**
(a) Convergent evolution (b) Phyletic evolution
(c) Allopatry (d) Divergent evolution

7. Which one is not a vestigeal organ in man **[MP PMT 1994]**
(a) Vermiform appendix (b) Plica semilunaris
(c) Ear muscles (d) Malleus

8. The humming bird, hawk and the humming moth illustrate

Or

What is common to whale seal and shark **[CBSE PMT 2007]**
(a) Adaptive radiation (b) Homology
(c) Convergent evolution (d) Divergent evolution

9. Which one of the following options gives one correct example each of convergent evolution and divergent evolution **[NCERT; CBSE PMT (Pre.) 2012]**

	Convergent evolution	Divergent evolution
(a)	Eyes of octopus and mammals	Bones of forelimbs of vertebrates
(b)	Thorns of Bougainvillia and tendrils of *Cucurbita*	Wings of butterflies and birds
(c)	Bones of forelimbs of vertebrates	Wings of butterfly and birds
(d)	Thorns of Bougainvillia and tendrils of *Cucurbita*	Eyes of Octopus and mammals

10. Which one illustrates palaeontological evidence in favour of oraganic evolution
(a) Duck billed platypus (b) Pappered moth
(c) Archaeopteryx (d) Darwin's finches

11. Which of the following is the earliest era **[Odisha JEE 2008]**
(a) Coenozoic (b) Mesozoic
(c) Paleozoic (d) Pre-cambrian

12. Mass extinction at the end of Mesozoic era was probably due to **[DUMET 2009]**
(a) Continental drift
(b) The collision of earth with large meteorites
(c) Massive glaciations
(d) Change in earth's orbit

13. The age of rock is calculated on the basis of
(a) Types of fossils present
(b) Number of strata present
(c) Amount of uranium present
(d) Amount of lead present

14. Which one of the following sets includes all homologous organs **[MP PMT 1994]**
(a) Hind legs of pig, duck and kangaroo
(b) Wings of bats, butterfly and bird
(c) Sting of honey bee, scorpion and snake
(d) Tail of rat, peacock and cockroach

15. Fossils are dated now by **[MP PMT 1994, 2001]**
(a) Stratigraphic position
(b) Amount of calcium residue
(c) Association with other animals
(d) Radioactive carbon (C^{14}) contents

16. Which one of the following are analogous structures **[NCERT; CBSE PMT 2014]**
(a) Thorns of *Bougainvillea* and tendrils of *Cucurbita*
(b) Flippers of dolphin and legs of horse
(c) Wings of bat and wings of pigeon
(d) Gills of prawn and lungs of man

17. Homologous organs are **[NCERT; MH CET 2003; MP PMT 2004; AIEEE (Pharmacy) 2004; NEET (Phase-I) 2016]**
(a) Leg of man, leg of horse, wing of bat
(b) Hand of man, tail of horse, wing of bat
(c) Hand of man, forelimb of horse, wing of bat, whale's flippers
(d) Head of man, leg of horse, wing of bat

18. Which one of the following groups are not analogous organs **[CPMT 2005, 09; Kerala PMT 2007]**
(a) Wings of birds and wings of butterfly
(b) Eye of octopus and eye of mammals
(c) Flippers of penguin and flippers of dolphin
(d) Thorns of bougainvilla and tendril of *Cucurbita*
(e) Tuberous root of sweet potato and stem tuber of potato

19. Amphibians were dominant during **[Kerala PMT 2009]**
(a) Carboniferous (b) Silurian
(c) Ordovician (d) Cambrian
(e) Jurassic

20. Evolution of unicellular organism was in the era
(a) Proterozoic (b) Palaeozoic
(c) Archaeozoic (d) Mesozoic

21. Origin of first toothed birds and gymnosperms took place during **[CPMT 2009]**
(a) Cretaceous (b) Triassic
(c) Jurassic (d) Permian

22. Wings of birds and forelimbs of horse are ____ organs **[Odisha JEE 2008]**
(a) Analogous (b) Homologus
(c) Vestigial (d) None of these

23. Earliest reptiles evolved in the period
(a) Ordovician (b) Silurian
(c) Devonian (d) Carboniferous

24. First mammals appeared in the period **[NCERT; MP PMT 2013]**
(a) Triassic (b) Jurassic
(c) Cretaceous (d) Tertiary

25. Which of the following are homologus organs **[BVP 2002]**
(a) Wings of Birds and Locust
(b) Wings of Bat and Butterfly
(c) Leg of Cockroach and Frog
(d) Wings of Birds and pectoral fins of Fish

26. Man evolved in **[CPMT 2003]**
(a) Triassic period (b) Jurassic
(c) Permian period (d) Pliocene

27. Which one of the following in birds, indicates their reptilian ancestry **[NCERT; MP PMT 2000; CBSE PMT 2008]**

(a) Two special chambers crop and gizzard in their digestive tract
(b) Eggs with a calcareous shell
(c) Scales on their hind limbs
(d) Four chambered heart

28. Connecting link between annelida and mollusca is **[DPMT 2004; MP PMT 2009; AFMC 2010]**

(a) *Neopilina* (b) *Nautilus*
(c) Glochidium larva (d) Veliger larva

29. Forelimbs of cat, lizard used in walking; forelimbs of whale used in swimming and forelimbs of bats used in flying are an example of **[CBSE PMT 2014]**

(a) Homologous organs (b) Convergent evolution
(c) Analogous organs (d) Adaptive radiation

30. Which one of the following periods is largely associated with extinction of dinosaurs and the increase in flowering plants and reptiles **[NCERT; DUMET 2009]**

(a) Jurassic (b) Triassic
(c) Cretaceous (d) Permian

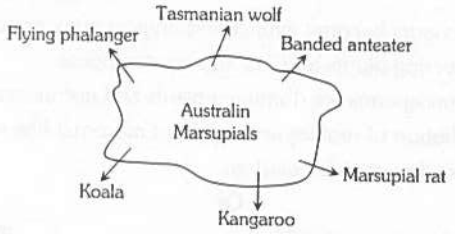
31. Organs that have different embryonic origin but perform similar functions are **[NCERT; CPMT 2000; DPMT 2004; J & K CET 2010; MP PMT 2011]**

(a) Homologous organs (b) Analogous organs
(c) Vestigeal organs (d) Atavism

32. Role of isolation in evolution is

(a) Differentiation of species (b) Maintenance of species
(c) Evolutionary divergence (d) Extermination of species

33. The given figure shows an example of **[NCERT]**



(a) Divergent evolution (b) Recapitulation
(c) Parallel evolution (d) Convergent evolution

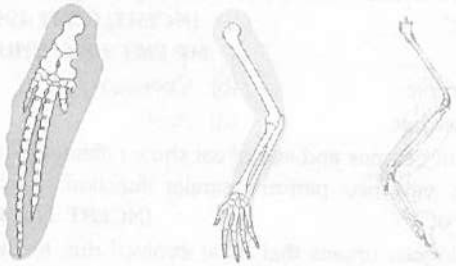
34. Which one is not a true fossil **[JIPMER 1994]**

(a) *Placoderm* (b) *Limulus*
(c) *Archeopteryx* (d) *Therapside*

35. Tendril of *Cucurbita* & throns of *Bougainvillea* are **[NCERT; DPMT 2007; CBSE PMT 2008; Kerala PMT 2011]**

(a) Vestigial organ
(b) Analogous organ
(c) Homologous organ
(d) None of these

36. The following structures shows that **[NCERT]**



(a) They have nothing to do with each other
(b) They are analogous
(c) They are vestigial structures
(d) They are homologous

37. A living connective link which provides evidence for organic evolution **[MP PMT 2000; CPMT 2009]**

(a) Archaeopteryx between reptiles and mammals
(b) Lung fish between pisces and reptiles
(c) Duck bill platypus between reptiles and mammals
(d) Sphenodon between reptiles and birds

38. The splint bone of present day horse is a vestige of **[DPMT 1993]**

(a) Fourth toe
(b) First toe
(c) Second toe
(d) Second and fourth toes in limbs

39. Vestigeal organs occur as **[DPMT 1993; JIPMER 1993; MP PMT 1997]**

(a) Useless because of incomplete development
(b) Inefficient parts
(c) Fully developed but useless
(d) Analogous

40. Occurrence of vestigeal organs is not explained by **[DPMT 1993; JIPMER 1993]**

(a) Theory of organic evolution
(b) Theory of special creation
(c) Scala naturae
(d) Natural classification system

41. Vestigeal pelvic girdle and bones of hind limbs are the characteristic of **[DPMT 1993]**

(a) Whales (b) Dolphins
(c) Sharks (d) Seal

42. Variation in gene frequencies within populations can occur by chance rather than by natural selection. This is referred to as **[CPMT 2004; NEET 2013]**

Or

Random unidirectional change in allele frequencies that occur by chance in all population and especially in small populations is known as **[NEET (Karnataka) 2013]**

(a) Genetic load (b) Genetic flow
(c) Genetic drift (d) Random mating

43. Which one of the following sets of structure includes only analogous organs

(a) Wings of butterfly, housefly and bat
(b) Hind legs of horse, grasshopper and bat
(c) Hands of man, monkey and kangaroo
(d) Mandibles of cockroach, mosquito and honey bee

44. Which of the following is commonly called "age of mammals and birds" **[NCERT; CPMT 1993, 96; MP PMT 2006; BHU 2012]**

(a) Mesozoic (b) Coenozoic
(c) Palaeozoic (d) Azoic

45. The eye of octopus and eye of cat show different patterns of structure, yet they perform similar function. This is an example of **[NCERT; NEET 2013]**

(a) Analogous organs that have evolved due to divergent evolution
(b) Homologous organs that have evolved due to convergent evolution
(c) Homologous organs that have evolved due to divergent evolution
(d) Analogous organs that have evolved due to convergent evolution

46. Appearance of ancestral characters in the new borns, such as tail, monstral face, gill slits, multiple mammae etc. are known as **[NCERT; AIIMS 2008]**

Or

Presence of tail in a child is an example of **[NCERT; AIIMS 2004, 08; MP PMT 2007; BHU 2012]**

(a) Homologous (b) Analogous
(c) Atavism (d) Vestigeal

47. Which one is not a vestigeal organ **[Kerala CET 2003]**

(a) Wings of Kiwi (b) Coccyx in man
(c) Pelvic girdle of Python (d) Flipper of seal

48. Basic principles of embryonic development were stated by **[CBSE PMT 1990]**

(a) Von Baer (b) Haeckel
(c) Darwin (d) Weismann

49. Parallelism is **[NCERT; CBSE PMT 1990; DPMT 2007]**

(a) Adaptive divergence in evolution
(b) Adaptive convergence of widely different species in evolution
(c) Adaptive convergence of closely related species in evolution
(d) None of these

50. Allopatric speciation is due to **[CBSE PMT 1990; KCET 2011]**

(a) Mutation
(b) Geographical separation of populations
(c) Migration of member of a species form one to other populations
(d) Hybridization between closely related species

51. Correct sequence is **[NCERT; CBSE PMT 1991]**

(a) Palaeozoic → Mesozoic → Coenozoic
(b) Mesozoic → Archaeozoic → Proterozoic
(c) Palaeozoic → Archaeozoic → Coenozoic
(d) Archaeozoic → Palaeozoic → Proterozoic

52. Vestigeal organ in man is **[CPMT 1993, 94]**

(a) Extra-abdominal muscles
(b) Thumb
(c) Conjunctiva
(d) Body hairs

53. Fossil X is older than fossil Y. Most evident answer is **[NCERT; CPMT 1993]**

(a) Fossil Y has got some of the vestigial organs which are functional in X
(b) Fossil Y has got homologous and analogous organs of fossil X
(c) Fossil X is found in deeper sedimentation than Y
(d) Fossil Y was found in better state than that of X

54. Age of fossils in the past was generally determined by radio-carbon method and other methods involving radioactive elements found in the rocks. More precise methods, which were used recently and led to the revision of the evolutionary periods for different groups of organisms, includes **[NCERT; CBSE PMT 2004; AIIMS 2007]**

(a) Electron spin resonance (ESR) and fossil DNA
(b) Study of carbohydrates/proteins in rocks
(c) Study of carbohydrates/proteins in fossils
(d) Study of conditions of fossilization

55. Living fossil is **[MP PMT 1994]**

(a) Latimeria (b) Uromastix
(c) Archaeopteryx (d) All the above

56. Two or more species occupying identical or overlapping areas are known as **[MP PMT 1994; CBSE PMT 1996; Odisha JEE 2005; BHU 2012]**

(a) Sympatric species (b) Allopatric species
(c) Sibling species (d) Polytypic species

57. The earliest site where human civilization and crop cultivation started was presumably

(a) Around Caspian and Mediterranean seas
(b) Around river Nile
(c) Chinese river valley
(d) All of these

58. Jurassic period of the Mesozoic era is characterised by **[CBSE PMT 2006]**

(a) Dinosaurs become extinct and angiosperms appear
(b) Flowering plants and first dinosaurs appear
(c) Gymnosperms are dominant plants and first birds appear
(d) Radiation of reptiles and origin of mammal-like reptiles

59. The rocks that contain fossil are

Or

The fossils are preserved in **[NCERT]**

(a) Metamorphic rocks (b) Igneous rocks
(c) Sedimentary rocks (d) All the above

60. Convergent evolution is illustrated by **[NCERT; CBSE PMT 2003]**

(a) Dogfish and whale
(b) Rat and dog
(c) Bacterium and protozoan
(d) Starfish and cuttle fish

61. Analogous organs have arisen in the evolutionary process through

(a) Recombination (b) Mutation
(c) Hybridisation (d) Adaptation

62. Presence of gills in the tadpole of frog indicates that **[NCERT; CBSE PMT 2004]**
(a) Frogs will have gills in future
(b) Frogs evolved from gilled ancestors
(c) Fishes were amphibious in the past
(d) Fishes evolved from frog-like ancestors

63. Distribution in space is called **[MP PMT 2004]**
(a) Geological distribution (b) Geographical distribution
(c) Zoological distribution (d) Cosmos distribution

64. Which of the following were abundant in mesozoic era **[NCERT; CPMT 1995]**

Or

Birds are evolved from **[JIPMER 1994]**
(a) Mammals (b) Reptiles
(c) Insects (d) Fishes

65. Two zoogeographical regions separated by high mountain ranges are **[NCERT; CBSE PMT 1995]**
(a) Palaearctic and Oriental
(b) Oriental and Australian
(c) Nearctic and Palaearctic
(d) Neotropical and Ethiopian

66. Which of the following is connecting link showing organic evolution
(a) *Plumnaeus* (b) *Pontobdella*
(c) *Macropus* (d) *Peripatus*

67. Being all mammals, whale, dolphins, bat, monkey and horse have some common characters but they also show conspicuous differences. This is due to phenomenon of **[NCERT; MP PMT 2004]**
(a) Normalisation (b) Genetic drift
(c) Convergence (d) Divergence

68. The study of fossils is called **[KCET 1994; MHCET 2001]**

Or

The field in which zoology and geology are very intimately connected, is

Or

Existence of coal / petroleum can be known from the study of **[NCERT]**
(a) Herpatology (b) Cytology
(c) Palaeontology (d) Organic evolution

69. A species is taxonomically **[CBSE PMT 1994]**
(a) A group of evolutionary related populations
(b) A population with common characteristics as evolutionary base of variation
(c) A fundamental unit in the phylogenetic history of organisms
(d) A basic category to which most taxonomic information is attached

70. The earliest fossil form in the phylogeny of horse is **[CBSE PMT 1994]**
(a) *Merychippus* (b) *Eohippus*
(c) *Equus* (d) *Mesohippus*

71. Which one of the following is a pair of homologus organs **[CBSE PMT 1994]**
(a) Lungs of rabbit and gills of rohu
(b) Wing of bat and wing of butterfly
(c) Pectoral fin of rohu and the forelimb of horse
(d) Wing of grasshopper and wing of crow

72. Which is not true of *Archaeopteryx* **[MHCET 2004]**
(a) Jaws are modified into beak
(b) Tail is bony and long
(c) Fore limbs are modified into wings
(d) Connecting link between birds and mammals

73. Who discovered the fossil of archaeopteryx from bavaria (Germany) **[DPMT 1993]**
(a) Thomas Huxley (b) Hermann von Meyer
(c) Colin Harrison (d) Andreas Wagner

74. Vestigeal organ in human being is **[RPMT 2006]**
(a) Incisor (b) Canines
(c) Molar (d) Premolar

75. Fossil found in Mandla district of MP is **[MP PMT 2007]**
(a) 260 million years old (b) 100 million years old
(c) 50 million years old (d) 20 million years old

76. Which is connecting link between Reptiles and Aves **[CBSE PMT 1993; RPMT 1999; J & K CET 2005; Bihar CECE 2006; CPMT 2009]**
(a) Archaeopteryx (b) Peripatus
(c) Ornithorynchus (d) Loligo

77. Analogous structures are a result of **[NCERT; CPMT 2005; NEET (Phase-I) 2016]**
(a) Divergent evolution (b) Convergent evolution
(c) Shared ancestry (d) Stabilizing selection

78. The wings of an insect and a bat exhibit **[MP PMT 1998, 2002; DPMT 2003; BVP 2004; Odisha JEE 2010]**
(a) Homology (b) Analogy
(c) Atavism (d) Connecting link

79. Which of the following are homologous organs **[CBSE PMT 1999]**
(a) Wings of bird and wings of insect
(b) Wings of bat and wings of cockroach
(c) Wings of bird and hands of human
(d) Nails of human being and claws in animals

80. Which of the following is vestigeal organ in humans **[CPMT 1995, 99; BHU 1999; AFMC 2002; J & K CET 2008]**
(a) Muscles of ear pinna
(b) Nictitating membrane
(c) Mammary glands in males
(d) All of the above

81. Which is incorrect **[NCERT; Odisha JEE 2004]**
(a) Wings of insects and birds are analogous
(b) Wings of insects and bats are analogous
(c) Wings of insects and birds are homologous
(d) Wings of bats and birds are homologous

82. Deviation of homologues are caused by **[Pune CET 1998]**
(a) Time consequence along
(b) Gradual changes in structure
(c) Drastic changes in structure
(d) No changes in basic structure

83. The term for similarity in organ structure seen in great diversity is **[Pune CET 1998]**
(a) Homology (b) Identical
(c) Analogy (d) Symmetrical

84. Which one of the following is a living fossil **[CPMT 1998; BVP 2004]**
(a) *Sphenodon* (b) *Heloderma*
(c) Rabbit (d) Frog

85. Fossils are studied for **[NCERT; DPMT 2004]**
(a) Tracing evolutionary history of organisms
(b) Studying extinct organisms
(c) Providing jobs to scientist
(d) Both 'a' and 'b'

86. Two organs which are similar in structure and origin, but not necessarily in function are called **[CBSE PMT 1995, 2003; MP PMT 1997; Pune CET 1998; Pb PMT 2000; CPMT 2004; J & K CET 2005]**
Or
The organs of different species that are related to each other through common descent though becomes functionally different are called **[NCERT]**
(a) Homologous (b) Analogous
(c) Apocrine (d) None of these

87. Wings of pigeon, mosquito and bat show **[AIIMS 1999; VITEEE 2008]**
(a) Atavism (b) Mutation
(c) Divergent evolution (d) Convergent evolution

88. Peripatus is known as a connecting link, because it has the characters of both **[NCERT; Bihar MDAT 1995; AFMC 2002; MHCET 2003; BCECE 2005; MP PMT 2006; CBSE PMT 2009; BHU 2012]**
(a) Aves and Fishes (b) Reptiles and Birds
(c) Fishes and Amphibians (d) Arthropoda and Annelids

89. Which of the following is the most evident source of evolution **[NCERT; CPMT 1995; 2000; BHU 2006]**
(a) Fossils (b) Embryos
(c) Morphology (d) Vestigeal organs

90. Which of the following is not vestigeal in human **[CBSE PMT 2000; J & K CET 2002; BHU 2004]**
(a) Coccyx (b) Nail
(c) Third molar (d) Abdomen

91. Ancestral amphibians were tetrapods that evolved during **[BHU 2002]**
(a) Jurassic period (b) Cretaceous period
(c) Devonian period (d) Carboniferous period

92. Examples of vestigial organs in the human body are **[CPMT 1998; MP PMT 1999; DPMT 2006]**
(a) Wisdom tooth, coccyx, vermiform appendix, nail
(b) Coccyx, wisdom tooth
(c) Coccyx, vermiform appendix, wisdom tooth, pancrease
(d) Auricular muscles, coccyx, nail, wisdom tooth

93. The dinosaurs were maximum during the period of **[NCERT; J & K CET 2002; NEET (Karnataka) 2013 MH CET 2015]**
(a) Jurassic (Mesozoic) (b) Triassic
(c) Cretaceous (d) Palaeocene

94. Archeopteryx, a transitional fossil between birds and reptiles was discovered from the rocks of following period **[MP PMT 2002]**
(a) Jurassic (b) Archeozoic era
(c) Cretaceous (d) Triassic

95. In terms of evolutionary origin, which one of the following is correct **[WB-JEE 2016]**
(a) Birds are closer to mammals
(b) Birds are closer to reptiles
(c) Both bats and birds originated from the same ancestor group
(d) Birds originated from animals like flying lizards

Lamarckism

1. Germplasm theory against Lamarck's principle, was given by **[NCERT; MP PMT 1994, 96, 99, 2009, 10; CPMT 1995, 96; EAMCET 1998; Pb PMT 1999; BHU 2001; Manipal 2005; J & K CET 2008]**
Or
Lamarck's acquired characters are not inherited and have no evolutionary value. This statement was given by
(a) Weismann (b) Darwin
(c) Lamarck (d) Hugo de Vries

2. Author of "*Philosophique Zoologique*" is **[NCERT; JIPMER 1993; CPMT 2001; MP PMT 2001; DPMT 2006]**
(a) Mendel (b) Darwin and Wallace
(c) Lamarck (d) Darwin

3. The scientists regarded as Neo–Lamarckist are **[AIIMS 1993]**
(a) August Weismann and T.H. Morgan
(b) Hardy Weinberg
(c) Correns, Tshermak and Hugo de Vries
(d) Kammerer and Mc Dougall

4. When an organ is used it will develop and if it is not used, it weakens to become vestigial. Who could have said their theory **[NCERT; DPMT 1993; AFMC 2001; MP PMT 2003]**
Or
The idea of use and disuse of organs was given by **[Kerala PMT 1997; AFMC 2001; BVP 2004; J & K CET 2008]**
(a) Darwin (b) de Vries
(c) Lamarck (d) Mendel

5. The basis of Lamarkism is **[MP PMT 2013]**
(a) Development of organ (b) Reduction of organ
(c) Effect of metabolism (d) Effect of environment

6. Lamarckian theory deals with **[MP PMT 1997; Odisha JEE 2005]**
(a) Acquired characters (b) Germplasm
(c) Struggle for existence (d) Mutation

7. Key point to Lamarck's view about organic evolution is that every offspring
(a) Is similar to its parents
(b) Inherits characters acquired by the parental generation
(c) Shows struggle for existence
(d) Repeats phylogeny in its ontogeny

8. Theory of inheritance of acquired characters was putforth by **[Odisha JEE 1994; MP PMT 1995, 2001; AFMC 1997; KCET 1998, 99; CPMT 2000]**
(a) Lamarck (b) Weismann
(c) Galton (d) de Vries

9. Most popular example of Lamarck is
(a) African Giraffe (b) Snakes
(c) Both (a) and (b) (d) Primose

10. A scientist who worked on rats cut their tails upto 21 successive generations but at last he found that tail remained normal. By this experiment theory of which scientist is disapproved **[CPMT 1995]**
(a) Darwin (b) Lamarck
(c) Hugo de Vries (d) Mendal

11. Who was the first to discard the idea of fixity of species **[Kerala PMT 2009]**
(a) Jean Baptiste Lamarck (b) Charles Darwin
(c) Robert Hooke (d) William Harvey
(e) Stanley Cohen

Darwinism

1. Who wrote the "*Origin of Species*" **[NCERT; CPMT 1993; MP PMT 2006, 10; Bihar CECE 2006; Odisha JEE 2009, 10; WB JEE 2011]**
(a) G.J. Mendel (b) Lamarck
(c) de Vries (d) Charles Darwin

2. A scientist who gave a theory very similar to that given by Darwin was
Or
Co–worker of Darwin was
(a) Malthus (b) Wallace
(c) Goldstein (d) Mendel

3. Industrial melanism is an example of **[AIPMT 2015]**
(a) Natural selection (b) Mutation
(c) Neo lamarckism (d) Neo darwinism

4. Name of the ship in which Charles Darwin went for his expedition **[NCERT; MP PMT 1993; Odisha JEE 2008]**
(a) Siboga (b) Beagle
(c) Sea gull (d) Atlantic

5. The finch species of Galapagos island are grouped according to their food sources. Which of the following is not a finch food **[NEET (Karnataka) 2013]**
(a) Carrion (b) Insects
(c) Tree buds (d) Seeds

6. Darwin gave the theory of evolution was based on **[CPMT 2003; J & K CET 2003]**
(a) Survival of the fittest
(b) Natural selection
(c) Mutation
(d) Descent with modifications

7. According to the Neo–Darwinian theory, which of the following is responsible for the origin of new species **[CPMT 1995; AFMC 2006]**
(a) Mutations
(b) Useful variations
(c) Mutations together with natural selection
(d) Hybridization

8. There is more competition for survival between **[AFMC 2006]**
(a) Same animals of same niche
(b) Different animals of same niche
(c) Same animals of different niche
(d) Different animals of different niche

9. Who gave the 'Theory of pangenesis' **[NCERT; CPMT 1998; MP PMT 1999, 2001; BVP 2001, 04; DPMT 2006]**
Or
Who is related with 'Galapagos Island' **[MP PMT 1994; AIIMS 1998]**
(a) Lamarck (b) Wallace
(c) Haeckel (d) Darwin

10. In the case of peppered moth (*Biston betularia*) the black-coloured from became dominant over the light-coloured form in England during industrial revolution. This is an example of **[AIIMS 1998; CPMT 1999; JIPMER 2001; AFMC 2002; RPMT 2006; CBSE PMT 2009]**
(a) Natural selection whereby the darker forms were selected
(b) Appearance of the darker coloured individuals due of very poor sunlight
(c) Protective mimicry
(d) Inheritance of darker colour character acquired due to the darker environment

11. If mating is random, population is large and mutation does not occur; then gene frequencies of population from generation to generation remain constant. This was put forwarded by **[AIIMS 1993]**
(a) Lederberg (b) Wallace
(c) Hardy Weinberg (d) Haeckel

12. Darwin's Finches are an excellent example of **[CBSE PMT 2008; CBSE PMT (Pre.) 2010; MH CET 2015]**
(a) Brood parasitism (b) Connecting links
(c) Adaptive radiation (d) Seasonal migration

13. By performing the replica plating experiment, Lederberg supported the **[Odisha JEE 2011]**
(a) Gene mutation theory (b) Natural selection theory
(c) Lamarck theory (d) Darwinian theory

14. Match the scientists and their contributions in the field of evolution

Name of the Scientist		Contributions	
A.	Charles Darwin	1.	Mutation theory
B.	Lamarck	2.	Germ plasm theory
C.	Hugo de Vries	3.	Philosophie Zoologique
D.	Ernst Haeckel	4.	The Origin of species
E.	August Weismann	5.	Biogenetic law
		6.	Essay on population

[KCET 1998; Kerala PMT 2008; AIIMS 2010]
(a) A – 4, B – 3, C – 1, D – 5, E – 2
(b) A – 4, B – 3, C – 5, D – 1, E – 6
(c) A – 4, B – 4, C – 5, D – 3, E – 1
(d) A – 2, B – 3, C – 1, D – 5, E – 2
(e) A – 3, B – 4, C – 1, D – 5, E – 2

15. Darwinian theory was unable to explain **[Pune CET 1998; BVP 2003; Haryana PMT 2005]**
(a) The significance of minute variations
(b) Presence of vestigeal or useless organs
(c) The presence of over specialized organs
(d) All of the above

16. Hardy-Weinberg equilibrium is known to be affected by gene flow, genetic drift, mutation, genetic recombination and **[Kerala PMT 2008]**
(a) Evolution (b) Limiting factors
(c) Saltation (d) Natural selection
(e) Over production

17. According to Darwin, the organic evolution is due to **[NEET 2013]**
(a) Reduced feeding efficiency in one species due to the presence of interfering species
(b) Intraspecific competition
(c) Interspecific competition
(d) Competition within closely related species

18. In forming the theory of evolution by natural selection, Darwin was greatly influenced by **[NCERT]**
(a) Mutations of Hugo de Vries
(b) Malthus idea of population control
(c) Environmental factors
(d) Lamarck acquired characters

19. "*Origin of Species*" was published in **[NCERT; CPMT 2002; Haryana PMT 2005; RPMT 2005; BHU 2012]**
(a) 1809 (b) 1858
(c) 1956 (d) 1859

20. "Darwin's finches" refers to **[AIIMS 1993]**
(a) Fossils of birds collected by Darwin at Galapagos islands
(b) A type of birds present on Galapagos islands
(c) Migratory birds collected by Darwin at Galapagos islands
(d) Fossils of reptiles collected by Darwin at Galapagos island

21. The Darwinian fitness of an organism is a measure of **[J & K CET 2012]**
(a) Its ability, relative to others in the population to pass its genes to the next generation
(b) The number of offspring it produces
(c) Its lifespan
(d) Its physical vigour

22. According to Darwin, evolution is ..... **[KCET 2010]**
(a) A sudden but discontinuous process
(b) A slow, gradual and continuous process
(c) A slow, sudden and discontinuous process
(d) A slow and discontinuous process

23. By the statement 'Survival of the Fittest', Darwin meant that **[KCET 2011]**
(a) The strongest of all species survives
(b) The most intelligent of the species survives
(c) The cleverest of the species survives
(d) The most adaptable of the species to changes survives

24. The idea of "*survival of the fittest*" was given by **[NCERT; AFMC 2005]**
(a) Darwin (b) Herbert Spencer
(c) Malthus (d) Lyell

25. The correct meaning of natural selection is **[MP PMT 2003]**
(a) Loss of uncompetant (b) Survival of the fittest
(c) Variation (d) Struggle for existence

26. Industrial melanism was highlighted by **[Kerala PMT 2008]**
(a) *Mimosa pudica* (b) *Triticum aestivum*
(c) *Biston betularia* (d) Rock python
(e) Polar bear

27. Whose bicentenary is the year 2009 **[Odisha JEE 2009]**
(a) Darwin (b) Edward Jenner
(c) Stanley Miller (d) T.H. Morgan

28. Natural Selection Theory of Darwin is objected to, because it **[CBSE PMT 1991]**
(a) Stresses upon slow and small variations
(b) Stresses upon interspecific competition
(c) Explains that natural calamities take a heavy annular toll of lives
(d) Explains, adaptation of certain inherited characters

29. '*The Descent of Man*' was published by
(a) Charles Darwin in 1871
(b) Charles Darwin in 1859
(c) Hugo de Vries in 1901
(d) Lamarck in 1809

30. Appearance of dark-coloured peppered moths among the light-coloured ones as a result of increased industrial pollution is an example of **[AIIMS 2010]**
(a) Disruptive selection
(b) Stabilishing selection
(c) Directional selection
(d) None of the above

31. de Vries discarded the principle of **[CPMT 1995]**
(a) Darwin (b) Lamarck
(c) Haeckel (d) Mendel

32. In which case Darwin theory is wrong **[NCERT; BHU 1995; MH CET 2015]**
(a) Arrival of the fittest
(b) Survival of the fittest
(c) Origin of species
(d) High efficiency of reproduction

33. Main basis of Neo–Darwinism is **[CPMT 1996]**

Or

Initiating force of evolution is **[MP PMT 2004]**

(a) Struggle for existence

(b) Variations

(c) Survival of the fittest

(d) Gene theory

34. Darwin could not properly explain the theory of evolution due to lack of **[Odisha JEE 2009]**

(a) Evidence (b) Variations

(c) Speciation (d) Genetics

35. Darwin judged the fitness of an individual by **[DUMET 2009]**

(a) Ability to defend itself

(b) Strategy to obtain food

(c) Number of offspring

(d) Dominance over other individuals

36. Prodigality of reproduction in darwinism refers to **[NCERT; MHCET 2004]**

(a) Every organism produces numerous offspring

(b) Successful organism produce numerous offspring

(c) Only a few individuals are able to reproduce

(d) Only a few individuals are able to survive

37. If Darwin's theory of pangenesis shows similarity with theory of inheritance of acquired characters then what shall be correct according to it **[AIIMS 2010]**

(a) Useful organs become strong and developed while useless organs become extinct. These organs help in struggle for survival

(b) Size of organs increase with ageing

(c) Development of organs is due to willpower

(d) There should be some physical basis of inheritance

38. Darwinism explains all the following except **[KCET 2009]**

(a) Within each species, there are variations

(b) Organisms tend to produce more number of offspring than can survive

(c) Offspring with better traits that overcome competition are best suited for the environment

(d) Variations are inherited from parents to offspring through genes

39. Which one of these is not a case of artificial selection **[Kerala PMT 2009]**

(a) Shetland pony (b) Great dane dog

(c) Broccoli (d) Peppered moth

(e) Arabian race horse

40. The diversity in the type of beaks of finches adapted of different feeding habits on the Galapagos islands as observed by Darwin, provides evidence for **[NCERT; CBSE PMT 1998]**

(a) Origin of species by natural selection

(b) Intraspecific variations

(c) Intraspecific competition

(d) Interspecific competition

41. What is the most important factor for the success of animal population **[CBSE PMT 1997]**

(a) Natality

(b) Unlimited food

(c) Adaptability

(d) Interspecies activity

42. Development of patagia in animals is an **[Pb. PMT 1999]**

(a) Cave adaptation

(b) Volant adaptation

(c) Aquatic adaptation

(d) Arboreal adaptation

43. Which one of the following was not given by Darwin's theory of evolution **[NCERT; AFMC 2009]**

(a) Struggle for existence (b) Over production

(c) Natural selection (d) Genetic drift

44. Development of unrelated groups of animals along parallel lines in adaptation to a similar environment is called **[Pb. PMT 1999; MP PMT 2002]**

(a) Adaptive convergence

(b) Adaptive radiation

(c) Adaptive divergence

(d) Adaptive induction

45. Darwin in his 'Natural Selection Theory' did not believe in any role of which one of the following in organic evolution **[CBSE PMT 2003]**

(a) Discontinuous variations

(b) Parasites, predators and natural enemies

(c) Survival of the fittest

(d) Struggle for existence

46. Industrial melanism is an example of **[CBSE PMT 2003; DUMET 2009]**

(a) Defensive adaptation of skin against ultraviolet radiations

(b) Drug resistance

(c) Darkening of skin due to smoke from industries

(d) Protective resemblance with the surrounding

47. One of the following phenomena supports Darwin's concept of natural selection in organic evolution **[CBSE PMT 2005]**
(a) Development of transgenic animals
(b) Production of 'Dolly', the sheep by cloning
(c) Prevalence of pesticide resistant insects
(d) Development of organs from 'stem cells' for organ transplantation

48. The biologist who has been called the "Darwin of the 20th century", was **[NCERT; AMU (Med.) 2012]**
(a) Linnaeus (b) Ernst Mayr
(c) Diener (d) Whittaker

49. According to Darwinism fossils of organisms found in south America resembles most, the fossils of **[Odisha JEE 2004]**

Or

Most primitive living mammals which provide an evidence of organic evolution from geographical distribution are found in **[AIIMS 1998]**
(a) North America (b) Africa
(c) Australia (d) Both (a) and (b)

50. Darwin's finches discovered from the Galapagos island provide evidence infavour of **[NCERT; AIEEE Pharmacy 2004; Pb. PMT 2004; CBSE PMT 2000, 07; AFMC 2009]**
(a) Camouflage
(b) Mimicry
(c) Biogeographical evidence of evolution
(d) Seasonal migration

51. The classical example of adaptive radiation in development of new species is **[NCERT; CPMT 2004]**
(a) Darwin finches (b) Marsupials of Australia
(c) Giant turtle (d) All of these

52. Theory of natural selection was proposed by **[MHCET 2001; BCECE 2005; J & K CET 2005; Odisha JEE 2011; MP PMT 2012]**
(a) Darwin (b) Lamarck
(c) de Vries (d) Theophrastus

53. Neo-Darwinism is **[MHCET 2004]**
(a) Natural selection theory (b) Modern mutation theory
(c) Modern synthetic theory (d) Population theory

Evolution of Man

1. Which of the following had the smallest brain capacity **[AIPMT (Cancelled) 2015]**
(a) *Homo sapiens* (b) *Homo neanderthalensis*
(c) *Homo habilis* (d) *Homo erectus*

2. The brain capacity of Homo erectus was **[J & K CET 2008; Kerala PMT 2011]**
(a) 800 to 1300 cc (b) 1650 cc
(c) 650 cc (d) 1400 cc

3. Dubois in 1891 found the fossil of Java ape man. It is

Or

Which one of the following is highly evolved
(a) *Sinanthropus pekinensis*
(b) *Homo erectus*
(c) *Homo rhodesiensis*
(d) *Homo sapiens*

4. Humans belong to the family **[J & K CET 2010]**
(a) Hominidae (b) Pongidae
(c) Hylobatidae (d) *Ramapithecus*

5. 'Peking man' is known as **[AFMC 2008]**

Or

Which of the primate is the closest relative of man
(a) Australopithecus (b) Sinanthropus
(c) Pithecanthropus (d) Homo sapiens

6. The recent ancestors of modern man were **[CMC Vellore 1993]**
(a) Java ape man and Peking man
(b) Peking man and Rhodesian Man
(c) Rhodesian man and Cro-Magnon man
(d) Cro-Magnon man and Neanderthal man

7. The age of the fossil of Dryopithecus on the geological time scale is **[CBSE PMT 1998]**
(a) 75×10^6 years back (b) 25×10^6 years back
(c) 2.5×10^6 years back (d) 50×10^6 years back

8. Which of the following is true for '*Homo sapiens*'
(a) Protruded mouth
(b) Cranial capacity of 1450 c.c.
(c) Omnivorous
(d) Developed chin

9. Neanderthal man differs from modern man in
(a) Receding jaws (b) Protruding jaws
(c) Could make good tools (d) Could make good pictures

10. '*Homo erectus*' is the zoological name of **[CPMT 1995]**

Or

Thick skull, cranial capacity about 1075 c.c., low fore head, absence of chin and large canine were present in
(a) Cro–Magnon man (b) Peking man
(c) Nut cracker man (d) Neanderthal man

11. During evolution of man many changes have taken place in his ancestral characters. Which one of the following is an unsignificant change **[CBSE PMT 1994, 96; BHU 2000]**
(a) Change of diet from hard tough fruits and roots into soft food
(b) Qualitative improvement in the structure of hands skills for making tools
(c) Disappearance of tail
(d) Improvement in speech for communication and social behaviour

12. The first probable fossil of man was
(a) Australopithecus (b) Zinjanthropus
(c) Pithecanthropus (d) Plesianthropus

13. The first fossil of *Australopithecus* was discovered in **[MHCET 2015]**
(a) Olduvai Gorge, Tanzania
(b) Fayum deposits of Egypt
(c) Siwalik hills in India
(d) Taung in South Africa

14. Oldest tool maker is

Or

Which primitive man used stones to produce fire **[CPMT 1995]**
(a) African man (b) Java man
(c) Proconsul (d) China man

15. *Homo sapiens/Homo Erectus* evolved in **[MP PMT 2012; WB JEE 2012]**
(a) Miocene (b) Oligocene
(c) Pliocene (d) Pleistocene

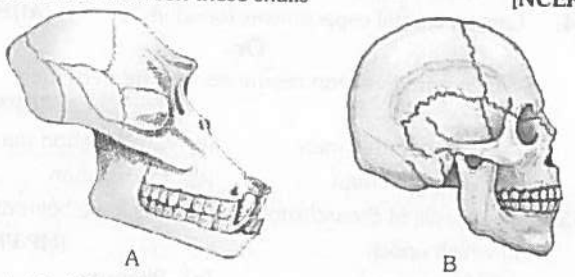
16. Cro-Magnon man was **[AFMC 2004]**
(a) Herbivorous (b) Frugivorous
(c) Sanguivorous (d) Carnivorous

17. The prehistoric ancestor of man which existed during late pleistocene, is **[CPMT 1995, 2009]**

Or

The extinct human who lived 1,00,000 to 40,000 years ago, in Europe, Asia and parts of Africa, with short stature, heavy eyebrows, retreating fore heads, large jaws with heavy teeth, stocky bodies a lumbering gait and stooped posture was **[CBSE PMT (Pre.) 2012]**
(a) Australopithecus (b) Zinjanthropus
(c) Neanderthal man (d) Atlantic man

18. The given illustration shows the skull of two different mammals. Which of the following accurately describes the differences between these skulls **[NCERT]**



(a) Skull A is the skull of an ape and skull B is the skull of human
(b) Skull A is of a primate and skull B is not of a primate
(c) Skull A has more brain capacity than skull B
(d) Skull A has more teeth than skull B

19. The cranial capacity of Java ape man was about **[CPMT 1995, 96; MH CET 2000; BVP 2001]**
(a) 560 c.c. (b) 900 c.c.
(c) 1,300 c.c. (d) 1,000 c.c.

20. Anthropometry is useful in the study of **[MHCET 2004]**
(a) Human evolution (b) Human habits
(c) Human nature (d) Human brains

21. Evolution of man is possible because our ape like ancestors has
(a) Migratory instinct (b) Developed brain
(c) Binocular vision (d) Large cranial capacity

22. Which of the following stood erect first **[MP PMT 2004]**

Or

The extinct human ancestor, who ate only fruits and hunted with stone weapons was **[AIIMS 2012]**
(a) Java man (b) Peking man
(c) Australopithecus (d) Cro-Magnon man

23. The modern man evolved **[Odisha JEE 2005]**
(a) 10,000 years ago (b) 25,000 years ago
(c) 2,50,000 years ago (d) 5,00,000 years ago

24. Who first discovered fossils of '*Ramapithecus*'
(a) Dubois (b) R. Dart
(c) G.E. Lewis (d) J.K. Fuhlort

25. In evolution.....evolved 1st time in annelida **[Odisha JEE 2004]**
(a) Cephlaization (b) True coelome
(c) Bilateral symmetry (d) Triploblastic nature

26. Man was originated in which of the following era **[MHCET 2000]**
(a) Paleocene (b) Pliocene
(c) Miocene (d) Devonian

27. Proper burial of dead bodies, for the first time started in which prehistoric man's period **[CPMT 1995, 2002; MP PMT 1999; BHU 2002; RPMT 2005]**
(a) Peking man (b) Java man
(c) Neanderthal man (d) Cro-Magnon man

28. The most recent and direct prehistoric ancestor of present man is **[CPMT 1993; MP PMT 1998; DPMT 2001]**
(a) Cro-Magnon (b) Preneanderthal
(c) Neanderthal (d) None of the above

29. The modern man differs from the apes in **[BHU 2004]**
(a) Protruding eyes (b) Spare body hair
(c) Wearing of clothes (d) Arms shorter than legs

30. Bipedal locomotion is advantageous because it
(a) Releases fore limbs to perform the important functions
(b) Increases the speed
(c) Reduces body weight
(d) Provides better support to the body

31. There are two opposing views about origin of modern man. According to one view Homo erectus in Asia were the ancestors of modern man. A study of variation of DNA however suggested African origin of modern man. What kind of observation on DNA variation could suggest this **[CBSE PMT 2005]**
(a) Greater variation in Asia than in Africa
(b) Greater variation in Africa than in Asia
(c) Similar variation in Africa and Asia
(d) Variation only in Asia and no variation in Africa

32. The highest cranial capacity is/was present in **[BHU 2004]**
(a) Java man (b) Peking man
(c) Handy man (d) Modern man

33. Common origin of man and chimpanzee is best shown by **[CBSE PMT 1997]**
(a) Dental formula (b) Cranial capacity
(c) Binocular vision (d) Chromosome number

34. Fossils of *Australopithecus* were first found in **[Pb. PMT 2004]**
(a) America (b) Australia
(c) S. Africa (d) E. Africa

35. Ancestors of mammals belongs to **[Kerala PMT 2004]**
(a) Ornithischia (b) Therapsida
(c) Silusidea (d) Chelonia
(e) None of these

36. Early Africa man was discovered in 1948 by Leakey. It was
(a) *Homo habilis* (b) *Gigantopithecus*
(c) *Proconsul* (d) *Homo erectus*

37. Australopithecus had a cranial capacity **[CPMT 1994]**
(a) 800 *c.c.* (b) 500 *c.c.*
(c) 600 *c.c* (d) 700 *c.c*

38. The closest relative of modern man is considered to be **[AFMC 1997; CPMT 2009]**
(a) Chimpanzee (b) Orangutan
(c) Apes (d) Gibbon

39. Among the human ancestors the brain size was more than 1000 *CC* in **[CBSE PMT 2007]**
(a) Homo neanderthalensis (b) Homo erectus
(c) Ramapithecus (d) Homo babilis

40. The fossils of Cro-Magnon were found in **[MH CET 2002, 04]**
(a) Algeria – In ternifine deposits
(b) Germany –In ravines
(c) France – Rock shelters
(d) Africa – Olduvi

41. Cranial capacity of Cro-Magnon was
(a) 1600 *c.c* (b) 1350 *c.c*
(c) 1075 *c.c.* (d) 1450 *c.c.*

42. The lowest capacity of cranium was found in the **[CPMT 1993]**
(a) Neanderthal man (b) Australopithecus
(c) Cro-Magnon man (d) Java man

43. What kind of evidence suggested that man is more closely related with chimpanzee than with other hominoid apes **[CBSE PMT 2004]**
(a) Evidence from fossil remains, and the fossil mitochosomes, DNA alone
(b) Evidence from DNA extracted from sex chromosomes, autosomes and mitochondria
(c) Evidence from DNA from sex chromosomes only
(d) Comparison of chromosomes morphology only

44. Which of the following is more close to man **[MP PMT 2004]**
(a) Pro-consul (b) Dryopithecus
(c) Gibbon (d) Orangutan

45. Cranial capacity of Neanderthal man is **[CPMT 1998]**
(a) 1350–1500 cm^3 (b) 1400–1450 cm^3
(c) 915–1250 cm^3 (d) 750–900 cm^3

46. Cranial capacity of modern man is **[MP PMT 1994]**
(a) 350–400 cm^3 (b) 500–1000 cm^3
(c) 915–1700 cm^3 (d) 1350–1500 cm^3

47. Which one of the following statements is correct **[CBSE PMT 1998]**
(a) *Homo erectus* is the ancestor of man
(b) Cro-magnon man's fossil has been found in Ethiopia
(c) Australopithecus is the real ancestor of modern man
(d) Neanderthal man is the direct ancestor of *Homo sapiens*

48. Which of the following is the most primitive ancestor of man **[CPMT 1999; JIPMER 2001; WB JEE 2011]**
Or
The primate which existed 15 mya among these was **[Kerala PMT 2010]**
Or
Which fossil man has been known from Shivalik hills in India **[BVP 2003; MH CET 2003; Odisha JEE 2005]**
(a) *Australopithecus* (b) *Ramapithecus*
(c) *Homo habilis* (d) *Homo neanderthalensis*

49. Biological name of the Java man is **[MP PMT 1993, 99; CPMT 2003; WB JEE 2010]**
(a) *Homo erectus*
(b) *Homo sapiens*
(c) *Homo habilis*
(d) *Pithecanthropus erectus* (*Homo erectus erectus*)

50. Island (continent) where largest number of human fossils have been discovered **[MP PMT 2006]**
(a) Europe (b) Africa
(c) America (d) Asia

51. What was the most significant trend in the evolution of modern man (*Homo sapiens*) from his ancestors **[CBSE PMT (Pre.) 2012]**
(a) Shortening of jaws
(b) Binocular vision
(c) Increasing cranial capacity
(d) Upright posture

52. Evolution of man took place in **[CBSE PMT 2002]**
Or
Geological evidence for most primitive mammal is found in
(a) Central Africa (b) Central Asia
(c) Australia (d) America

53. When the entire sole rests on the ground during walking as in case of a man, it is known as
(a) Plantigrade (b) Digitigrade
(c) Perikaryon (d) Hallux

54. Largest cranial capacity was found in **[AIIMS 2001]**
Or
Which primitive man resembles with modern man **[CPMT 1995]**
(a) Neanderthal man (b) Cro-Magnon man
(c) Java ape man (d) Peking man

55. The fossils of *Sinanthropus pekinensis* have been discovered in which epoch **[MP PMT 1994]**
(a) Pleistocene (b) Pliocene
(c) Eocene (d) Palaeocene

56. In *Homo habilis*, '*habilis*' refers to **[CPMT 1999]**
(a) Wandering species (b) Ancient man
(c) Modern man (d) Tool maker

57. Which of the following is the correct order of evolutionary history of man **[CBSE PMT 2001]**
(a) *Peking man, heidel berg man, neanderthal, cro-magnon*
(b) *Peking man, homosapiens, cro-magnon, neanderthal*
(c) *Peking man, neanderthal, homosapiens, heidelberg,*
(d) *Peking man, cro-magnon, homosapiens, neanderthal*

58. Which one of the following character differentiate man from other mammals **[RPMT 2000]**
(a) Superior Intelligence (b) Power of speech
(c) Social life (d) Greater cranial capacity

59. Which of the following was the transitional stage (connective link) between apes and humans **[AIIMS 2000; MHCET 2004]**
(a) *Homo habilis* (b) *Homo erectus*
(c) *Australopithecus ramidus* (d) *Australopithecus africanus*

60. Which of the following has the lowest cranial capacity **[AFMC 2000]**
(a) Gorilla (b) Chimpanzee
(c) Modern man (d) Java ape man

61. Ancestor of man who first exhibited bipedal gait **[MP PMT 2000, 09; WB JEE 2009]**
(a) *Australopithecus* (b) Cro–Magnon man
(c) Java ape man (d) Peking man

62. *Homo sapiens* originated how many years ago **[CPMT 1996]**
(a) About $1\frac{1}{2}$ lakh years ago
(b) About 2 lakh years ago
(c) About $2\frac{1}{2}$ lakh years ago
(d) About 3 lakh years ago

63. *Pithecanthropus erectus* fossil was found in **[BHU 1995]**
(a) China (b) Japan
(c) Java (d) Texas

64. Neanderthal man lived in **[MP PMT 1995]**
(a) Desert (b) Deep forest
(c) Mountains (d) Cave

65. In human evolution which is most recent **[MP PMT 1995]**
(a) Middle Paleolithic (b) Upper Paleolithic
(c) Neolithic (d) Mesolithic

66. Which one of the following is direct ancestor of modern man **[CBSE PMT 1996]**
(a) *Australopithecus* (b) *Ramapithecus*
(c) *Homo erectus* (d) *Homo habilis*

NCERT Exemplar Questions

1. Which of the following is used as an atmospheric pollution indicator **[NCERT]**
(a) Lepidoptera (b) Lichens
(c) Lycopersicon (d) Lycopodium

2. The theory of spontaneous generation stated that **[NCERT]**
(a) Life arose from living forms only
(b) Life can arise from both living and non-living
(c) Life can arise from non-living things only
(d) Life arises spontaneously, neither from living nor from the non-living

3. Animal husbandry and plant breeding programmes are the examples of **[NCERT]**
(a) Reverse evolution (b) Artificial selection
(c) Mutation (d) Natural selection

4. Palaentological evidences for evolution refer to the **[NCERT]**
(a) Development of embryo (b) Homologous organs
(c) Fossils (d) Analogous organs

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

6. Analogous organs arise due to **[NCERT]**
(a) Divergent evolution (b) Artificial selection
(c) Genetic drift (d) Convergent evolution

7. $(p+q)^2 = p^2 + 2pq + q^2 = 1$ represents an equation used in **[NCERT]**
(a) Population genetics (b) Mendelian genetics
(c) Biometrics (d) Molecular genetics

8. Appearance of antibiotic-resistant bacteria is an example of **[NCERT]**
(a) Adaptive radiation
(b) Transduction
(c) Pre-existing variation in the population
(d) Divergent evolution

9. Evolution of life shows that life forms had a trend of moving from **[NCERT]**
(a) Land to water (b) Dryland to wet land
(c) Fresh water to sea water (d) Water to land

10. Viviparity is considered to be more evolved because **[NCERT]**
(a) The young ones are left on their own
(b) The young ones are protected by a thick shell
(c) The young ones are protected inside the mother's body and are looked after they are born leading to more chances of survival
(d) The embryo takes a long time to develop

11. Fossils are generally found in **[NCERT]**
(a) Sedimentary rocks (b) Igneous rocks
(c) Metamorphic rocks (d) Any type of rock

12. For the MN-blood group system, the frequencies of M and N alleles are 0.7 and 0.3 respectively. The expected frequency of MN-blood group bearing organisms is likely to be **[NCERT]**
(a) 42% (b) 49%
(c) 9% (d) 58%

13. Which type of selection explains industrial melanism observed in moth, Biston bitularia **[NCERT]**
(a) Stabilising (b) Directional
(c) Disruptive (d) Artificial

14. The most accepted line of descent in human evolution is **[NCERT; NEET (Phase-II) 2016]**
(a) Australopithecus → Ramapithecus → *Homo sapiens* → *Homo habilis*
(b) *Homo erectus* → *Homo habilis* → *Homo sapiens*
(c) Ramapithecus → Australopithecus → *Homo habilis* → *Homo erectus* → *Homo sapiens*
(d) Australopithecus → Ramapithecus → *Homo erectus* → *Homo habilis* → *Homo sapiens*

15. Which of the following is an example for link species **[NCERT]**
(a) Lobe fish (b) Dodo bird
(c) Sea weed (d) Chimpanzee

16. Match the scientists listed under column 'I' with ideas listed Column 'II'

Column I	Column II
A. Darwin	i. Abiogenesis
B. Oparin	ii. Use and disuse of organs
C. Lamarck	iii. Continental drift theory
D. Wagner	iv. Evolution by natural selection

Options **[NCERT]**
(a) A-i, B-iv, C-ii, D-iii
(b) A-iv, B-i, C-ii, D-iii
(c) A-ii, B-iv, C-iii, D-i
(d) A-iv, B-iii, C-ii, D-i

17. In 1953 S. L. Miller created primitive earth conditions in the laboratory and gave experimental evidence for origin of first form of life from pre-existing non-living organic molecules. The primitive earth conditions created include **[NCERT]**

(a) Low temperature, volcanic storms, atmosphere rich in oxygen
(b) Low temperature, volcanic storms, reducing atmosphere
(c) High temperature, volcanic storms, non-reducing atmosphere
(d) High temperature, volcanic storms, reducing atmosphere containing CH_4, NH_3 etc

18. Variations during mutations of meiotic recombinations are **[NCERT]**

(a) Random and directionless
(b) Random and directional
(c) Small and directional
(d) Random, small and directional

Critical Thinking

Objective Questions

1. The 2000 year old seed excavated from King Herod's place at dead sea belong to **[KCET 2015]**

(a) *Dendrocalamus* strictus (b) Lupine articus
(c) *Phoenix dactylifera* (d) Strobilanthus kunthiana

2. If you go back in the history approx. 4500 million years back when atmosphere was reducing the organism were **[CPMT 2001; MP PMT 2001; BVP 2003; BHU 2003]**

(a) Autotroph, aerobic
(b) Chemo-autotroph, anaerobic
(c) Chemo-heterotroph, anaerobic
(d) Heterotroph, anaerobic

3. The ancestors of modern day Frogs and Salamanders are **[KCET 2015]**

(a) Icthyophis (b) Jawless fish
(c) Amphioxus (d) Coelocanth

4. Following are the two statements regarding the origin of life

(A) The earliest organisms that appeared on the earth were non-green and presumably anaerobes
(B) The first autotrophic organisms were the chemoautotrophs that never released oxygen. Of the above statements which one of the following options is **correct** **[NEET (Phase-I) 2016]**

(a) (A) is correct but (B) is false
(b) (B) is correct but (A) is false
(c) Both (A) and (B) are correct
(d) Both (A) and (B) are false

5. Given below are four statements (A-D) each with one or two blanks. Select the option which correctly fills up the blanks in two statements

Statements :

(A) Wings of butterfly and birds look alike and are the results of (i), evolution.
(B) Miller showed that CH_4, H_2, NH_3 and (i), when exposed to electric discharge in a flask resulted in formation of (ii).
(C) Vermiform appendix is a (i) organ and an (ii) evidence of evolution.
(D) According to Darwin evolution took place due to (i) and (ii) of the fittest.

Options **[NCERT; CBSE PMT (Mains) 2010]**

(a) (D) – (i) Small variations, (ii) Survival
(A) – (i) Convergent
(b) (A) – (i) Convergent,
(B) – (i) Oxygen, (ii) nucleosides
(c) (B) – (i) Water vapour, (ii) Amino acids
(C) – (i) Rudimentary, (ii) Anatomical
(d) (C) – (i) Vestigial, (ii) Anatomical
(D) – (i) Mutations, (ii) Multiplication

6. A species that contains two or more sub-species are called

(a) Sibling species (b) Sub-species pool
(c) Polytypic species (d) Biological races

7. Animals living in colder region have shorter tail and ears as compared to the animals living in warmer regions. This phenomenon is called **[CBSE PMT 1996; AMU (Med.) 2009; AFMC 2009, 10]**

(a) Bergman's law (b) Glober's law
(c) Allen's law (d) Jordan's law

8. The characters such as pointed elongated snout, strong and stout forelimbs, well developed claws are observed in _____ adaptation **[MHCET 2015]**

(a) Arboreal (b) Aerial
(c) Cursorial (d) Fossorial

9. Trilobites were evolved during which of the following period **[CPMT 1999; MH CET 2000; BHU 2004]**

(a) Salvian (b) Cambrian
(c) Ordovician (d) Pre-cambrian

10. Which one of the following evidences does not favour the Lamarckian concept of inheritance of acquired characters **[CBSE PMT 1994; BHU 2000; MH CET 2003]**

(a) Melanization in peppered moth in industrial areas
(b) Presence of webbed toes in acquatic birds
(c) Lack of pigment in cave–dwelling animals
(d) Absence of limbs in snakes

11. "In different races, there may be difference in culture and ways of living but capacity in all is the same". It was the opinion of
(a) Darwin (b) Wallace
(c) Lamarck (d) Shapiro

12. Present day mammals have their predecessor in **[Pune CET 1998]**
(a) Therapsids (b) Diapsids
(c) Synapsids (d) Anapsids

13. Adaptation of a species is its **[AIIMS 2001]**
(a) Ecdysis (b) Metamorphosis
(c) Acquired character (d) Hereditary character

14. Which one of the following sequences was proposed by Darwin and Wallace for organic evolution **[CBSE PMT 2003]**
(a) Variations, natural selection, overproduction, constancy of population size
(b) Overproduction, variations, constancy of population size, natural selection
(c) Variations, constancy of population size, overproduction, natural selection
(d) Overproduction, constancy of population size, variations, natural selection

15. In the developmental history of mammalian heart, it is observed that it passes through a two–chambered fish–like heart, three–chambered frog–like heart and finally four–chambered stage. To which hypothesis can this above cited statement be approximated **[CBSE PMT 1998; AIIMS 2007]**
(a) Biogenetic law (b) Hardy Weinberg law
(c) Lamarck's principle (d) Mendelian principle

16. Organisms which obtain energy by the oxidation of reduced inorganic compounds are called **[CBSE PMT 2002]**
(a) Saprozoic (b) Chemoautotrophs
(c) Photoautotrophs (d) Coproheterotroph

17. Some of the important evidences of organic evolution are **[CBSE PMT 2007]**
(a) Occurrence of homologous and vestigeal organs
(b) Occurrene of analogous and vestigeal organs
(c) Occurrence of homologous and analogous organs
(d) Occurrence of analogous organs only

18. Flagella of prokaryotic and eukaryotic cells differ in **[CBSE PMT 2004]**
(a) Microtubular organization and type of movement
(b) Microtubular organization and function
(c) Type of movement and placement in cell
(d) Location in cell and mode of unctioning

19. Indicate the completely correct statement about human races **[CBSE PMT 1994]**
(a) All human races can interbreed but most will produce infertile young ones
(b) Different human races cannot interbreed
(c) Some human races can interbreed
(d) All human races can interbreed and produce fertile offspring

20. Correct sequence of stages in the evolution of the modern man, *(Homo sapiens)*, is **[Pb. PMT 2000; Kerala PMT 2004; CPMT 2010]**
(a) *Neanderthal man, Australopithecus, Cro-magnon man, Homo erectus, modern man*
(b) *Australopithecus, Homo erectus, Neanderthal man, Cro-man, modern man*
(c) *Homo erectus, Australopithecus, Neanderthal man, Cro-magnon man, modern man*
(d) *Australopithecus, Neanderthal man, Cro-magnon man, Homo erectus, modern man*

21. Which one of the following sets represents the correct sequence of the evolution of man **[MP PMT 2001]**
(a) *Kenyapithecus - Australopithecus - Homo habilis - Pithecanthropus - Homo sapiens*
(b) *Kenyapithecus - Australopithecus - Pithecanthropus - Homo habilis - Homo sapiens*
(c) *Australopithecus - Kenyapithecus - Homo habilis - Pithecanthropus - Homo sapiens*
(d) *Pithecanthropus - Australopithecus, Kenyapithecus - Homo habilis - Homo sapiens*

22. In recent years, DNA sequences (nucleotide sequence) of *mt*-DNA and *Y* chromosomes were considered for the study of human evolution, because **[CBSE PMT 2003]**
(a) They can be studied from the samples of fossil remains
(b) They are small, and therefore, easy to study
(c) They are uniparental in origin and do not take part in recombination
(d) Their structure is known in greater detail

23. The early stage human embryo distinctly possesses **[AIIMS 2003]**
(a) Gills (b) Gill slits
(c) External ear (Pinna) (d) Eye brows

24. Select the wrong pair **[Kerala PMT 2007]**
(a) Haldane - Hot dilute soup
(b) Oparin - Protobiont
(c) Fox - Coacervates
(d) Spallanzani - Abiogenesis
(e) Francisco Redi - Biogenesis

25. Which of the following was expert in making tools, weapons, paintings etc **[BHU 2005]**

Or

Who drew excellent pictures of animals in caves, made tools, curved ornaments from ivory stone arrows etc **[MP PMT 1994]**
(a) Java ape man (b) Peking man
(c) Cro-Magnon man (d) Rhodesian man

26. Select the correct match **[MHCET 2015]**
(a) Gibbon – Cercopithecoidea
(b) Lemur – Prosimii
(c) New world monkey – Hominoidea
(d) Tarsier – Anthropoidea

27. Fossil contents of the alimentary canal are termed as
(a) Casts (b) Coprolites
(c) Impressions (d) Trails

28. Species is **[AFMC 2002]**

(a) Population of individuals having same genotypes and phenotypes

(b) A group of individuals inhabiting a geographical area

(c) A group of interbreeding populations

(d) Population of one type

29. Which one of the following statements is correct regarding evolution of mankind **[CBSE PMT 1997]**

(a) Neanderthal man and Cro-Magnon man were living at the same time

(b) Australopithecus was living in Australia

(c) *Homo erectus* is preceded by *Homo habilis*

(d) None of these

30. Match the evolution concepts and their proposers and select the right option

i.	Saltation	A.	Darwin
ii.	Formation of life was Proceeded by chemical evolution	B.	Louis Pasteur
iii.	Reproductive fitness	C.	De vries
iv.	Life comes from pre-existing life	D.	Oparin and Haldane

[Kerala PMT 2012]

(a) i-C; ii-D; iii-A; iv-B (b) i-D; ii-C; iii-B; iv-A

(c) i-D; ii-B; iii-C; iv-A (d) i-B; ii-C; iii-A; iv-D

(e) i-A; ii-D; iii-C; iv-B

31. A potential danger to a population that has been greatly reduced in number is the **[NCERT; J & K CET 2012]**

(a) Hardy-Weinberg disequilibrium

(b) Tendency towards assortative mating

(c) Reduced gene flow

(d) Loss of genetic variability

32. An isolated population of humans with approximately equal numbers of blue-eyed and brown-eyed individuals was decimated by an earthquake. Only a few brown-eyed people remained to form the next generation. This kind of change in the gene pool is called a **[NCERT; J & K CET 2012]**

(a) Hardy-Weinberg equilibrium

(b) Blocked gene flow

(c) Bottleneck effect

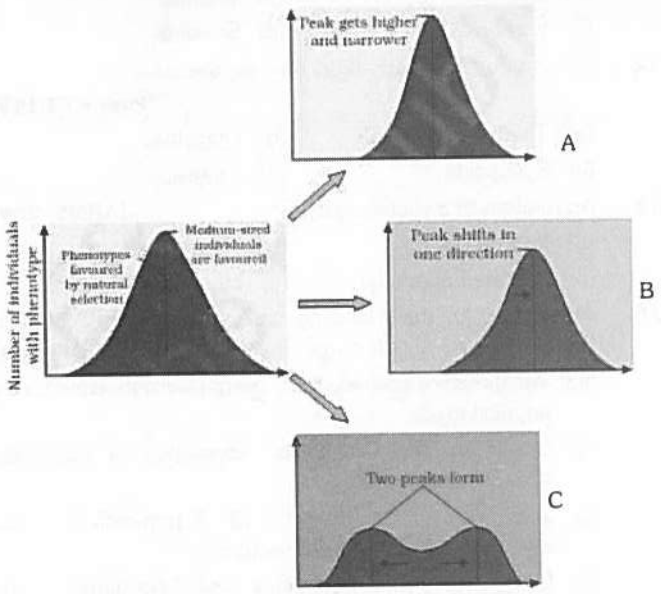
(d) Founder effect

33. The tendency of population to remain in genetic equilibrium may be disturbed by **[NEET 2013]**

(a) Lack of random mating (b) Random mating

(c) Lack of migration (d) Lack of mutations

34. Following diagrammatic representation refers the natural selection on different traits. Choose the right option in which all the three graphs A, B and C are identified correctly **[NCERT]**



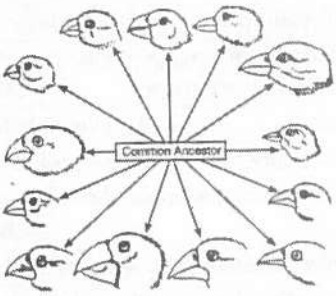
(a) A - Directional, B - Disruptive, C - Stabilising

(b) A - Stabilising, B - Disruptive, C - Directional

(c) A - Stabilising, B - Directional, C - Disruptive

(d) A - Directional, B - Stabilising, C - Disruptive

35. The diversity within the wild bird species in the given figure can best be explained by which process **[NCERT]**



(a) Natural selection (b) Adaptive radiation

(c) Ecological succession (d) Both (a) and (b)

36. A molecule that can act as a genetic material must fulfill the traits given below, except **[NEET (Phase-II) 2016]**

(a) It should provide the scope for slow changes that are required for evolution

(b) It should be able to express itself in the form of 'Mendelian characters'

(c) It should be able to generate its replica

(d) It should be unstable structurally and chemically

37. Interspecific hybridization in the mating of **[NEET (Phase-II) 2016]**

(a) More closely related individuals within same breed for 4-6 generations

(b) Animals within same breed without having common ancestors

(c) Two different related species

(d) Superior males and females of different breeds

38. Which of the following is the correct sequence of events in the origin of life **[NEET (Phase-II) 2016]**

I. Formation of protobionts
II. Synthesis of organic monomers
III. Synthesis of organic polymers
IV. Formation of DNA-based genetic systems

(a) II, III, IV, I (b) I, II, III, IV
(c) I, III, II, IV (d) II, III, I, IV

A R Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below :

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion
(c) If the assertion is true but the reason is false
(d) If both the assertion and reason are false
(e) If the assertion is false but reason is true

1. Assertion : We have lost all the direct evidences of origin of life.
Reason : The person responsible to protect the evidences were not skilled. **[AIIMS 1998]**

2. Assertion : *Ginkgo biloba* is a living fossil.
Reason : Organism which have persisted and remain unchanged for the past several million years while their relative disappeared. **[AIIMS 2000]**

3. Assertion : Leaf butterfly and stick insect show mimicry to dodge their enemies.
Reason : Mimicry is a method to acquire body colour blinding with the surroundings. **[AIIMS 2003, 09]**

4. Assertion : Natural selection is the outcome of difference in survival and reproduction among individuals that show variation in one or more traits.
Reason : Adaptive forms of a given trait tend to become more common; less adaptive ones become less common or disappear. **[AIIMS 2004]**

5. Assertion : Coacervates are believed to be the precursors of life.
Reason : Coacervates were self-duplicating aggregates of proteins surrounded by lipid molecules. **[AIIMS 2004, 08]**

6. Assertion : From evolutionary point of view, human gestation period is believed to be shortening.
Reason : One major evolutionary trend in humans has been the larger head undergoing relatively faster growth rate in the foetal stage. **[AIIMS 2004]**

7. Assertion : Cell like aggregates of complex organic compounds are called coacervates.
Reason : Coacervates have power to grow and divide.

8. Assertion : The modern horse evolved during pliocene epoch.
Reason : It arose from Pliohippus.

9. Assertion : Homologous organs have common ancestry and similar function.
Reason : Analogous organs have unlike origin and dissimilar function.

10. Assertion : New world and old world monkeys are alike.
Reason : Old world monkeys are closer to man.

11. Assertion : The theory of survival of the fittest is widely misunderstood.
Reason : Evolution does not always increase the chances of a species survival and species do not survive when such chances happen rapidly. **[EAMCET 2009]**

12. Assertion : All primates have a common ancestry.
Reason : The most primate was shrew like animals.

13. Assertion : Most evolutionary trees place information about the pattern of relationship among organisms on the vertical axis and information about time on the horizontal axis.
Reason : An evolutionary tree depicts the pattern of relationships among parents and their offsprings. **[AIIMS 2009]**

14. Assertion : Chimpanzee is the closest relative of present day humans.
Reason : The banding pattern in the autosome number 3 and 6 are remarkably similar. **[AIIMS 2009]**

15. Assertion : *Dryopithecus africans* is a common ancestor of man and great apes.
Reason : It gave rise to *Ramapithecus*.

16. Assertion : Cro-magnon man has more intelligence than the man of present time.
Reason : He is regarded as most recent ancestor of today's man.

17. Assertion : Mutations cause evolution.
Reason : Ancon sheep and hornless cattle are developed by inducing mutation.

18. Assertion : Darwin's finches show a variety of beaks suited for eating large seeds, flying insects and cactus seeds.
Reason : Ancestral seed-eating stock of Darwin's finches radiated out from South American mainland to different geographical areas of the Galapagos Islands, where they found competitor-free new habitats. **[AIIMS 2005]**

19. Assertion : Geographic isolation brings about sympatric speciation.
Reason : Reproductive isolation brings about allopatric speciation.

20. Assertion : *Homo habilis* was the first tool maker.
Reason : He was cave-dweller.

21. Assertion : Formation of new species is called speciation.
Reason : The deme has a common gene pool.

22. Assertion : Comparative biochemistry provides a strong evidence in favour of common ancestry of living beings.
Reason : Genetic code is universal. **[AIIMS 2005]**

23. Assertion : Atavism is the reappearance of disappeared ancestral characters.
Reason : Third molars and hair on body are examples of atavism.

24. Assertion : Evolution of man is the example of progressive evolution.
Reason : Tapeworm is developed due to retrogressive evolution.

25. Assertion : Human ancestors never used their tails and so the tails expressing gene has disappeared in them.
Reason : Lamarck's theory of evolution is popularly called theory of continuity of germ plasm. **[AIIMS 2005, 08]**

26. Assertion : Petrified fossils contain hard parts of organisms.
Reason : Moulds and casts lack the remains of organisms.

Answers

Origin of Life

1	a	2	b	3	a	4	d	5	a
6	a	7	b	8	a	9	b	10	a
11	c	12	b	13	c	14	a	15	a
16	a	17	b	18	a	19	b	20	c
21	d	22	a	23	c	24	a	25	a
26	a	27	d	28	a	29	b	30	a
31	b	32	a	33	a	34	d	35	a
36	a	37	c	38	a	39	c	40	b
41	d	42	d	43	b	44	c	45	c
46	a	47	d	48	d	49	b	50	a

Organic Evolution and Speciation

1	c	2	d	3	c	4	b	5	a
6	a	7	b	8	b	9	b	10	d
11	b	12	b	13	e	14	a	15	a
16	b	17	b	18	b	19	b	20	a
21	c	22	d	23	c	24	d	25	d
26	c	27	d	28	a	29	c	30	d
31	b	32	b	33	a	34	a	35	b
36	c	37	d	38	c	39	b	40	c
41	a	42	a	43	d	44	a	45	d
46	b	47	c	48	d	49	b	50	a
51	b	52	c	53	c	54	d	55	b
56	b	57	c	58	c	59	b	60	b
61	a	62	d	63	d	64	d	65	b
66	c								

Evidences of Evolution

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

Lamarckism

1	a	2	c	3	d	4	c	5	d
6	a	7	b	8	a	9	c	10	b
11	a								

Darwinism

1	d	2	b	3	a	4	b	5	a

6	b	7	c	8	a	9	d	10	a
11	c	12	c	13	b	14	a	15	d
16	d	17	c	18	b	19	d	20	b
21	d	22	b	23	d	24	b	25	b
26	c	27	a	28	a	29	a	30	c
31	a	32	a	33	b	34	d	35	c
36	b	37	c	38	d	39	d	40	a
41	c	42	b	43	d	44	a	45	a
46	d	47	c	48	b	49	c	50	c
51	d	52	a	53	c				

Evolution of Man

1	c	2	a	3	b	4	a	5	b
6	d	7	b	8	b	9	b	10	b
11	c	12	a	13	d	14	b	15	d
16	d	17	c	18	a	19	b	20	a
21	d	22	c	23	a	24	c	25	b
26	b	27	c	28	a	29	d	30	a
31	b	32	d	33	d	34	c	35	b
36	a	37	b	38	a	39	a	40	c
41	a	42	b	43	b	44	b	45	b
46	d	47	d	48	b	49	d	50	b
51	d	52	a	53	a	54	b	55	a
56	d	57	a	58	d	59	c	60	b
61	a	62	a	63	c	64	d	65	c
66	c								

NCERT Exemplar Questions

1	b	2	c	3	b	4	c	5	b
6	d	7	a	8	c	9	d	10	c
11	a	12	a	13	b	14	c	15	d
16	b	17	d	18	a				

Critical Thinking Questions

1	c	2	c	3	d	4	c	5	a
6	c	7	c	8	d	9	b	10	c
11	b	12	a	13	d	14	d	15	a
16	b	17	a	18	a	19	d	20	b
21	a	22	c	23	b	24	d	25	c
26	b	27	b	28	c	29	c	30	a
31	d	32	c	33	a	34	c	35	d
36	d	37	c	38	d				

Assertion and Reason

1	c	2	a	3	a	4	a	5	c
6	d	7	b	8	e	9	d	10	e
11	a	12	b	13	d	14	a	15	b
16	b	17	b	18	a	19	d	20	b
21	b	22	b	23	c	24	b	25	d
26	b								

Answers and Solutions

Origin of Life

12. (b) Charles Darwin (1809-1882) was an English naturalist. In 1831, Darwin got an opportunity to travel on *H.M.S.* Beagle (a ship in which Charles Darwin sailed around the world) for a voyage of world exploration.
Alfred Russel Wallace (1823-1913), another English naturalist, also travelled widely and studied the fauna and flora of South America and South East Asia. Evolutionary ideas similar to those of Darwin developed in Wallace's mind. The thinking of both Darwin and Wallace in respect of organic evolution was similar. In 1859, Wallace's paper and a summary of Darwin theory together appeared in the Journal of the proceeding of Linnean Society. Finally in 1859, Darwin published his observations and conclusions under the name "Origin of species by Natural Selection".

15. (a) Earth came into existence about 4.6 billion years ago from a large spinning cloud of gas and dust.

30. (a) Protobionts are prebiotic chemical aggregates having one or more properties of living systems. Process of aggregation of organic molecules is called coacervation. It produced three types of protobionts – coacervates, microspheres and vesicles. Coacervates are reversible emulsoid aggregates consisting of protein and polysaccharide with some water.

41. (d) Abiogenesis or spontaneous creation or Autobiogenesis was proposed by von Helmont (1577-1644) and state that life originated abiogenetically from non living materials by spontaneous generation about 3.5 billion years ago.

42. (d) Father Suarez was a strong believer (supporter) of the theory of special creation. He believed that whole life on earth was formed in 6 days.

43. (b) The spark discharge glass apparatus was designed by Miller and Urey to show that simple organic compounds could be formed in nature from the inorganic molecules.

44. (c) Coacervates are the colloidal aggregates of large complex organic molecules capable of growth and division.

45. (c) George Cuvier and orbigne were the chief supporter of theory of catastrophism. It states that there had been several creations, each preceded by a catastrophs due to some geological disturbances like volcanic erruptions, upheaveling of earth; unprecended increase in sea level etc.

47. (d) Oparin and Sydney Fox held that large organic molecules synthesized abiotically on primitive earth later came together spontaneously and due to intermolecular attraction, formed large colloidal aggregates called coacervates.

49. (b) Big bang theory was proposed by Lemaitre in 1931.

Organic Evolution and Speciation

2. (d) Hardy Weinberg equilibrium is applicable for randomly mating populations only.

5. (a) Process of evolution of different species in a given area starting from a point and radiating to other area of geography (habitats) is called adaptive radiations
Example : Darwian's finches
Australian marsupials.

7. (b) Seas form the barriers to free intercontinental movement and separates the continents, causing evolution and endemism. Endemic species are those species which are in a restricted area.

17. (b) Microevolution is the development of minute changes due to gene mutations and recombinations. These changes occur below the level of species.

18. (b) Darwin gave Natural selection theory, Hugo de Vries proposed mutation theory of evolution, Lamarck proposed theory of inheritance of acquired characters and Huxley said that the birds are glorified reptiles.

21. (c) Environmental variations are those variations which are merely due to environment. These variations are temporary and have nothing to do with the next generation. Hereditary variations are those variations which transfer to next generation. Discontinuous variations are sudden changes in organism which are also heritable.

30. (d) Inclusive fitness theory is proposed by Hamilton.
Lamarck proposed theory of inheritance of acquired characters and theory of use and disuse of organs.
Darwin proposed theory of natural selection. Weismann proposed theory of continuity of germplasm.

33. (a) The earliest known bird in fossil record is *Archaeopteryx lithographica*, meaning ancient wing. It dates back to late jurassic period about 140 million years ago. It was discovered in a slate quarry at Langenaltheim, Bavaria (Germany) in 1861 by Andreas Wagner. A second skeleton was discovered in 1877 and third in 1956 from the same locality.

39. (b) According to Lotsy (1918) a species is a group of genetically identical individuals.

43. (d) Modern concept of evolution depends mainly upon genetic variations involving mutation and gene recombination, natural selection, speciation and reproductive isolation.

46. (b) Biological species concept states that the members of the same species are reproductively compatible but are reproductively isolated from other species.

59. (b) Miller and Urey performed an experiment to demonstrate that simple organic compounds could be formed in nature from inorganic molecules.

63. (d) These are the isolating mechanisms involved in the premating reproductive isolation.

Evidences of Evolution

4. (a) Homologous structures are similar because they have been inherited from a common ancestor. For example, forelimbs of dog and camel, have both evolved from a common ancestral mammal.

9. (a) Divergent evolution : Bones of forelimbs of vertebrates
Convergent evolution : Eyes of octopus and mammals.

12. (b) Mesozoic era is also known as the 'age of reptiles'. It is believed that mass extinction at the end of mesozoic era was probably due to the collision of earth with meteorites.

15. (d) Radioactive carbon C^{14} has a shorter half life period. This carbon is present in all the fossils.

16. (cd) Wings of bat are skin folds stre tched mainly between elongated finger but the wings of birds are a feather covering all along the arm. They look similar because they have a common use for flying, but their origin are not common. This makes them analogous characteristics rather than homologous characteristics.

25. (d) Homologous organs are those organs which have the same origin and similar basic structure but may differ in external appearance and function. Wings of birds and pectoral fins of fishes are an example of the homologous organs.

26. (d) Man-like apes gave rise to primitive man-like forms, the hominids in the Pliocene epoch.

28. (a) Connecting link is the intermediate form of organism between two groups of organisms.
Example : *Neopilina* is a connecting link between Annelida and Mollusca.

29. (a) All are modified forelimbs, with the same types of bones, they have become different due to adaptation to habitat.

30. (c) Cretaceous period of Mesozoic era occurred on earth about 65-146 million years ago. During this period, the flowering plants appeared and became dominant, mass extinctions of marine life and some terrestrial life, including dinosaurs occurred and modern continents became well separated.

31. (b) Analogous organs have different embryonic origin but perform similar functions. These organs are developed in organisms, widely different phylogentically due to similar habitats and modes of life.
Example : Wings of insects, birds and bats.

34. (b) *Limulus* is a living arthropod.

42. (c) Genetic drift or Sewall Wright effect is an important mechanism in evolutionary change in small populations. In a small population not all the alleles which are representative of that species may be present. Therefore, chance events may result in the elimination of that allele from population.

44. (b) Coenozoic era – Age of mammals.
Mesozoic era – Age of reptiles.
Palaeozoic – Age of ancient life
Azoic era – Complete absence of living organism.

46. (c) Atavism or reversion is the sudden reappearance of some ancestral features.

47. (d) The forelimbs of aquatic mammals like whales & seals are modified into flippers for swimming.

49. (c) Parallel evolution is the independent development of similar characteristics in two related groups of organisms in response to similar requirements or environmental influences.

59. (c) Sedimentary rocks are formed by the settling of the sediments of the rain water and has a fair chance of trapping the organisms in it for fossilization.

65. (a) Himalayan mountain ranges separate *Palaearctic* and *Oriental* zoogeographical regions.

66. (d) *Peripatus* is a connecting link between annelida and arthropoda.

67. (d) Homologous organs are found in forms showing adaptive radiation from a common ancestor, so these give evidence of divergent evolution.

71. (c) Pectoral fins of rohu and fore limbs of horse have similar origin and basic structure, hence these are homologous organs.

72. (d) *Archaeopteryx* is the connecting link between birds and reptiles. It shows that birds have been evolved from reptilian ancestors. As per Huxley "Birds are the glorified reptiles".

74. (c) 'Wisdom teeth' are third molars of our dentition. Being useless, these are poorly developed and vestigeal.

81. (c) The wings of an insect are analagous to wings of bird and bat. It is due to the fact that the basic structure of wings of the insect is different from the wings of bird and bat. However their function is similar.

85. (d) The study of fossils is known as palaeontology. Fossils are the remains or impressions of the hard parts of the past individuals in the strata of the earth. Fossils are studied for tracing evolutionary history of organisms and studying extinct organisms.

86. (a) Homologous organs are similar in structure and origin but not necessarily in function. Hence, organs from different species having a similar basic form, microscopic structures, body position and embryonic development are said to be homologous.

87. (d) Wings of pigeon, mosquito and bat perform same function (flying) but have evolved from separate ancestral populations. This similarity developed in distantly related groups as an adaptation for same function is called convergent evolution.

88. (d) It acts as connecting link between Annelids and Arthropods. Like annelids, it has continuous muscle layers in the body wall, unjointed leg like parapodia, nephridia for excretion and simple gut. Main arthropod characters are claws on the legs, haemocoel, tracheae for respiration, dorsal hearts with ostia etc.

90. (b) Vestigeal organs are those which occur in reduced form and are useless. But nails are the derivatives of epidermis, involving keratin and are protective in function.

93. (a) The dominant animals during the Jurassic period were dinosaurs.

94. (a) Archaeopteryx, intermediate between reptiles and birds, originated towards the close of Jurassic period.

Lamarckism

6. (a) Jean Baptiste de Lamarck proposed "theory of inheritance of acquired characters" or populary known as "use and disuse" theory.

8. (a) Jean Baptiste Lamarck (1744–1829), a French biologist putforth his views on the evolution of life as a theory of *'inheritance of acquired characters'* in his book *'Philosophic Zoologique'* (1809).

Darwinism

2. (b) Alfred Russel Wallace (1823–1913) was contemporary to Darwin. He independently proposed theory of natural selection and origin of species.

4. (b) In 1831, Darwin got an opportunity to travel by *H.M.S.* Beagle for a voyage of world exploration, planned by British Admiralty. The voyage lasted for five years.

5. (a) Carrion are dead bodies. No finches feed on carrion.

30. (c) Directional selection is the natural selection that favours the establishment of one particular advantageous mutation within a population, resulting in a change in phenotype in that direction.

33. (b) Darwinism could not explain the origin of adaptive characters. Neo–Darwinism could explain the sources of variability.

37. (c) According to both the views, 'something' is passed from parent to offspring, which causes development of specific characters, i.e., all that has been acquired by the organism during its lifetime is preserved by generation and transmitted to offsprings in form of pangenes or gemmules.

42. (b) Patagia or wings are used for flying. So, the animals possessing patagia exhibit volant or flight adaptations.

45. (a) Darwin supported his 'Natural selection Theory' on the basis of continuous variation inspite of discontinuous variation.

46. (d) Industrial melanism is an adaptation where the moths living in the industrial areas develop melanin pigments to match their body to the soot covered surroundings.

49. (c) Prototherians the most primitive mammals which provide an evidence of organic evolution from geographical distribution are found is Australia.

50. (c) There are thirteen types of finches described by Darwin. They are geographically isolated and found in Galapagos Islands of south pacific.

51. (d) Development of different functional structures from a common ancestral form is called adaptive radiation.

These are –

1. Darwin's finches of the Galapagos Islands.
2. Australian Marsupials.
3. Limbs of mammals.

53. (c) Neo-Darwinism has emerged out as the 'modern synthetic theory of evolution. It designated by Huxley (1942).

Dobzhansky's (1937) book "Genetics and the origin of species" provided the initial basis of this theory and Muller (1949), Fisher (1958), Wright (1968), Mayr (1963, 70) Stebbins (1966-76) etc. helped significantly in its formulation.

Evolution of Man

1. (c) Brain capacity of *Homo habilis* was 650-800 CC while *Homo erectus* showed 900 CC; *Homo neanderthalensis* showed 1400 CC; *Homo sapiens* showed 1450 CC cranial capacity.

3. (b) Actual name of this fossil was *Pithecanthropus erectus*. This was classified under *Homo erectus*.

5. (b) 'Peking man' is also known as *Homo erectus pekinensis* or *Sinanthropus pekinensis*.

19. (b) It had a cranial capacity of about 940*c.c.*

20. (a) Anthropometry refers measurement of human traits like length of limbs, stature, body weight, etc. in human population and human ancestors. It is of great use in the study of human evolution.

26. (b) Pliocene is the epoch of tertiary period of coenozoic era. Man was originated in this era.

27. (c) Neanderthals were the first human beings who believed in the immortality of soul, and practised ceremonial burial.

29. (d) The modern man differs from the apes in arms shorter than legs, in apes the arms are used in locomotion, called branchiation this is a type of suspension and swinging of the body.

32. (d) The cranial capacity of Java man (*Homo erectus erectus*) is 900 c.c. The cranial capacity of peking man (*Homo erectus pekinesis*) is 1075 c.c. The cranial capacity of handy man (homo habilis) is 700 c.c. and the cranial capacity of modern man (*Homo sapiens sapiens*) is 1400 – 1450 c.c.

33. (d) The chromosomes of man and chimpanzees are quite similar. The number of chromosomes in chimpanzee is 48 and in man is 46, which become reduce due to fusion of 2 chromosomes.

34. (c) *Australopithecus* fossils were discovered in 1920 by Prof. Raymond from taunqs in South Africa.

38. (a) The closest relative of modern man is considered to be Chimpanze on the basis of :

(i) Similar banding pattern in 3rd and 6th chromosome.
(ii) Similar blood groups (ABO)
(iii) Similar blood proteins.

40. (c) Cro-magnon man (*Homo sapiens fossilis*) is the direct ancestor of modern man. Its fossil remains were found in 1864 from rock shelters caves in France. More fossils were later found from caves of North-West Italy, Poland, Checoslovakia and France.

42. (b) Their brain capacity ranged from 450-600 *c.c* or slightly above.

48. (b) Ramapethicus belongs to Pliocene epoch, so it is the most primitive ancestor of man.

49. (d) Biological name of Java man is *Homo erectus erectus* or *Pithecanthropus erectus*.

59. (c) *Australopithecus ramidus* is the most ape-like hominid ancestor and is considered to be missing link between hominids and apes.

60. (b) The cranial capacity of chimpanzee is 400 *cc*.

63. (c) Its fossils (some teeth, skull cap and femur bone) were found in 1891 by a Dutch anatomist, Eugene *Dubois* on the bank of Solo river in Eastern Java.

Critical Thinking Questions

2. (c) The first living organisms developed in reducing atmosphere were chemo-heterotrophs as they required ready-made organic materials as food and anaerobes as they were capable of respiration in the absence of oxygen.

5 (a) According to Darwin, evolution took place due to small variations and survival of the fittest. Wings of butterfly and birds are analogous or convergent. Vermiform appendix is vestigial organ.

6. (c) Species having more than one subspecies are called Polytypic species, while the species having no subspecies are called monotypic species.

7. (c) According to Allen's Law : The extremities such as tail and pinnae become smaller in animals living in cold climate.

9. (b) Trilobites and brachiopods were the most abundant animals evolved during the cambrian period. They become extint in permian period.

19. (d) Human races are sub–divisions of a single species, therefore they are capable of interbreeding.

23. (b) Possession of pharyngeal gill slits and gill pouches is one of the three diagnostic characters of chordates. So, these structures do appear in the embryonic stages of all vertebrates.

28. (c) Species are the groups of individuals that sexually interbreed or are potentially interbreeding form.

36. (d) A molecule which is unstable structurally and chemically cannot act as a genetic material

Assertion and Reason

1. (c) During the profound changes that have been taking place since the remote past we have lost the direct evidences of origin of life. Due to these changes, the scientists, though skilled were not able to protect the evidence.

2. (a) *Ginkgo biloba* is a living fossil because its ancestors are unchanged for the last many hundred years while its relative disappeared.

3. (a) Mimicry is the resemblance of one organism to another or to any natural object for the purpose of concealment, protection or for some other advantages. It is found in *Iguana, Chameleon* (girgit), leaf butterfly and stick insect.

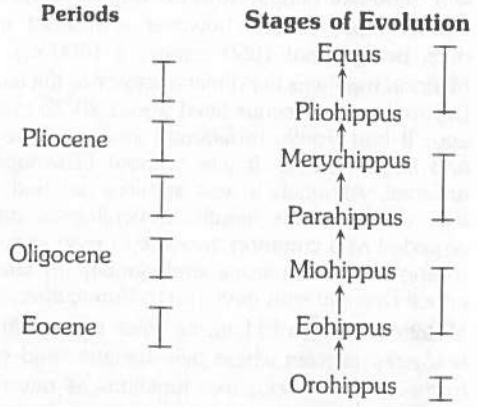
4. (a) The Darwin Wallace theory of Natural Selection can be generalised as the change in species by the survival of an organismal type exhibiting a natural variation that gives it an adaptive advantage in an environment. Thus leading to a new environmental equilibrium. The idea of the survival of the fittest explain the above evolution by natural selection. According to survival of fittest, some of the variations exhibited by living things make it easier for them to survive and reproduce thus more adaptive forms increase. Those which are not fit (or less adaptive) become eliminated.

5. (c) Oparin and Sydney Fox held that large organic molecules synthesised abiotically on primitive earth and formed large colloidal aggregates due to intermolecular attraction. These colloidal particles were called coacervates. In coacervates, lipid molecules are joined end to end forming a layer around each aggregate. This represents a single lipid membrane. Coacervates divide by budding like bacteria.

6. (d) As the humans would require more gestation period (should have been 21 months as compared to 9 months and will increase). Similarly the head size is increasing (especially the frontal brain) hence growth rate needs to increase but surprisingly most of the brain growth occurs after birth till 2 years (when the anterior fontanellae close at 18 months) and some more till 30 years when finally the cranial sutures close. Thus an increase in brain/skull size would require increase in gestation period.

7. (b) Oparin reported that if a mixture of a large protein and a polysaccharides is shaken, coacervates are formed. The core of these coacervates was mainly formed of protein, polysaccharides and some water and was partially isolated from the surrounding aqueous solution having lower amount of proteins and polysaccharides. Coacervates could grow by absorbing materials from outside and could increase in number by budding.

8. (e) *Equus* is the modern horse which arose from *Pliohippus* in pleistocene epoch. *Pliohippus*, the pliocene horse, evolved from *Merychippus* in pliocene epoch about one crore years ago.



9. (d) Homologous organs are those which have the same essential structure, which they inherit from common ancestors though they may be very differently modified in adaptation to different functions.

Analogous organs are structurally different organs which get modified to perform similar functions.

10. (e) The new world monkey's possess a flat nose with widely separated and outwardly directed nostrils. Their tail is long, sensitive and prehensile for grasping the branches of trees, but their limbs cannot be used for grasping the branches of trees, because of non-opposable thumbs and mostly clawed digits. The Old world monkeys posses a narrow nose with closely placed and downwardly directed nostrils. Their tail is generally short and not prehensile, but their limbs having opposable thumbs and nailed digits, are well adapted for grasping. They are closer to man as they have better developed brain, smaller ear pinnae, sensitive finger tips, presence of both rods and cones in the retina of eyes etc.

11. (a) A species composed of only a few organisms has limited genetic variation and mating possibilities. Should conditions for survival change and should some of these organisms die due to their lack of characteristics that could accommodate that change the species would become smaller over time and could eventually die out.

12. (b) All primates have a common ancestry (monophytic origin). Primate evolution began 80-100 million years ago. The evolutionary history of eutherian mammals dates back to early cretaceous period. The earliest eutherians were shrew-like terrestrial insectivores. They were small, ground dwelling mammals.

13. (d) An evolutionary tree depicts the pattern of relationships among major groups of organisms. Most evolutionary trees place information about the pattern of relationships among organisms on the horizontal axis and information about time on the vertical axis.

14. (a) Banding pattern of chromosome is the direct evidence that chimpanzee is human's closest relative.

15. (b) Cro-Magnon man emerged about 34000 years ago. Thus it is regarded as most recent ancestor of today's man. It has, therefore, been called as *Homo sapiens fossilis*. The Cro-Magnon man was like us, about 1.8 meters tall, well-built body. Its face was perfectly orthognathous with a narrow elevated nose, broad and arched forehead, moderate brow-ridges, strong jaws with man-like dentition and a well developed chin. Its cranial capacity was, however somewhat more than ours, being about 1650 cc(ours is 1400 cc). The Cro-Magnon man was the direct ancestor of the living man.

16. (b) *Dryopithecus africanus* lived about 20-25 million years ago. It had frontly broadened jaws, semierect posture and large canines. It was without browridges. It was arboreal. Although it was ape-like but had arms and legs of the same length. *Dryopithecus africanus* is regarded as a common ancestor of man and great apes (orangutan, chimpanzee and gorilla). In late Miocene epoch *Dryopithecus* gave rise to *Ramapithecus*.

17. (b) Mutation theory of Huge de Vries states that evolution is a jerky process where new varieties and species are formed by mutations that functions as raw material of evolution. A number of mutations have appeared in the past. Mutations are also induced. Ancon sheep is a short legged variety which appeared suddenly in Massachusetts in 1971. Hornless cattle developed as mutation from the horned cattle in 1889.

18. (a) Darwin finches are an excellent example of the way in which the species gene pools have adapted in order for long term survival via their offspring. Finches were formed due to divergent evolution (Adaptive radiation) to avoid interspecific competition.

The common birds of Galapagos islands, the finches were markedly different from the finches of main land. The closely related species of finches had beak of different shapes and sizes, and adapted for feeding on completely different diets. Darwin also found that fossils of Galapagos islands are most similar to living species of South America. The food supply increases in arithmetic ratio but the population increases in geometric ratio. With the study of this theory it struck to Darwin that there is struggle for existence among plants and animals.

19. (d) In allopatric speciation (species formation), a part of the population becomes geographically isolated from the main population. The population becomes entirely separated and finally constitutes a new species. In sympatric speciation, a small segment of the original population becomes isolated reproductively. As the isolating mechanism comes into force, a new subspecies emerges. In due course of time a new species is formed.

20. (b) *Homo habilis* was the first tool maker and used tools of chipped stones extensively. It is also called handy man because heaps of tools found with these fossils included sharpened stones which indicates that *Homo habilis* was capable of "making tools". He also led community life in caves and greatly cared for the young ones.

21. (b) The phenomenon of development of a new species from pre-existing one is called speciation. A species is a collection of demes. The deme is a groups of populations with a common gene pool.

22. (b) Convincing evidence of common ancestry comes from the similarities in the biochemical composition, reactions and physiological activities of living beings, like metabolic process, enzymes, cytochrome *C*, insulin, haemoglobin, blood and lymph etc. Genetic code is the sequence of DNA nucleotides that determines the amino acid sequence of the translated protein. The genetic code is read in triplets of bases called codons.

Genetic code is applicable universally *i.e.* a codon specifies the same amino acid from a virus to a tree or human beings. The *m*RNA from chick oviduct introduced in *E. coli* produces an ovalbumen in the bacterium exactly similar to one formed in chick.

23. (c) Atavism is the appearance of certain ancestral characters which had either disappeared or were reduced. There are present some examples of atavism in human being, viz., the power of moving pinna in some persons, greatly developed canine teeth, exceptionally long dense hairs, short tail in some babies and presence of additional mammae in some individuals. Third molars and hair on the body are examples of vestigeal organs.

24. (b) Progressive evolution is the formation of more complex specialized organisms from simple and less elaborate forms. Examples : evolution of amphibians from fish like ancestors and evolution of birds and mammals from reptile-like ancestors. Retrogressive evolution is the formation of simple and less elaborate forms from more complex and specialized ones. Example : evolution of many parasitic organisms like tape worm which does not have digestive system. It absorbs food through body surface.

25. (d) If humans share ancestry with other primates, then we should expect to see remnants of that common ancestry in our genes. For example, tails. This characteristic is still exhibited occassionally in atavism. According to current evolutionary theory, the ancestors of humans lost their tails about 25 million years ago, when apes (tail-less primates) diverged from monkeys (tailed primates). Theory of the continuity of the germplasm was given by Weismann.

26. (b) Replacement of organic parts by mineral deposits is called petrification. Fossils formed through petrification are termed petrified fossils. These fossils consists of only the hard parts of extinct organisms. Moulds of hardened and fossilized mud that surrounded an extinct individuals have been found. In most cases, the buried individuals have been completely destroyed, but the moulds have retained true copies of their shapes. Sometimes, a mould is found with petrified fossil of the individual also. Such fossils are termed as casts.

Evolution

SET Self Evaluation Test

1. Geologically one of the following eras is known as "*Golden age of Reptiles*" or "*Golden age of Dinosaurs*"
[CBSE PMT 1994, 2002; CPMT 1996, 2003, 05, 10; Pb. PMT 2000; BVP 2000, 02, 04; Kerala CET 2003; Haryana PMT 2005; J & K CET 2005, 08; MP PMT 2007; VITEEE 2008]
(a) Mesozoic (b) Cenozoic
(c) Palaeozoic (d) None of the above

2. How many years are considered in one minute in Geological clock **[GUJCET 2015]**
(a) 52,000 years (b) 1, 87,500,000 years
(c) 3, 25,000 years (d) 1, 90,000 years

3. Species diversity generally increases as one proceeds from **[CBSE PMT 1994; AMU (Med.) 2006]**
(a) Low altitude to high altitude, and from low latitudes to high latitudes
(b) High altitude to low altitude, and from low latitudes to high latitudes
(c) High altitude to low altitude, and from high latitudes to low latitudes
(d) Low altitude to high altitude, and from high latitudes to low latitudes

4. What is correct **[AIIMS 2009, 11]**
(a) Natural selection is responsible for extinction of dinosaurs
(b) Lion and Leopard have convergent evolution
(c) *Homo habilus* and *Homo erectus* are closely related
(d) *Biston betularia* shows cryptic camouflage

5. To be evolution of successful, a mutation must occur in
(a) Germplasm DNA (b) Somatoplasm DNA
(c) RNA (d) Cytoplasm

6. Hardy and weinberg principle explains **[DPMT 2006; AIIMS 2010]**
(a) Genetic equilibrium (b) Non random mating
(c) Evolutionary force (d) All of the above

7. In case of evolution which of the following statement is not correct **[Odisha PMT 2002]**
(a) Fossilized animals provide important information to trace evolution
(b) Wing of birds and forelimbs of cows are homologous
(c) In higher animals early development stages are similar
(d) Variation among individuals are not important in natural selection

8. Homeostasis is **[CBSE PMT 1991]**
(a) Disturbance in regulatory control
(b) Tendency to resist internal changes
(c) Plant and animal extracts used in homeopathy
(d) A tendency to change with change in environment

9. What does the term 'reproductive isolation' refers to **[AIIMS 2010]**
(a) An individual is unable to fertilise itself
(b) Genes are not exchanged between two populations
(c) Individuals from two population never mate
(d) Individuals from two populations never produce offsprings

10. When two related populations occupy geographically or spatially separate areas, they are called **[Kerala PMT 2007; J & K CET 2010]**
Or
The organisms separated by geographical barriers are termed **[NCERT]**
(a) Allopatric population (b) Quantum population
(c) Saltational population (d) Parapatric population
(e) Sympatric population

11. Major radiation of mammals birds and pollinating insects took place in which epoch **[Kerala PMT 2006]**
(a) Oligocene (b) Eocene
(c) Pliocene (d) Paleocene
(e) Miocene

AS Answers and Solutions

1	a	2	d	3	c	4	d	5	a
6	a	7	d	8	b	9	b	10	a
11	d								

3. (c) The environmental conditions in these region are favourable and hence species have become diversified.

5. (a) The mutations which occur in germplasm DNA are heritable and natural selection becomes active over such mutations.

7. (d) Since variations, which help the organisms in adaptations, are selected by nature and form the basis of evolution.

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